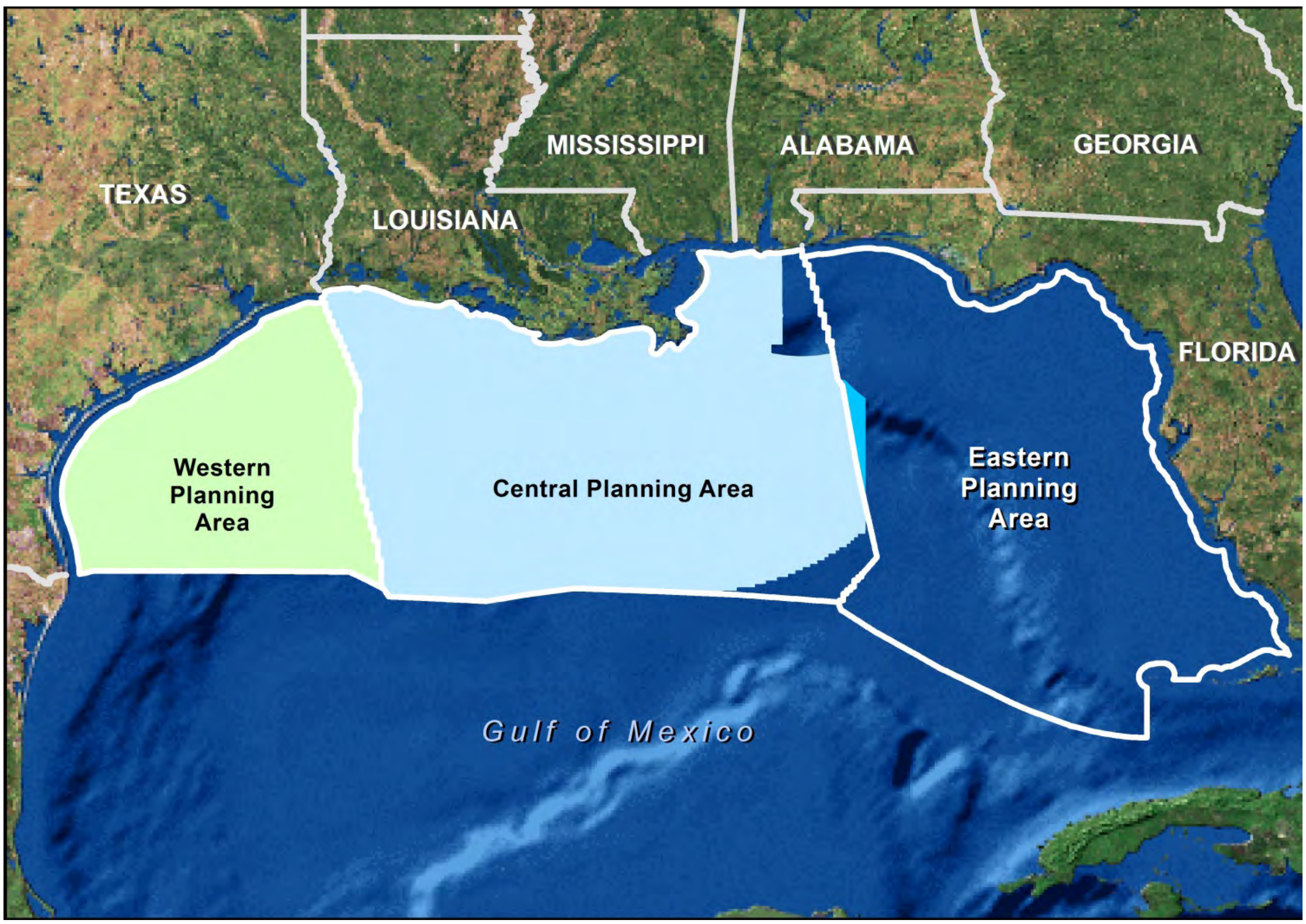
OCS EIS/EA
BOEM 2016-018

Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022

Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261

Draft Environmental Impact Statement

Volume I: Chapters 1-4



U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

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Draft Environmental Impact Statement

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Author

Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

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REGIONAL DIRECTOR'S NOTE

In the *Proposed Outer Continental Shelf Oil & Gas Leasing Program: 2017-2022* (Five-Year Program), 10 regionwide lease sales (encompassing the Western Planning Area, Central Planning Area, and the portion of the Eastern Planning Area not subject to Congressional moratorium) are scheduled for the Gulf of Mexico. Federal regulations allow for several related or similar proposals to be analyzed in one environmental impact statement (EIS) (40 CFR § 1502.4). Since each lease sale proposal and projected activities are very similar for each proposed lease sale area, the Bureau of Ocean Energy Management (BOEM) has prepared a single EIS for the 10 proposed lease sales: *Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2022; Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261; Draft Environmental Impact Statement* (Draft Multisale EIS).

This Draft Multisale EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments. It is important to note that this Draft Multisale EIS was prepared using the best information that was publicly available at the time the document was prepared. This Multisale EIS's analysis focuses on identifying the baseline conditions and potential environmental effects of oil and natural gas leasing, exploration, development, and production in the GOM. This Multisale EIS will also assist decisionmakers in making informed, future decisions regarding the approval of operations, as well as leasing. At the completion of this EIS process, a decision will be made only for proposed Lease Sale 249.

BOEM's Gulf of Mexico OCS Region and its predecessors have been conducting environmental analyses of the effects of Outer Continental Shelf (OCS) oil and gas development since the inception of the National Environmental Policy Act of 1969. We have prepared and published more than 50 draft and 50 final EISs. 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 oil- and gas-related 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.

Michael A. Celata

Michael A. Celata
Regional Director
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

COVER SHEET

Environmental Impact Statement
for
Proposed Gulf of Mexico OCS Oil and Gas
Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261

	Draft (x)	**Final ( )**
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

Agency	Headquarters' Contact	Region Contacts
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ABSTRACT

This Draft Multisale Environmental Impact Statement (EIS) covers the proposed 2017-2022 Gulf of Mexico's OCS oil and gas lease sales as scheduled in the *Proposed Outer Continental Shelf Oil & Gas Leasing Program: 2017-2022* (Five-Year Program). The 10 proposed Region-wide lease sales are Lease Sale 249 in 2017, Lease Sales 250 and 251 in 2018, Lease Sales 252 and 253 in 2019, Lease Sales 254 and 256 in 2020, Lease Sales 257 and 259 in 2021, and Lease Sale 261 in 2022.

The proposed actions are major Federal actions requiring an EIS. This document provides the following information in accordance with the National Environmental Policy Act and its implementing regulations, and it will be used in making decisions on the proposals. 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 the proposed actions are adopted. Activities and disturbances associated with the proposed actions on biological, physical, and socioeconomic resources are considered in the analyses.

This Draft Multisale EIS analyzes the potential impacts of the proposed actions on air and water quality, coastal habitats, deepwater benthic communities, *Sargassum*, live bottom habitats, fishes and invertebrates, birds, protected species, commercial and recreational fisheries, recreational resources, archaeological resources, human resources, and land use. It is important to note that this Draft Multisale EIS was prepared using the best information that was publicly available at the time the document was prepared. Where relevant information on reasonably foreseeable significant adverse impacts is incomplete or unavailable, the need for the information was evaluated to determine if it was essential to a reasoned choice among the alternatives and if so, was either acquired or in the event it was impossible or exorbitant to acquire the information, accepted scientific methodologies were applied in its place.

Additional copies of this Draft Multisale EIS and the other referenced publications may be obtained from the Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, Public Information Office (GM 250C), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394, by telephone at 504-736-2519 or 1-800-200-GULF, or on the Internet at http://www.boem.gov/nepaprocess/.

EXECUTIVE SUMMARY

PURPOSE OF AND NEED FOR THE PROPOSED ACTIONS

Proposed 2017-2022 Gulf of Mexico OCS Region Lease Sale Schedule	
Lease Sale Number	Year
249	2017
250 and 251	2018
252 and 253	2019
254 and 256	2020
257 and 259	2021
261	2022

The Bureau of Ocean Energy Management (BOEM) proposes to conduct 10 regionwide Gulf of Mexico (GOM) oil and gas lease sales, which are tentatively scheduled in the *Proposed Outer Continental Shelf Oil & Gas Leasing Program: 2017-2022* (Five-Year Program; USDOI, BOEM, 2016a). Five regionwide lease sales are tentatively scheduled in August of each year from 2017 through 2021 and five regionwide lease sales are tentatively scheduled in March of each year from 2018 through 2022. The lease sales proposed in the GOM in the Five-Year Program are regionwide lease sales comprised of the Western, Central, and a small portion of the Eastern Planning Areas (WPA, CPA, and EPA, respectively) not subject to Congressional moratorium (**Figure 1**). Even though the Five-Year Program includes regionwide lease sales, any individual lease sale could still be scaled back during the prelease sale process to conform more closely to the separate planning area model used in the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program*: *2012-2017* (2012-2017 Five-Year Program; USDOI, BOEM, 2012a), should circumstances warrant.

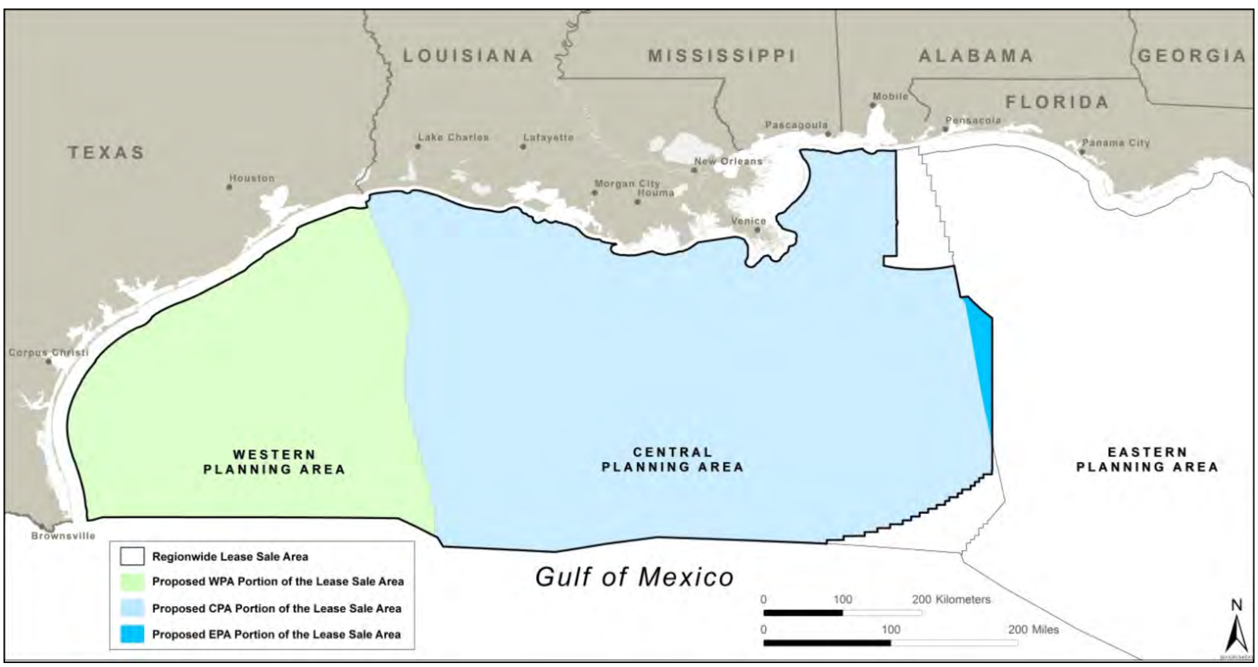

Figure 1. Proposed Regionwide Lease Sale Area Combining the Western, Central, and Eastern Planning Areas.

The proposed lease sales would provide qualified bidders the opportunity to bid upon and lease acreage in the Gulf of Mexico Outer Continental Shelf (OCS) in order to explore, develop, and produce oil and natural gas.

Purpose of the Proposed Actions

> *"It is hereby declared to be the policy of the United States that . . . the Outer Continental Shelf is a vital national resource held by the Federal Government for the public, which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs."*
>
> OCSLA, 43 U.S.C. §§ 1331 *et seq.*

The Outer Continental Shelf Lands Act of 1953, as amended (43 U.S.C. §§ 1331 *et seq*. [1988]), hereafter referred to as OCSLA, establishes the Nation's policy for managing the vital energy and mineral resources of the OCS. Section 18 of OCSLA requires the Secretary of the Interior to prepare and maintain a schedule of proposed OCS oil and gas lease sales determined to "best meet national energy needs for the 5-year period following its approval or reapproval" (43 U.S.C. § 1344). The Five-Year Program establishes a schedule that the U.S. Department of the Interior (USDOI or DOI) will use as a basis for considering where and when leasing might be appropriate over a 5-year period.

The purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and gas resources in accordance with the OCSLA.

Need for the Proposed Actions

The need for the proposed actions is to further the orderly development of OCS resources in an environmentally and economically responsible manner. Oil serves as the feedstock for liquid hydrocarbon products, including gasoline, aviation and diesel fuel, and various petrochemicals. Oil from the Gulf of Mexico OCS contributes to meeting domestic demand and enhances national economic security.

The Decision to be Made

BOEM will make an individual decision on whether and how to proceed with each proposed lease sale in the Five-Year Program. After completion of this Multisale EIS, BOEM will make a decision on proposed Lease Sale 249 (i.e., prepare a Record of Decision for Lease Sale 249 only). As discussed in **Chapter 1.3.1**, individual decisions will be made on each subsequent lease sale after completion of the appropriate supplemental NEPA documents.

Scoping

BOEM conducted a public scoping process that extended from April 29 to June 1, 2015. Public scoping meetings were held in five cities (New Orleans, Louisiana; Houston, Texas; Panama City, Florida; Mobile, Alabama; and Gulfport, Mississippi). In addition to accepting oral and written comments at each public meeting, BOEM accepted written comments by mail, email, and through the regulations.gov web portal (http://www.regulations.gov). BOEM received a total of 10 comments in response to the Notice of Intent to Prepare an EIS. Many of the comments cited broad environmental concerns or specific concern about impacts on marine wildlife in general or on protected species such as marine mammals and sea turtles. Others cited concerns about impacts to critical habitats, fish and fisheries, sensitive benthic communities, and pelagic resources. Several of the comments had concerns with the effects of oil spills and the safety of offshore operations. Within the broad category of socioeconomics, comments focused on impacts on fisheries, recreation, tourism, and local jobs. Some of the comments provided recommendations for inclusion of particular alternatives or mitigation in this Multisale EIS analysis. Some comments recommended the implementation of specific analysis methodologies, while others recommended that recent industry technology and safety advances be taken into consideration.

Pursuant to the OCSLA, the Bureau of Ocean Energy Management published a Call for Information (Call) to request and gather information to determine the Area Identification (Area ID) for each lease sale. The Call was published in the *Federal Register* (2015a) on September 4, 2015. The Call invited potential bidders to nominate areas of interest within the program area(s) included in the 2017-2022 Draft Proposed Program. The Call was also an opportunity for the public to provide information on environmental, socioeconomic, and other considerations relevant to determining the Area ID. The comment period for the Call closed on October 5, 2015. BOEM received one comment letter in response to the Call from the Louisiana Department of Natural Resources. The Louisiana Office of Coastal Management requested that BOEM consider secondary and cumulative impacts of OCS lease sales on coastal environments as well as identify, quantify, and mitigate (e.g., compensatory mitigation) secondary and cumulative harm that occurs to Louisiana's coastal wetlands, and implement plans for validating predictions of social and environmental effects on coastal resources. Using information provided in response to the Call and from scoping comments, BOEM then developed an Area ID recommendation memorandum. The Area ID is an administrative prelease step that describes the geographic area for environmental analysis and consideration for leasing. On November 20, 2015, the Area ID decision was made. One Area ID was prepared for all proposed lease sales. The Area ID memorandum recommended keeping the entire regionwide area of the GOM included in the Draft Proposed Program for consideration in this Multisale EIS. The area identified for lease includes all of the available unleased blocks in the GOM not subject to Congressional moratorium pursuant to the Gulf of Mexico Energy Security Act of 2006.

ALTERNATIVES

BOEM has identified four action alternatives, and the no action, to be analyzed in this Multisale EIS. These alternatives are briefly described below. The mitigating measures (pre- and postlease), including the proposed stipulations, are fully described in **Chapter 2 and Appendix D**, as are the deferred alternatives not analyzed in detail.

Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Alternative A would allow for a proposed regionwide lease sale encompassing all three planning areas within the U.S. portion of the Gulf of Mexico OCS for any given lease sale in the Five-Year Program. This is BOEM's preferred alternative. This alternative would offer for lease all available unleased blocks within the WPA, CPA, and EPA portions of the proposed lease sale area for oil and gas operations (**Figure 2**), with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006 (discussed in the *OCS Regulatory Framework* white paper [Cameron and Matthews, 2016]);

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(3) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary (i.e., the boundary as of the publication of this Multisale EIS).

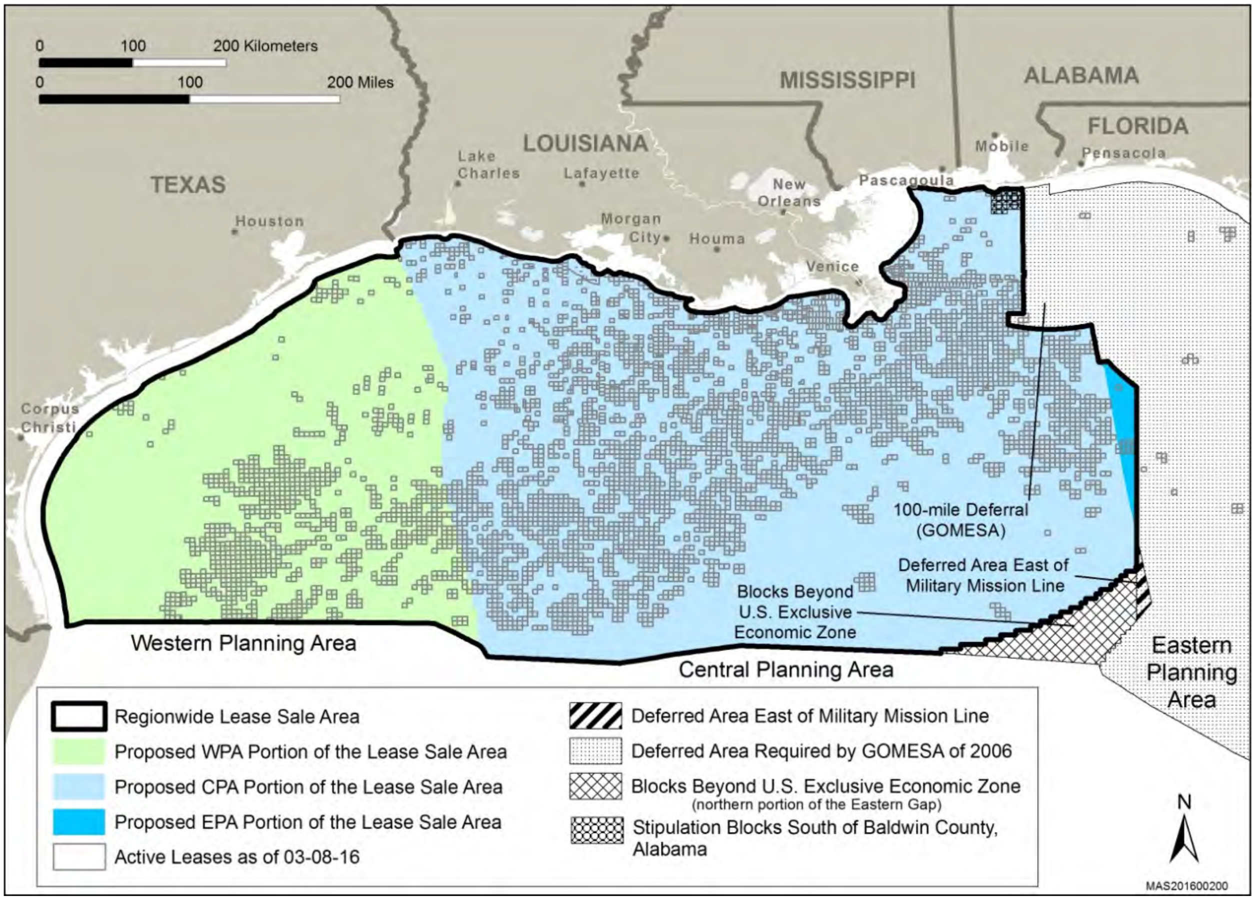

Figure 2. Proposed Regionwide Lease Sale Area, Encompassing the Available Unleased Blocks within All Three Planning Areas (approximately 92.2 million acres with approximately 72.5 million acres available for lease as of March 2016).

Alternative B—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Alternative B would allow for a proposed lease sale encompassing the CPA and EPA within the U.S. portion of the Gulf of Mexico OCS (**Figure 3**). Available blocks within the WPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the CPA and EPA portions of the proposed lease sale area as those planning area portions described in Alternative A for oil and gas operations, with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006 (discussed in the *OCS Regulatory Framework* white paper [Cameron and Matthews, 2016]); and

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap.

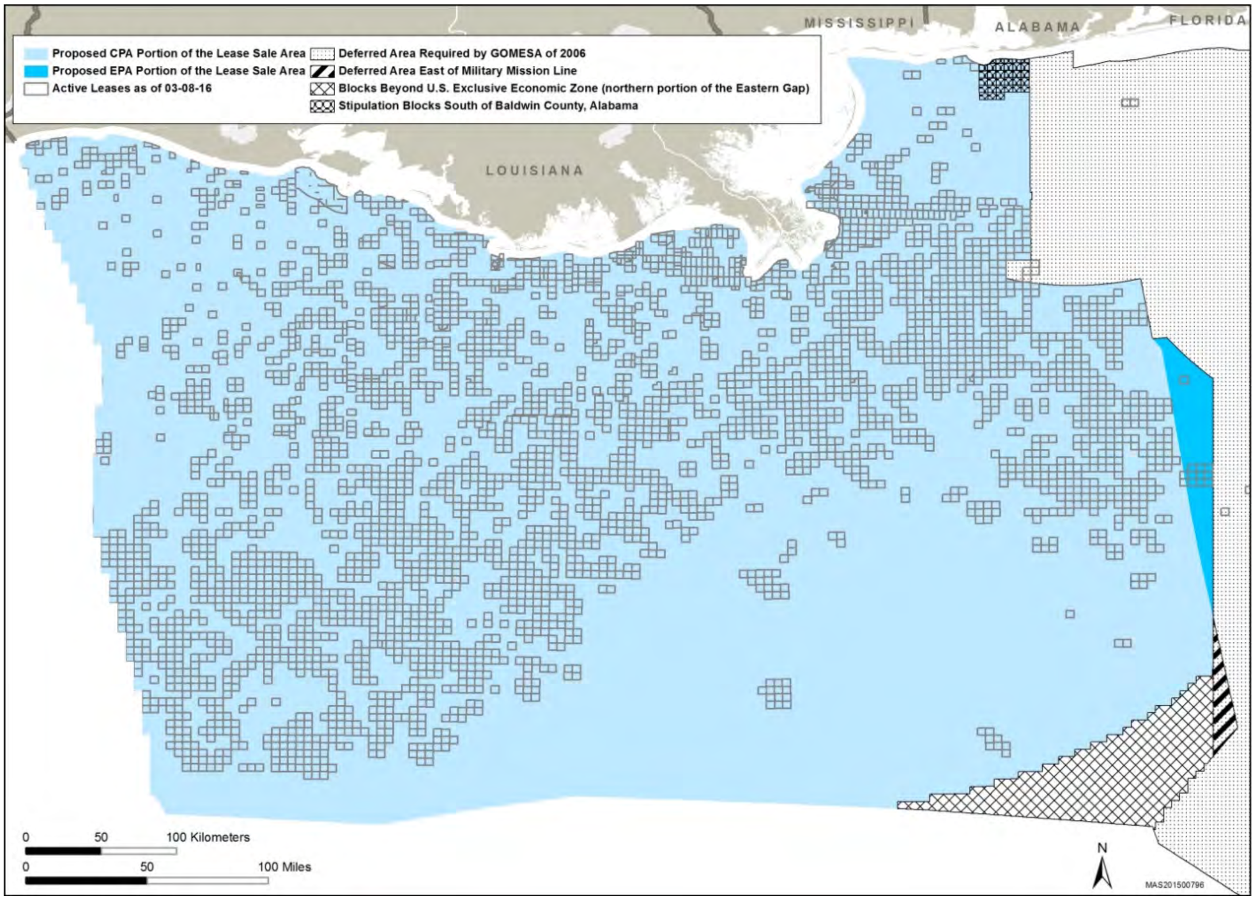

Figure 3. Proposed Lease Sale Area for Alternative B, Excluding the Available Unleased Blocks in the WPA (approximately 66.45 million ac with approximately 48.3 million ac available for lease as of March 2016).

Alternative C—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Alternative C would allow for a proposed lease sale encompassing the WPA within the U.S. portion of the Gulf of Mexico OCS (**Figure 4**). Available blocks within the CPA and EPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the WPA portion of the proposed lease sale area for oil and gas operations, with the following exception:

(1) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary (i.e., the boundary as of the publication of this Multisale EIS).

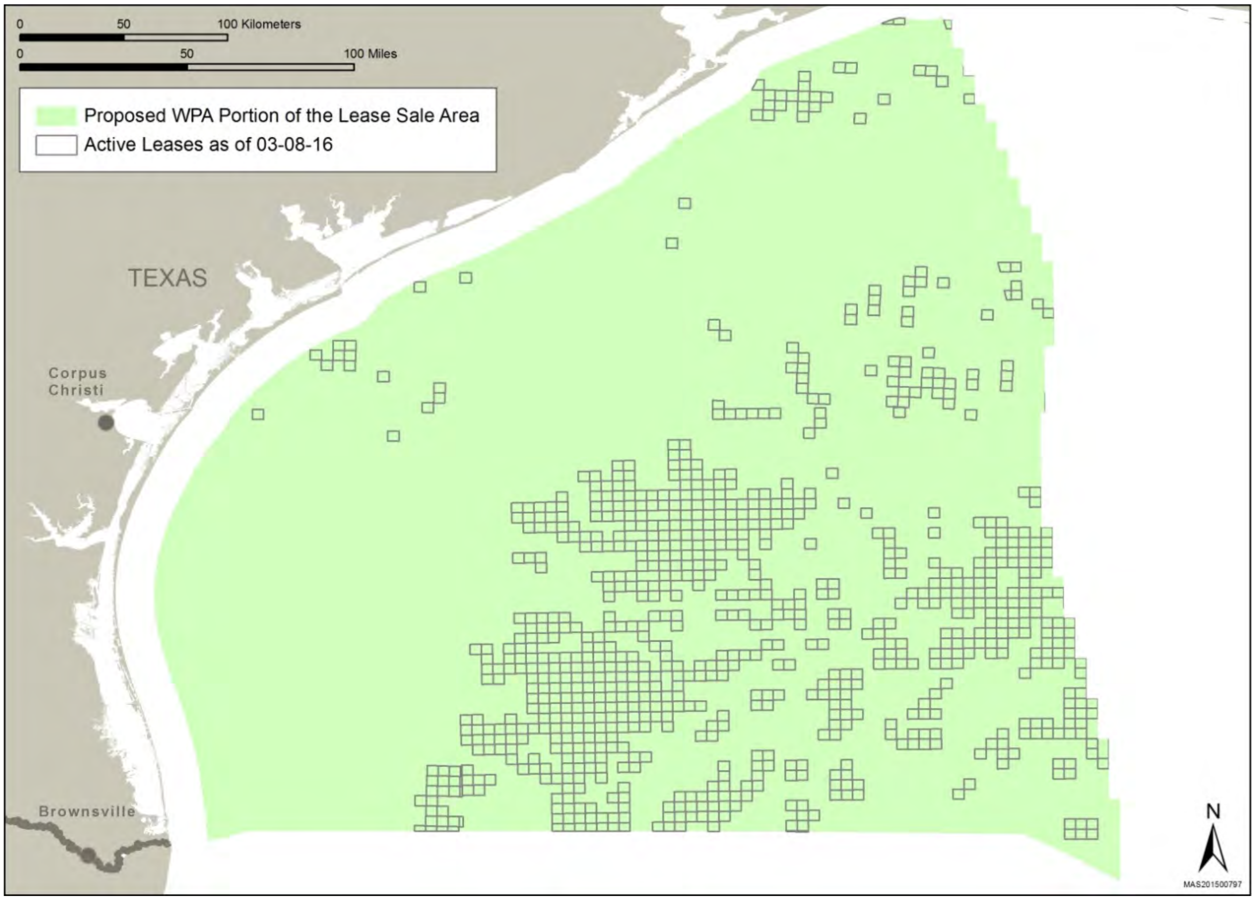

Figure 4. Proposed Lease Sale Area for Alternative C, Excluding the Available Unleased Blocks in the CPA and EPA (approximately 28.58 million ac with approximately 23.6 million ac available for lease as of March 2016).

Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D could be combined with any of the action alternatives above (A, B, or C) and would allow the flexibility to offer leases under any alternative with additional exclusions. Under Alternative D, the decisionmaker could exclude from leasing any available unleased blocks subject to any one and/or combination of the following stipulations:

- Topographic Features Stipulation;
- Live Bottom (Pinnacle Trend) Stipulation; and
- Blocks South of Baldwin County, Alabama, Stipulation (not applicable to Alternative C).

This alternative considered blocks subject to these stipulations because these areas have been emphasized in scoping, can be geographically defined, and adequate information exists regarding their ecological importance and sensitivity to OCS oil- and gas-related activities, as shown in **Figure 5**. All of the assumptions (including the other potential mitigating measures) and estimates would remain the same as described for any given alternative.

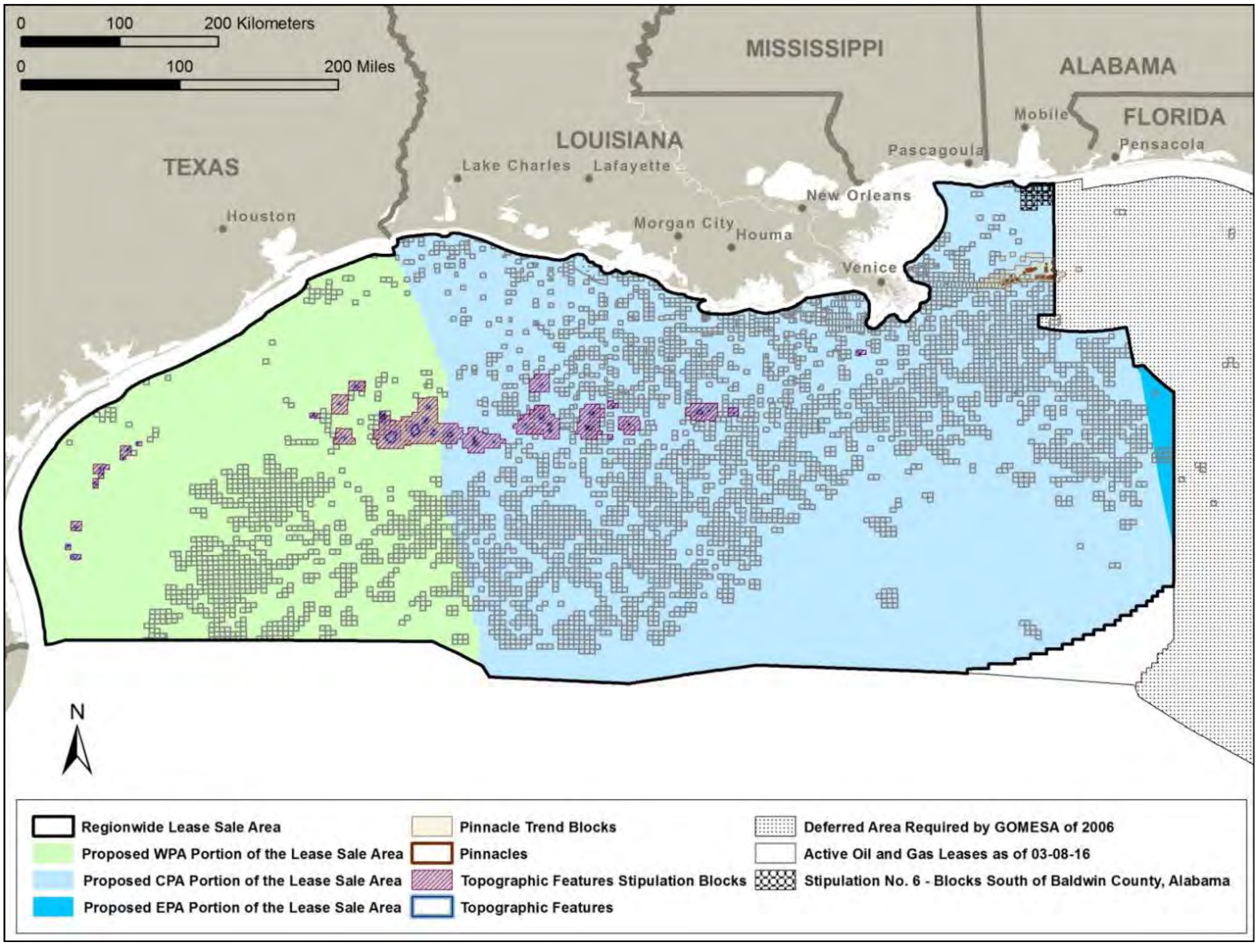

Figure 5. Identified Topographic Features, Pinnacle Trend, and Baldwin County Stipulation Blocks in the Gulf of Mexico.

Alternative E—No Action

Alternative E is the cancellation of a single proposed lease sale. The opportunity for development of the estimated oil and gas that could have resulted from a proposed action (i.e., a single lease sale) or alternative to a proposed action, as described above, would be precluded or postponed to a future lease sale. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed. Cancellation of a proposed lease sale, however, would not stop all OCS oil- and gas-related activities. Activities related to previously issued leases and permits (as well as those that may be issued in the future under a separate decision) related to the OCS oil and gas program would continue. If a lease sale were to be cancelled, the resulting development of oil and gas would most likely be postponed to a future lease sale; therefore, the overall level of OCS oil- and gas-related activity would only be reduced by a small percentage, if any.

MITIGATING MEASURES

Proposed lease stipulations and other mitigating measures designed to reduce or eliminate environmental risks and/or potential multiple-use conflicts between OCS operations and U.S. Department of Defense activities may be applied to the chosen alternative. Mitigating measures in the form of lease stipulations are added to the lease terms and are therefore enforceable as part of the lease. The 10 lease stipulations being considered are the Topographic Features Stipulation; Live Bottom (Pinnacle Trend) Stipulation; Military Areas Stipulation; Evacuation Stipulation; Coordination Stipulation; Blocks South of Baldwin County, Alabama, Stipulation; Protected Species Stipulation; United Nations Convention on the Law of the Sea Royalty Payment Stipulation; Below Seabed Operations Stipulation; and the Stipulation on the Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico (Transboundary Stipulation). The United Nations Convention on the Law of the Sea Royalty Payment Stipulation is applicable to a proposed lease sale even though it is not an environmental or military stipulation. **Chapter 2.2.4**provides a brief description of each stipulation and the potential benefits associated with its use. **Appendix D** provides a more detailed analysis of the 10 lease stipulations and their effectiveness.

Application of lease stipulations will be considered by the Assistant Secretary of the Interior for Land and Minerals Management (ASLM). The inclusion of the stipulations as part of the analysis of the proposed actions does not ensure that the ASLM will make a decision to apply the stipulations to leases that may result from a 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 warrant. Any lease stipulations or mitigating measures to be included in a lease sale will be described in the Final Notice of Sale. In addition, mitigations may be added to plan and/or permits for OCS oil- and gas-related activities (**Chapter 2.2.4.3**). For more information on mitigating measures that are added at the postlease stage, refer to **Appendix B** ("Commonly Applied Mitigating Measures").

DIRECT AND INDIRECT ACTIONS ASSOCIATED WITH A PROPOSED LEASE SALE

BOEM describes the potentially occurring actions associated with a single lease sale and the cumulative activities that provide a framework for a detailed analysis of the potential environmental impacts. Exploration and development scenarios describe the infrastructure and activities that could potentially affect the biological, physical, and socioeconomic resources in the GOM. They also include a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors.

Offshore activities are described in the context of scenarios for a proposed action (**Chapter 3.1**) and for the OCS Program (**Chapter 3.3**). BOEM's Gulf of Mexico OCS Region developed these scenarios to provide a framework for detailed analyses of potential impacts of a proposed lease 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 a traditionally employed range of activities (e.g., the installation of platforms, wells, and pipelines, and the number of helicopter operations and service-vessel trips) that would be needed to develop and produce the amount of resources estimated to be leased.

Within each resource section in **Chapter 4**, the cumulative analysis considers environmental and socioeconomic impacts that may result from the incremental impact of a proposed action when added to all past, present, and reasonably foreseeable future activities, including non-OCS oil- and gas-related activities such as import tankering and commercial fishing, as well as all OCS oil- and gas-related activities (OCS Program). This includes projected activity from lease sales that have been held but for which exploration or development has not yet begun or is continuing. In addition, impacts from natural occurrences, such as hurricanes, are analyzed.

ENVIRONMENTAL IMPACTS

The affected environment and the potential impacts of a single lease sale and each alternative have been described and analyzed by resource. Analysis of the alternatives include routine activities, accidental events, cumulative impact analysis, incomplete or unavailable information, and conclusions for each resource. This Multisale EIS also considers baseline data in the assessment of impacts from a proposed action on the resources and the environment (**Chapter 4**).

The major issues that frame the environmental analyses in this Multisale EIS are the result of concerns raised during years of scoping for the Gulf of Mexico OCS Program. Issues related to OCS oil and gas exploration, development, production, and transportation activities include the potential for oil spills, wetlands loss, air emissions, wastewater discharges and water quality degradation, marine trash and debris, structure and pipeline emplacement activities, platform removal, vessel and helicopter traffic, multiple-use conflicts, support services, population fluctuations, land-use planning, impacts to recreation and beaches, aesthetic interference, environmental justice, and conflicts with State coastal zone management programs. Environmental resources and activities identified during the scoping process that warrant an environmental analysis include air quality, water quality, coastal habitats (including wetlands and seagrasses), barrier beaches and associated dunes, live bottom habitats (including topographic features and pinnacle trends), *Sargassum* and associated communities, deepwater benthic communities, marine mammals, sea turtles, birds, fishes and invertebrate resources, commercial fisheries, recreational fishing, recreational resources, archaeological resources, and socioeconomic factors (including environmental justice), and within the CPA only, beach mice.

Other relevant issues include impacts from the *Deepwater Horizon* explosion, oil spill, and response; impacts from past and future hurricanes on environmental and socioeconomic resources; and impacts on coastal and offshore infrastructure. During the past several years, the Gulf Coast States and Gulf of Mexico oil and gas activities have been impacted by major hurricanes. The description of the affected environment includes impacts from these relevant issues on the physical environment, biological environment, and socioeconomic activities, and on OCS oil- and gas-related infrastructure.

Impact Conclusions

The full analyses of the potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts are described in the individual resource discussions in **Chapter 4**. A summary of the potential impacts from a proposed action on each environmental and socioeconomic resource and the conclusions of the analyses can be found in the following discussions. **Table 1** provides a comparison of the expected impact levels by alternative and is derived from the analysis of each resource in **Chapter 4**. The impact level ratings have been specifically tailored and defined for each resource within the **Chapter 4** impact analysis. BOEM has concluded that the selection of Alternative E would result in no additional discernible impacts to the resources analyzed; therefore, Alternative E ratings were not included. Cumulative impacts of current and past activities, however, would continue to occur under Alternative E.

Table 1. Alternative Comparison Matrix.

Impact Level Key				
Beneficial	Negligible	Minor	Moderate	Major

Resource	Alternative A	Alternative B	Alternative C	Alternative D
Air Quality	Minor	Minor	Minor	Minor
Water Quality	Minor	Minor	Minor	Minor
Estuarine Systems	Minor	Negligible	Negligible	Negligible to Minor
Coastal Barrier Beaches and Associated Dunes	Negligible	Negligible	Negligible	Negligible
Deepwater Benthic Communities	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Sargassum and Associated Communities	Negligible	Negligible	Negligible	Negligible
Live Bottoms Topographic Features	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Pinnacles and Low-Relief Features	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Fishes and Invertebrate Resources	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Birds	Moderate	Moderate	Moderate	Moderate
Protected Species Marine Mammals	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Sea Turtles	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate

Impact Level Key				
Beneficial	Negligible	Minor	Moderate	Major
Resource	**Alternative A**	**Alternative B**	**Alternative C**	**Alternative D**
Beach Mice	Negligible	Negligible	Negligible	Negligible
Protected Birds	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Protected Corals	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Commercial Fisheries	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor
Recreational Fishing	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Recreational Resources	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor
Archaeological Resources	Negligible	Negligible	Negligible	Negligible
Human Resources and Land Use Land Use and Coastal Infrastructure	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major
Economic Factors	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Social Factors (including Environmental Justice)	Minor	Minor	Minor	Minor

Note: BOEM has concluded that the selection of Alternative E would result in no additional discernible impacts to the resources analyzed; however, cumulative impacts of current and past activities would continue to occur.

Air Quality

Air quality is the degree at which the ambient air is free of pollution; it is assessed by measuring the pollutants in the air. To protect public health and welfare, the Clean Air Act established National Ambient Air Quality Standards (NAAQS) for certain common and widespread pollutants. The seven common "criteria pollutants" are particle pollution (also known as particulate matter [$PM_{2.5}$ and PM_{10}]), carbon monoxide (CO); nitrogen dioxide (NO_2); sulfur dioxide (SO_2); lead (Pb); and ozone (O_3). Air emissions from OCS oil and gas development in the Gulf of Mexico would arise from emission sources related to drilling and production with associated vessel support, flaring and venting, decommissioning, fugitive emissions, and oil spills. Associated activities that take place as a result of a proposed action support and maintain the OCS oil and gas platform sources. Air emissions from non-OCS oil- and gas-related emissions in the Gulf of Mexico would arise from emission sources related to State oil and gas programs, onshore industrial and transportation sources, and natural events. Since the primary NAAQS are designed to protect human health, BOEM focuses on the impact of these activities on the States, where there are permanent human populations.

Based on Year 2008 and Year 2011 OCS emission inventories, postlease 1-hour NO_x modeling, and past studies, emissions of pollutants into the atmosphere from routine activities and accidental events associated with the OCS Program are projected to be **minor**. Additionally, reductions in emissions have been achieved through the use of low sulfur fuels, catalytic reduction, and other efforts. The incremental contribution of a single regionwide proposed lease sale to the cumulative impacts would be **minor**. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a regionwide proposed lease sale would be very small. The cumulative contribution to visibility impairment from a regionwide proposed lease sale is also expected to be very small. A full analysis of air quality can be found in **Chapter 4.1**.

Water Quality

Water quality is a term used to describe the condition or environmental health of a waterbody or resource, reflecting its particular biological, chemical, and physical characteristics and the ability of the waterbody to maintain the ecosystems it supports and influences. It is an important measure for both ecological and human health. The impacts of OCS Program-related routine operational discharges (**Chapter 3.1.5.1**) on water quality are short term and localized, and are therefore considered **negligible**. The potential impacts from OCS Program-related oil spills on water quality after mitigation are also short term and are considered **minor**. This is because, after removal of most free product, the residual oil dissipates quickly through dispersion and weathering; however, secondary impacts to water quality may occur, such as the introduction of additional hydrocarbon into the dissolved phase through the use of dispersants and the sinking of hydrocarbon residuals from burning. The impacts from a proposed action are a small addition to the cumulative impacts on water quality when compared with inputs from hypoxia, potentially leaking shipwrecks, chemical weapon and industrial waste dumpsites, natural oil seeps, and natural turbidity. The incremental contribution of the routine activities and accidental events associated with a proposed action to the cumulative impacts on water quality is not expected to be significant. A full analysis of water quality can be found in **Chapter 4.2**.

Coastal Habitats

Estuarine Systems (Wetlands and Seagrasses/Submerged Vegetation)

The estuarine system is the transition zone between freshwater and marine environments. It can consist of many habitats, including wetlands and submerged vegetation. The impacts to these habitats from routine activities associated with a proposed action are expected to be **negligible** due to the projected low probability for any new pipeline landfalls (0-1 projected), the minimal contribution to the need for maintenance dredging, and the mitigating measures expected to be used to further reduce these impacts, e.g., use of modern techniques such as directional drilling. Overall, impacts to estuarine habitats from oil spills associated with activities related to a proposed action would be expected to be **minor** because of the distance of most postlease activities from the coast, the expected weathering of spilled oil, the projected low probability of large spills near the coast, the resiliency of wetland vegetation, and the available cleanup techniques. Cumulative impacts to estuarine habitats are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities outlined in **Chapter 4.3.1** and the human and natural impacts. Development pressures in the coastal regions of the GOM have been largely the result of tourism and residential beach-side development, and this trend is expected to continue. Storms will continue to impact the coastal habitats and have differing impacts. The incremental contribution of a proposed action to the cumulative impacts on estuarine habitats is expected to be **negligible** to **minor**. A full analysis of estuarine habitats can be found in **Chapter 4.3.1**.

Coastal Barrier Beaches and Associated Dunes

The coastal barrier beaches and associated dunes are those beaches and dunes that line the coast of the northern GOM, including both barrier islands and beaches on the mainland. The impacts to coastal barrier beaches and dunes from routine activities associated with a proposed action are expected to be **negligible** due to the minimal number of projected onshore pipelines, the minimal contribution to vessel traffic and the need for maintenance dredging, and the mitigating measures that would be used to further reduce these impacts. The greater threat from an oil spill to coastal beaches is from a coastal spill as a result of a nearshore vessel accident or pipeline rupture and from cleanup activities. Overall, impacts to coastal barrier beaches and dunes from oil spills associated with OCS oil- and gas-related activities related to a proposed action would be expected to be **minor** because of the distance of most of the resulting activities from the coast, expected weathering of spilled oil, projected low probability of large spills near the coast, and available cleanup techniques. Cumulative impacts to coastal barrier beaches and dunes are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities outlined in **Chapter 4.3.2** and the other human and natural impacts. Development pressures in the coastal regions of the GOM have been largely the result of tourism and residential beach-side development, and this trend is expected to continue. Efforts to stabilize the GOM shoreline have adversely impacted coastal beach landscapes. Storms will continue to impact the coastal habitats and have differing impacts. The incremental contribution of a proposed action to the cumulative impacts on estuarine habitats is expected to be **negligible** to **minor**. A full analysis of coastal barrier beaches and associated dunes can be found in **Chapter 4.3.2**.

Deepwater Benthic Communities

BOEM defines “deepwater benthic communities” as including both chemosynthetic communities (chemosynthetic organisms plus seep-associated fauna) and deepwater coral communities (deepwater coral plus associated fauna). These communities are typically found in water depths of 984 feet (ft) (300 meters [m]) or deeper throughout the GOM, although deepwater benthic habitats are relatively rare compared with ubiquitous soft bottoms. The OCS oil- and gas-related impact-producing factors for deepwater benthic communities can be grouped into three main categories: (1) bottom-disturbing activities; (2) drilling-related sediment and waste discharges; and (3) noncatastrophic oil spills. These impact-producing factors have the potential to damage individual deepwater habitats and disrupt associated benthic communities if insufficiently distanced or otherwise mitigated. However, impacts from individual routine activities and accidental events are usually temporary, highly localized, and expected to impact only small numbers of organisms and substrates at a time. Moreover, use of the expected site-specific plan reviews/mitigations will distance activities from deepwater benthic communities, greatly diminishing the potential effects. Therefore, at the regional, population-level scope of this analysis and assuming adherence to all expected regulations and mitigations, impacts from routine activities and reasonably foreseeable accidental events are expected to be **negligible** to **minor**. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS and non-OCS cumulative effects experienced by live bottom habitats. The OCS oil- and gas-related cumulative impacts to deepwater benthic communities are estimated to be **negligible to minor**. A full analysis of deepwater benthic communities can be found in **Chapter 4.4**.

Sargassum **and Associated Communities**

Sargassum in the GOM is comprised of *S. natans* and *S. fluitans*, and is characterized by a brushy, highly branched thallus with numerous leaf-like blades and berrylike pneumatocysts. The *Sargassum* cycle is truly expansive, encompassing most of the western Atlantic Ocean and the Gulf of Mexico with the growth, death, and decay of these plant and epiphytic communities, which may play a substantial role in the global carbon cycle. Several impacting factors can affect *Sargassum*, including vessel-related operations, oil and gas drilling discharges, operational discharges, accidental spills, non-OCS oil- and gas-related vessel activity, and coastal water quality. Routine vessel operations and accidental events that occur during drilling operations or vessel operations, and oiling due to an oil spill were the impact-producing factors that could be reasonably expected to impact *Sargassum* populations in the GOM. All of these impact-producing factors would result in the death or injury to the *Sargassum* plants or to the organisms that live within or around the plant matrix. However, the unique and transient characteristics of the life history of *Sargassum* and the globally widespread nature of the plants and animals that use the plant matrix buffer against impacts at any given location. Impacts to the overall population of the *Sargassum* community are therefore expected to be **negligible** from either routine activities or reasonably foreseeable accidental events. The incremental impact of OCS oil- and gas-related activities on the population of *Sargassum* would be **negligible** and would not result in cumulative impacts to the population. Impacts from changing water quality would be much more influential on *Sargassum* than OCS development and would still occur without the presence of OCS oil- and gas-related activities. A full analysis of *Sargassum* and associated communities can be found in **Chapter 4.5**.

Live Bottom Habitats

Topographic Features

Defined topographic features (**Chapter 4.6.1**) are a subset of GOM live bottom habitats that are large enough to have an especially important ecological role, with specific protections defined in the proposed Topographic Features Stipulation. Within the Gulf of Mexico, BOEM has identified 37 topographic features where some degree of protection from oil and gas development may be warranted based on geography and ecology. Of all the possible impact-producing factors, it was determined that bottom-disturbing activities associated with drilling, exploration, and vessel operations were the only impact-producing factors from routine activities that could be reasonably expected to substantially impact topographic features. The impact-producing factors resulting from accidental events include bottom-disturbing activities from drilling, exploration, and vessel operations, as well as the release of sediments and toxins released during drilling. Oil spill-related activities were also considered to be a substantial source of potential impact to topographic features.

Adherence to the Topographic Features Stipulation, which is detailed in **Appendix D**, would assist in preventing most of the potential impacts on topographic feature communities by increasing the distance of OCS oil- and gas-related activities from these features. Should this stipulation be applied to any future lease sale, as it has been historically, impacts of a proposed action to topographic features from routine activities and accidental events or the cumulative impact of a proposed action in the GOM are expected to be **negligible**. The incremental contribution of a proposed action to the cumulative impacts on topographic features is expected to be **negligible** with adherence to the proposed Topographic Features Stipulation. Impacts ranging from **negligible** to **moderate** may still be expected from non-OCS oil- and gas-related activities depending on factors such as fishing and pollution; however, the incremental impact of the proposed activities should not result in an augmentation of the expected impacts. Additionally, any localized impacts at one topographic feature does not preclude that impacts will occur at other topographic features. A full analysis of topographic features can be found in **Chapter 4.6.1**.

Pinnacles and Low-Relief Features

The Pinnacle Trend is an approximately 64 x 16 mile (103 x 26 kilometer) area in water depths of about 200-650 ft (60-200 m). It is in the northeastern portion of the CPA at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon (**Figure 2-4-to Figure 4-16**). Outside of the Pinnacle Trend, low-relief live bottom epibenthic communities occur in isolated locations in shallow waters (<984 ft; 300 m) throughout the GOM, wherever there is suitable hard substrate and other physical conditions (e.g., depth, turbidity, etc.) for development. Hard bottom habitats occur throughout the GOM but are relatively rare compared with ubiquitous soft bottoms. The impact-producing factors for pinnacles and low-relief live bottom features can be grouped into three main categories: (1) bottom-disturbing activities; (2) drilling-related sediment and waste discharges; and (3) oil spills. These impact-producing factors have the potential to damage individual deepwater habitats and disrupt associated benthic communities if insufficiently distanced or otherwise mitigated. At the broad geographic and temporal scope of this analysis, and assuming adherence to all expected lease stipulations and typically applied regulations and mitigations, routine activities are expected to have largely short-term localized and temporary effects. Although accidental events have the potential to cause severe damage to specific live bottom communities, the number of such events is expected to be very small. Therefore, at the regional, population-level scope of this analysis, impacts from reasonably foreseeable routine activities and accidental activities are expected to be **negligible** to **minor**. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS and non-OCS cumulative impacts experienced by live bottom habitats. The OCS oil- and gas-related cumulative impacts to live bottom communities are estimated to be **negligible**. A full analysis of pinnacles and low-relief features can be found in **Chapter 4.6.2**.

Fish and Invertebrate Resources

The distribution of fishes and invertebrates vary widely, and species may be associated with different habitats at various life stages, which is discussed further in **Chapter 4.7**. The impact-producing factors affecting these resources are anthropogenic sound, bottom-disturbing activities, habitat modification, and accidental oil spills. The impacts from routine activities, excluding infrastructure emplacement, would be expected to be **negligible** or **minor** due to short-term localized effects. The installation of OCS oil- and gas-related infrastructure constitutes a long-term modification of the local habitat and is hypothesized to have resulted over the life of the program in **moderate** changes in the distribution of some species. Although this effect is not necessarily adverse and infrastructure is expected to be decommissioned and sites restored to natural habitat, the cumulative impact over the life of the OCS Program extensively pertains to time and space. Accidental spills have been historically low-probability events and are typically small in size. The expected impact to fishes and invertebrate resources from accidental oil spills is **negligible**. Commercial and recreational fishing are expected to have the greatest direct effect on fishes and invertebrate resources, resulting in impact levels ranging from **negligible** for most species to potentially **moderate** for some targeted species (e.g., hogfish spp., gray triggerfish, and greater amber jack [*Seriola dumerili*]). The analysis of OCS oil- and gas-related and non-OCS oil- and gas-related routine activities, accidental events, and cumulative impacts indicates the overall impact to fishes and invertebrate resources would range from **negligible** to **moderate** for different species. A full analysis of fish and invertebrate resources can be found in **Chapter 4.7**.

Birds

The affected birds include both terrestrial songbirds and many groups of waterbirds. Routine impacts to coastal, marine, and migratory birds that were considered include routine discharges and wastes, noise, platform severance with explosives (barotrauma), geophysical surveys with airguns, platform presence and lighting, construction of OCS oil- and gas-related onshore facilities, and pipeline landfalls. The impacts to birds from OCS oil-and gas-related routine activities are similar wherever they may occur in the GOM, and all are considered **negligible** to **minor**. Negligible impacts would be little to no impacts that are measured or measurable for a population. No mortality of a flock or large population would occur, and no overall disturbance-causing changes in behavioral patterns would be expected. Minor impacts would occur when one of the two following conditions are met: (1) flocks or large populations of birds would experience stimuli or impact-producing factors and would be disturbed or otherwise affected overall, resulting in acute behavioral changes; however, these impacts would be short term and reversible; and (2) one or more incidents where one or more individuals experience injury or mortality may occur, but with no measured or measurable impact on a large population. Accidental impacts to birds are caused by oil spills, spill cleanup, and emergency air emissions. Seabirds may not always experience the greatest impacts from a spill but it may take longer for populations to recover because of their unique population ecology (demography). Some species of seabirds can have a clutch size of just one egg, and they have relatively long life spans and often have delayed age at first breeding. Impacts for overall accidental events would be **moderate**. However, other seabirds, such as gulls, have larger clutches (laughing gulls usually have three eggs/clutch except in the tropics) and may recover quite quickly.

This conclusion is based on the increment of a proposed action compared with all cumulative OCS oil- and gas-related and non-OCS oil- and gas-related impacts. A full analysis of birds can be found in **Chapter 4.8**.

Protected Species

Marine Mammals

The Gulf of Mexico marine mammal community is diverse and distributed throughout the GOM, with the greatest abundances and diversity of species inhabiting oceanic and OCS waters. The major potential impact-producing factors affecting marine mammals in the GOM as a result of cumulative past, present, and reasonably foreseeable OCS energy-related activities are decommissioning activities, operational discharges, G&G activities, noise, transportation, marine debris, and accidental oil spill and spill-response activities. Accidental events that involve large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (i.e., days, weeks, or months), pose an increased likelihood of impacting marine mammal populations inhabiting GOM waters. While accidental events have the potential to impact marine mammal species, the number of such events is expected to be very small.

At the regional, population-level scope of this analysis, impacts from routine activities and reasonably foreseeable accidental activities are expected to be **negligible** to **moderate**. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS and non-OCS cumulative effects experienced by marine mammal populations. The incremental contribution of a proposed action to cumulative impacts to marine mammal populations, depending upon the affected species and their respective population estimate, even when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response; non-OCS oil- or gas-related factors; and the minimization of the OCS oil- or gas-related impacts through lease stipulations and regulations, would be expected to be **negligible**. A full analysis of marine mammals can be found in **Chapter 4.9.1**.

Sea Turtles

Five sea turtle species have been listed and are present throughout the northern GOM; however, only Kemp's ridley and loggerheads commonly nest on beaches in the GOM. Because of expected mitigations (e.g., BOEM and the Bureau of Safety and Environmental Enforcement [BSEE] proposed compliance with Notices to Lessees and Operators [NTLs] under the proposed Protected Species Stipulation and conditions of approval on postlease activities), the routine activities (e.g., noise or transportation) and accidental events (e.g., oil spills) related to a proposed action are not expected to have long-term adverse effects on the size and productivity of any sea turtle species or populations in the northern GOM. Lethal effects could occur from chance collisions with OCS oil- and gas-related service vessels or ingestion of accidentally released plastic materials from OCS oil- and gas-related vessels and facilities. However, there have been no reports to date on such incidences. Most routine activities and accidental events are therefore expected to have **negligible** to **moderate** impacts. For example, a minor impact might be a behavioral change in response to noise while a moderate impact might be a spill contacting an individual and causing injury or mortality.

Historically, intense harvesting of eggs, loss of suitable nesting beaches, and fishery-related mortality have led to the rapid decline of sea turtle populations. Anthropogenic actions continue to pose the greatest threat to sea turtles since their listing under the Endangered Species Act (ESA), as well as different natural threats including climate change and natural disasters. Cumulative impacts to sea turtles would be expected to be **negligible** as a result of a proposed action. Population-level impacts are not anticipated. A full analysis of sea turtles can be found in **Chapter 4.9.2**.

Beach Mice

The four subspecies of beach mouse (*Peromyscus polionotus* ssp.) are small coastal rodents that are only found along beaches in parts of Alabama and northwest Florida. Beach mice rely on dune systems as favorable habitat for foraging and maintaining burrows. Due to the distance between beach mouse habitat and OCS oil- and gas-related activities, routine impacts are not likely to affect beach mouse habitat except under very limited situations. Pipeline emplacement or construction, for example, could cause temporary degradation of beach mouse habitat; however, these activities are not expected to occur in areas of designated critical habitat. Accidental oil spills and associated spill-response efforts are not likely to impact beach mice or their critical habitat because the species live above the intertidal zone where contact is less likely. Habitat loss from non-OCS oil- and gas-related activities (e.g., beachfront development) and predation have the greatest impacts to beach mice. The overall analyses of impact-producing factors associated with the routine activities, accidental events, and cumulative impacts of OCS oil- and gas-related and non-OCS oil- and gas-related activities on beach mice concluded that impacts from a proposed action would be **negligible**. A full analysis of beach mice can be found in **Chapter 4.9.3**.

Protected Birds

Protected birds are those species or subspecies listed under the ESA by the U.S. Fish and Wildlife Service (FWS) as threatened or endangered due to the decrease in their population sizes or loss of habitat; therefore, a proposed action could have a greater impact. BOEM is undergoing consultation with the FWS to minimize the potential impacts to ESA-listed species. Impacts from routine activities, which include discharges and wastes affecting air and water quality, noise, and possibly artificial lighting, would be **negligible** to protected birds. The listed bird species considered are typically coastal birds and would not be exposed to much of the oil- and gas-related activities. Waste discharges to air or water produced as a result of routine activities are regulated by the U.S. Environmental Protection Agency and BOEM, and these discharges are subject to limits to reduce potential impacts; therefore, due to precautionary requirements and monitoring, the impacts to protected birds would be **negligible**. The major impact-producing factors resulting from accidental events associated with a proposed action that may affect protected birds include accidental oil spills and response efforts and marine debris. In the case of an accidental oil spill, impacts would be **negligible** to **moderate** depending on the magnitude and time and place of such an event. Major impacts could occur if a large oil spill occurred with direct contact to a protected bird species or if the habitat became contaminated resulting in mortality of a listed species. Marine debris produced by OCS oil- and gas-related activities as a result of accidental disposal into the water may affect protected birds by entanglement or ingestion. Due to the regulations prohibiting the intentional disposal of items, impacts would be expected to be **negligible**; however, impacts may scale up to **moderate** if the accidental release of marine debris caused mortality of a listed bird. Overall, BOEM would expect **negligible** to **moderate** impacts to protected birds considering routine activities, accidental events, and cumulative impacts. A full analysis of protected birds can be found in **Chapter 4.9.4**.

Protected Corals

Elkhorn, staghorn, boulder star, lobed star, and mountainous corals are listed by the National Marine Fisheries Service as threatened due to the decrease in their population sizes; therefore, impacts from a proposed action could have a higher level than realized by other coral species. BOEM understands this and is undergoing consultation for these species to minimize the potential impacts. Though the listed species are protected, they would have the same impacts from a proposed action as other coral species. Without effective mitigations, a proposed action could directly impact coral habitat within the GOM. Assuming adherence to all expected lease stipulations and other postlease, protective restrictions and mitigations, the routine activities related to a proposed action are expected to have mostly short-term localized and temporary effects because the site-specific survey information and distancing requirements described in NTL 2009-G39 will allow BOEM to identify and protect live bottom features (which protected corals may inhabit) from harm by proposed OCS oil- and gas-related activities during postlease reviews. While accidental events have the potential to cause severe damage to specific coral communities, the number of such events is expected to be small. Further, many of the protected corals occur in the Flower Garden Banks National Marine Sanctuary, which under the current boundaries is not proposed for future leasing under any of the alternatives in this Multisale EIS. Therefore, the incremental contribution of activities resulting from a proposed action to the overall cumulative impacts on protected corals is expected to be **negligible**. Proposed OCS oil- and gas-related activities would contribute incrementally to the overall OCS and non-OCS cumulative impacts experienced by corals. A full analysis of protected corals can be found in **Chapter 4.9.5**.

Commercial Fisheries

A proposed action could affect commercial fisheries by affecting fish populations or by affecting the socioeconomic aspects of commercial fishing. The impacts of a proposed action on fish populations are presented in **Chapter 4.7**. Routine activities such as seismic surveys, drilling activities, and service-vessel traffic can cause space-use conflicts with fishermen. Structure emplacement could have positive or negative impacts depending on the location and species. For example, structure emplacement prevents trawling in the associated area and, thus, could impact the shrimp fishery. On the other hand, production platforms can facilitate fishing for reef fish such as red snapper and groupers. Accidental events, such as oil spills, could cause fishing closures and have other impacts on the supply and demand for seafood. However, accidental events that could arise from a proposed action would likely be small and localized. A proposed action would be relatively small when compared with the overall OCS Program, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, Federal and State fisheries management strategies, and other non-OCS oil- and gas-related factors. Therefore, the incremental contribution of a proposed action to the cumulative impacts to commercial fisheries would range from **beneficial** to **minor**. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access. Alternative E would prevent these impacts from occurring, although commercial fisheries would still be subject to the impacts from the OCS Program, as well as the impacts from non-OCS sources. A full analysis of commercial fisheries can be found in **Chapter 4.10**.

Recreational Fishing

The Gulf of Mexico's extensive estuarine habitats (**Chapter 4.3.1**), live bottom habitats (**Chapter 4.6**), and artificial substrates (including artificial reefs, shipwrecks, and oil and gas platforms) support several valuable recreational fisheries. Alternatives A-D can affect recreational fishing by affecting fish populations or by affecting the socioeconomic aspects of recreational fishing. The impacts of Alternatives A-D on fish populations are presented in **Chapter 4.7**. Vessel traffic can cause space-use conflicts with anglers. Structure emplacement generally enhances recreational fishing, although this positive effect will be offset during decommissioning unless a structure were maintained as an artificial reef. Accidental events, such as oil spills, can cause fishing closures and can affect the aesthetics of fishing in an area. However, accidental events that could arise would likely be small and localized. Alternatives A-D should also be viewed in light of overall trends in OCS platform decommissioning, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternatives A-D on recreational fisheries are expected to be **negligible** to **minor**. A full analysis of recreational fishing can be found in **Chapter 4.9.11**.

Recreational Resources

Alternatives A-D would contribute to the negligible to minor aesthetic impacts and space-use conflicts that arise due to the broader OCS Program. These conflicts arise due to marine debris, the visibility of platforms, and vessel traffic. Structure emplacements can have positive impacts on recreational fishing and diving because platforms often act as artificial reefs. Oil spills can negatively affect beaches and other coastal recreational resources. Alternatives A-D should also be viewed in light of economic trends, as well as various non-OCS oil- and gas-related factors that can cause space-use conflicts and aesthetic impacts, such as commercial and military activities. Because of the relatively small contribution of any given lease sale under any of the proposed action alternatives to the overall OCS Program, in addition to other non-OCS oil- and gas-related activities, the various impacts are expected to be **beneficial** to **minor**. A full analysis of recreational resources can be found in **Chapter 4.12**.

Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are capable of providing scientific or humanistic understanding of past human behavior, cultural adaptation, and related topics through the application of scientific or scholarly techniques, such as controlled observation, contextual measurement, controlled collection, analysis, interpretation, and explanation (30 CFR § 250.105). Archaeological resources are primarily impacted by any activity that directly disturbs or has the potential to disturb the seafloor. For the OCS Program, this includes the placement of drilling rigs and production systems on the seafloor; pile driving associated with platform emplacement; pipeline placement and installation; the use of seismic receiver nodes and cables; the dredging of new channels, as well as maintenance dredging of existing channels; anchoring activities; post-decommissioning activities, including trawling clearance; and the masking of archaeological resources from industry-related infrastructure and debris.

Regardless of which planning area a proposed lease sale is held, the greatest potential impact to an archaeological resource as a result of a proposed action under any of the action alternatives is site-specific and would result from direct contact between an offshore activity or accidental event and a site. Archaeological surveys, where required prior to an operator beginning OCS oil- and gas-related activities on a lease, are expected to be effective at identifying possible archaeological sites. There is no acceptable threshold of negative cumulative impacts to archaeological sites. A proposed action's alternatives, including the drilling of wells and installation of platforms, installation of pipelines, anchoring, and removal of platforms and other structures installed on the seafloor and site clearance activities without archaeological review and mitigation, may result in major, adverse impacts to archaeological sites. Identification, evaluation, and avoidance or mitigation of archeological resources is expected to result in **negligible**, long-term cumulative impacts to archeological resources; however, if an archaeological site were to be impacted, impacts may range from **negligible** to **major**. A full analysis of archaeological resources can be found in **Chapter 4.13**.

Human Resources and Land Use (Including Environmental Justice)

Land Use and Coastal Infrastructure

Oil and gas exploration, production, and development activities on the OCS are supported by an expansive onshore network of coastal infrastructure that includes hundreds of large and small companies. Because OCS oil- and gas-related activities are supported by this long-lived, expansive onshore network, the potential impacts of a proposed lease sale are not expected to produce any major impacts to land use and coastal infrastructure. The impacts of reasonably foreseeable accidental events such as oil spills, chemical and drilling fluid spills, and vessel collisions are not likely to last long enough to adversely affect overall land use or coastal infrastructure in the analysis area. In the cumulative analysis, activities relating to all past, present, and future OCS oil- and gas-related activities and State oil and gas production are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks. Non-OCS oil- and gas-related factors contribute substantially to the cumulative impacts on land use and coastal infrastructure, while there is only a small incremental contribution of a proposed lease sale. The cumulative impacts on land use and coastal infrastructure could range from **negligible** to **major** depending on the specifics of each situation, whether the impacts are measurable, how long the impacts would last, and the size of the affected geographic area as defined in **Chapter 4.14.1**. A full analysis of land use and coastal infrastructure can be found in **Chapter 4.14.1**.

Economic Factors

A proposed lease sale would lead to beneficial impacts arising from industry expenditures, government revenues, corporate profits, and other market impacts. Some of these impacts would be concentrated along the Gulf Coast, while others would be widely distributed. A proposed lease sale would also lead to negative economic impacts arising from accidental events and other sources. There would be some differences in economic impacts among Alternatives A-D, corresponding to the differences in the scales and distributions of likely activities. Alternatives A-D should be viewed in light of the OCS Program, as well the numerous forces that can affect energy markets and the overall economy. Most of the incremental economic impacts of a proposed action are forecast to be positive, although there would be some **negligible** to **minor** adverse impacts due to oil spills and to the effects on industries that compete with the offshore oil and gas industry for resources. A full analysis of economic factors can be found in **Chapter 4.14.2**.

Social Factors (Including Environmental Justice)

Potential social impacts resulting from a proposed action would occur within the larger socioeconomic context of the GOM region. The affected environment of the analysis area is quite large geographically and in terms of population (133 counties and parishes with over 22.7 million residents). The impacts from routine activities related to a proposed action are expected to be **negligible**, widely distributed, and to have little impact because of the existing extensive and widespread support system for the petroleum industry and its associated labor force. Outside of a low-probability catastrophic oil spill, which is not reasonably foreseeable and not part of a proposed action, any potential accidental events are not likely to be of sufficient scale or duration to have adverse and disproportionate long-term impacts for people and communities in the analysis area. Non-OCS oil- and gas-related factors, which include all human activities, natural events, and processes, actually contribute more to cumulative impacts than do factors related to OCS oil- and gas-related activities alone. When considered with existing and projected routine activities and cumulative impacts and the potential accidental events, the incremental contributions of a proposed action and the OCS Program to social impacts are expected to be **minor**. The oil and gas industry in the GOM region is expansive and long-lived over several decades with substantial infrastructure in place to support both onshore and offshore activities. BOEM’s scenario estimates call for 0-1 new gas processing plant and 0-1 new pipeline landfall over the 50-year life of a single proposed action. Impacts to GOM populations from a proposed action would be immeasurable for environmental justice since these low-income and minority communities are located onshore, distant from Federal OCS oil- and gas-related activities. Also, since these vulnerable populations are located within the larger context of onshore and State-regulated nearshore oil and gas activities that are connected to downstream infrastructure over which BOEM has no regulatory authority, BOEM has determined that a proposed action would not produce environmental justice impacts in the GOM region. A full analysis of social factors and an environmental justice determination can be found in **Chapter 4.14.3**.

APPENDICES

To improve the readability of this Multisale EIS, more detailed supporting information has been placed in the appendices, which include postlease processes, commonly applied mitigating measures, a Memorandum of Agreement between BOEM and the U.S. Environmental Protection Agency, prelease stipulations, OSRA figures, species not considered further, and State Coastal Management Programs.

Appendix A describes postlease activities, including the following: geological and geophysical surveys; exploration and development plans; permits and applications; inspection and enforcement; pollution prevention, oil-spill response plans, and financial responsibility; air emissions; flaring and venting; hydrogen sulfide contingency plans; archaeological resources regulation; coastal zone management consistency review and appeals for postlease activities; best available and safest technologies, including at production facilities; personnel training and education; structure removal and site clearance; marine protected species NTLs; and the Rigs-to-Reefs program.

Appendix B describes commonly applied mitigations that were developed as a result the continuing OCS Program in the Gulf of Mexico. These are mitigations that BOEM and BSEE could apply to permits and approvals. These mitigating measures address concerns such as endangered and threatened species, geologic and manmade hazards, military warning and ordnance disposal areas, archaeological sites, air quality, oil-spill response planning, chemosynthetic communities, artificial reefs, operations in hydrogen sulfide-prone areas, and shunting of drill effluents in the vicinity of biologically sensitive features. Operational compliance of the mitigating measures is enforced through BSEE's onsite inspection program.

Appendix C is the Memorandum of Agreement between BOEM and the USEPA; it outlines the roles and responsibilities for both agencies during the preparation of this Multisale EIS.

Appendix D describes the potential lease stipulations that were developed as a result of numerous scoping efforts for the continuing OCS Program in the Gulf of Mexico. The 10 lease stipulations being considered are the Topographic Features Stipulation; Live Bottom (Pinnacle Trend) Stipulation; Military Areas Stipulation; Evacuation Stipulation; Coordination Stipulation; Blocks South of Baldwin County, Alabama, Stipulation; Protected Species Stipulation; United Nations Convention on the Law of the Sea Royalty Payment Stipulation; Below Seabed Operations Stipulation; and the Stipulation on the Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico (Transboundary Stipulation). The United Nations Convention on the Law of the Sea Royalty

Payment Stipulation is applicable to a proposed lease sale even though it is not an environmental or military stipulation.

Appendix E provides the combined probabilities for an offshore oil spill ≥1,000 barrels occurring and contacting coastal and offshore areas for each of the proposed actions.

Appendix F is a listing of species not considered further in this Multisale EIS because these species are not generally found in the area of activity and/or impact. Therefore, it is not reasonably foreseeable that these species would have population effects from a proposed action.

Appendix G describes State Coastal Management Programs (CMPs). Each State's CMP is a comprehensive statement setting forth objectives, enforceable policies or guidelines, and standards for public and private use of land and water resources and uses in that State's coastal zone. The programs provide for direct State land and water use planning and regulations. The programs also include a definition of what constitutes permissible land uses and water uses. To ensure conformance with State CMP policies or guidelines and local land use plans, BOEM prepares a Federal consistency determination for each proposed OCS lease sale. Federal consistency is the Coastal Zone Management Act requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone must be consistent to the maximum extent practicable with the enforceable policies or guidelines of a coastal State's federally approved CMP.

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ABBREVIATIONS AND ACRONYMS

°C	degree Celsius
°F	degree Fahrenheit
µg	microgram
µg/g	micrograms/gram
2012-2017 Five-Year Program	*Proposed Final Outer Continental Shelf Oil & Gas Leasing Program: 2012-2017*
2012-2017 WPA/CPA Multisale EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017; Western Planning Area Lease Sales 229, 233, 238, 246, and 248; Central Planning Area Lease Sales 227, 231, 235, 241, and 247; Final Environmental Impact Statement; Volumes I-III*
2D	two dimensional
3D	three dimensional
ac	acre
Agreement	Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico
AL	Alabama
API	American Petroleum Institute
Area ID	Area Identification
ASLM	Assistant Secretary of the Interior for Land and Minerals
bbl	barrel
Bbbl	billion barrels
Bcf	billion cubic feet
BBO	billion barrels of oil
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	blowout preventer
BP	Before Present
BSEE	Bureau of Safety and Environmental Enforcement
BTEX	benzene, toluene, ethylbenzene, and xylene
Call	Call for Information
Cd	cadmium
CD	Consistency Determination
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CEWAF	chemically enhanced (dispersed) water-accommodated fractions
CFR	Code of Federal Regulations
CG	Coast Guard (also: USCG)
CH_4	methane
CIAP	Coastal Impact Assistance Program
CMP	Coastal Management Program

CO	carbon monoxide
CO_2	carbon dioxide
COE	Corps of Engineers (U.S. Army)
CPA	Central Planning Area
CPA 235/241/247 Supplemental EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2015-2017; Central Planning Area Lease Sales 235, 241, and 247; Final Supplemental Environmental Impact Statement*
CPRA	Coastal Protection and Restoration Authority
Cu	copper
CSA	Continental Shelf Associates
CYP1A	cytochrome P-4501A
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act
CZMA	Coastal Zone Management Act
dB	decibel
dB re: 1μPa	decibels referenced 1 microPascal
DOI	Department of the Interior (U.S.) (also: USDOI)
DOT	Department of Transportation (U.S.) (also: USDOT)
DMR	discharge monitoring report
DPP	development and production plan
Draft Proposed Program	*2017-2022 OCS Oil and Gas Leasing: Draft Proposed Program*
EFH	essential fish habitat
e.g.	for example
EIA	Economic Impact Area
EIS	environmental impact statement
EPA	Eastern Planning Area
EPA 225/226 EIS	*Gulf of Mexico OCS Oil and Gas Lease Sales: 2014 and 2016; Eastern Planning Area Lease Sales 225 and 226; Final Environmental Impact Statement*
EPAct	Energy Policy Act of 2005
ERMA	Environmental Response Management Application
ESA	Endangered Species Act of 1973
ESI	Environmental Sensitivity Index
et al.	and others
et seq.	and the following
FERC	Federal Energy Regulatory Commission
Five-Year Program	*2017-2022 Outer Continental Shelf Oil & Gas Leasing: Proposed Program* (also: 2017-2022 Five-Year Program)
Five-Year Program EIS	*Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022, Final Environmental Impact Statement*
FL	Florida
FGBNMS	Flower Garden Banks National Marine Sanctuary
FPSO	floating production, storage, and offloading system
FR	*Federal Register*

ft	feet
FWS	Fish and Wildlife Service
G&G	geological and geophysical
g	gram
GAP	General Activities Plan
GIS	Geographic Information System
GIWW	Gulf Intracoastal Waterway
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
GPS	global positioning system
GUIS	Gulf Islands National Seashore
GWEI	Gulfwide Emission Inventory
H_2S	hydrogen sulfide
ha	hectare
HAPC	habitat area of particular concern
Hg	mercury
HRG	high-resolution geophysical
i.e.	that is
km	kilometer
IPCC	Intergovernmental Panel on Climate Change
ITL	Information to Lessees and Operators
LA	Louisiana
lb	pound
LCA	Louisiana Coastal Area
LNG	liquefied natural gas
LOOP	Louisiana Offshore Oil Port
m	meter
MAG-PLAN	MMS Alaska-GOM Model Using IMPLAN
MARAD	Maritime Administration (U.S. Department of Transportation)
Mcf	thousand cubic feet
MCV	modular capture vessel
mg/L	milligrams/liter
mi	mile
mm	millimeter
MMbbl	million barrels
MMcf	million cubic feet
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MODU	mobile offshore drilling unit
MOU	Memorandum of Understanding
MS	Mississippi
MWCC	Marine Well Containment Company
N_2O	nitrous oxide

NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NAZ	narrow azimuth
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NGL	natural gas liquids
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
nmi	nautical-mile
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent to Prepare an EIS
NOS	National Ocean Service
NPDES	National Pollutant and Discharge Elimination System
NPS	National Park Service
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NTL	Notice to Lessees and Operators
O_3	ozone
OBF	oil-based fluid
OCD	Offshore and Coastal Dispersion
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ODMDS	ocean dredged-material disposal site
OSAT	Operational Science Advisory Team
OSHA	Occupational Safety and Health Administration
OSRA	Oil Spill Risk Analysis
OSRP	oil-spill response plan
OSV	offshore supply/service vessel
P.L.	Public Law
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PBR	Potential Biological Removal
PDARP/PEIS	*Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement*
pH	potential of hydrogen
PM	particulate matter
$PM_{2.5}$	particulate matter less than or equal to 2.5 μm
PM_{10}	particulate matter less than or equal to 10 μm
ppm	parts per million
PSD	Prevention of Significant Deterioration

psi	pounds per square inch
RESTORE Act	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act
ROD	Record of Decision
RSDFO	Regional Supervisor for District Field Operations
SAP	Site Assessment Plan
SBF	synthetic-based fluid
SBM	synthetic-based mud
Secretary	Secretary of the Interior
SEL	sound exposure level
SMART	Special Monitoring of Applied Response Technologies
SO_2	sulphur dioxide
SO_x	sulphur oxides
Stat.	Statute
SURF	subsea umbilical, risers, and flowlines
sVGP	Small Vessel General Permit
Tcf	trillion cubic feet
TLP	tension-leg platform
Trustee Council	Natural Resource Damage Assessment Trustee Council
TX	Texas
U.S.	United States
U.S.C.	United States Code
UME	unusual mortality event
UNCLOS	United Nations Convention on the Law of the Sea
USCG	U.S. Coast Guard (also: CG)
USDHS	U.S. Department of Homeland Security
USDOC	U.S. Department of Commerce
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior (also: DOI)
USDOT	U.S. Department of Transportation (also: DOT)
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VGP	Vessel General Permit
VOC	volatile organic compound
VSP	vertical seismic profiling
W.	west
WAF	water-accommodated fraction
WAZ	wide azimuth
WBF	water-based fluid
WPA	Western Planning Area
yd	yard
Zn	zinc

CONVERSION CHART

To convert from	To	Multiply by
centimeter (cm)	inch (in)	0.3937
millimeter (mm)	inch (in)	0.03937
meter (m)	foot (ft)	3.281
meter^2 (m^2)	foot^2 (ft^2)	10.76
meter^2 (m^2)	yard^2 (yd^2)	1.196
meter^2 (m^2)	acre (ac)	0.0002471
meter^3 (m^3)	foot^3 (ft^3)	35.31
meter^3 (m^3)	yard^3 (yd^3)	1.308
kilometer (km)	mile (mi)	0.6214
kilometer^2 (km^2)	mile^2 (mi^2)	0.3861
hectare (ha)	acre (ac)	2.47
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) = 1.15 mi (1.85 km) or 6,076 ft (1,852 m) tonnes = 1 long ton or 2,240 pounds (lb)		

CHAPTER 1

PURPOSE OF AND NEED FOR THE PROPOSED ACTIONS

What's in This Chapter

- The Bureau of Ocean Energy Management (BOEM) proposes 10 regionwide Gulf of Mexico lease sales: one per year in August 2017 through 2021 and one per year in March 2018 through 2022.
- These lease sales are being proposed pursuant to the Outer Continental Shelf Lands Act of 1953 (OCSLA) and are intended to help meet the Nation's energy needs in the next 5 years.
- The need for the proposed actions is to manage the development of Outer Continental Shelf (OCS) energy resources in an environmentally and economically responsible manner. Oil from the Gulf of Mexico OCS would contribute to meeting domestic demand and enhance national economic security.
- Pursuant to the OCSLA's staged leasing process, for each lease sale proposed in the Five-Year Program, BOEM makes individual decisions on whether and how to proceed with each proposed lease sale.
- Following an established, robust decisionmaking process that invites input from numerous interested parties and the general public, BOEM produced this 2017-2022 Gulf of Mexico Multisale Environmental Impact Statement (Multisale EIS) to use as the basis for the first proposed lease sale and for supplemental NEPA reviews for the subsequent proposed lease sales.
- This Multisale EIS explains the environmental considerations and potential mitigations to assess the potential environmental consequences of the proposed actions and alternatives.

1 PURPOSE OF AND NEED FOR THE PROPOSED ACTIONS

Proposed 2017-2022 Gulf of Mexico OCS Region Lease Sale Schedule	
Lease Sale Number	Year
249	2017
250 and 251	2018
252 and 253	2019
254 and 256	2020
257 and 259	2021
261	2022

The Bureau of Ocean Energy Management (BOEM) proposes to conduct 10 regionwide Gulf of Mexico (GOM) oil and gas lease sales, which are tentatively scheduled in the *Proposed Outer Continental Shelf Oil & Gas Leasing Program: 2017-2022* (Five-Year Program; USDOI, BOEM, 2016a). Five regionwide lease sales are tentatively scheduled in August of each year from 2017 through 2021 and five regionwide lease sales are tentatively scheduled in March of each year from 2018 through 2022. The lease sales proposed in the GOM in the Five-Year Program are regionwide lease sales comprised of the Western, Central, and a small portion of the Eastern Planning Areas (WPA, CPA, and EPA, respectively) not subject to Congressional moratorium. These planning areas are located off the States of Texas, Louisiana, Mississippi, Alabama, and Florida (**Figure 1-1**). Even though the Five-Year Program includes regionwide lease sales, any individual lease sale could still be scaled back during the prelease sale process to conform more closely to the separate planning area model used in the *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program*: *2012-2017* (2012-2017 Five-Year Program; USDOI, BOEM, 2012a), should circumstances warrant.

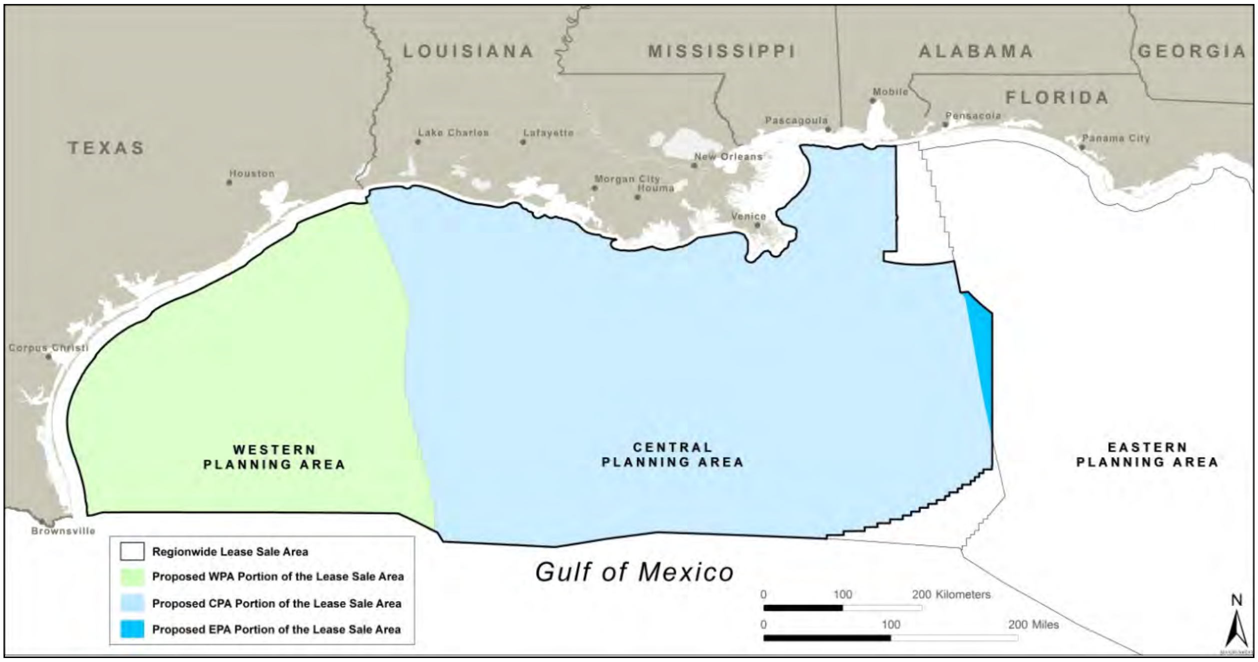

Figure 1-1. Proposed Regionwide Lease Sale Area Combining the Western, Central, and Eastern Planning Areas.

The Secretary of the Interior (Secretary) has designated BOEM as the administrative agency responsible for the leasing of submerged Outer Continental Shelf (OCS) lands and for the supervision of certain offshore operations after lease issuance. BOEM is responsible for managing development of the Nation's offshore resources in an environmentally and economically responsible way. The functions of BOEM include the following: leasing; oversight of exploration and development; plan administration; environmental studies; National Environmental Policy Act (NEPA) analyses; resource evaluation, economic, and the Marine Minerals Program analyses; and the renewable energy program. The Bureau of Safety and Environmental Enforcement (BSEE) is responsible for enforcing safety and environmental regulations. The functions of BSEE include all field operations, including permitting for drilling and decommissioning, research, inspections, offshore regulatory programs, oil-spill response, and training and environmental compliance functions.

The proposed lease sales would 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.

1.1 Purpose of the Proposed Actions

The Outer Continental Shelf Lands Act of 1953, as amended (43 U.S.C. §§ 1331 *et seq*.), hereafter referred to as OCSLA, establishes the Nation's policy for managing the

> *"It is hereby declared to be the policy of the United States that ... the Outer Continental Shelf is a vital national resource held by the Federal Government for the public, which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs."*
>
> OCSLA, 43 U.S.C. §§ 1331 *et seq.*

vital energy and mineral resources of the OCS. Section 18 of OCSLA requires the Secretary to prepare and maintain a schedule of proposed OCS oil and gas lease sales determined to "best meet national energy needs for the 5-year period following its approval or reapproval" (43 U.S.C. § 1344). The Five-Year Program establishes a schedule that the U.S. Department of the Interior (USDOI or DOI) will use as a basis for considering where and when leasing might be appropriate over a 5-year period.

The purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and gas resources in accordance with OCSLA.

1.2 NEED FOR THE PROPOSED ACTIONS

The need for the proposed actions is to manage the development of the OCS energy resources in an environmentally and economically responsible manner. Oil serves as the feedstock for liquid hydrocarbon products, including gasoline, aviation and diesel fuel, and various petrochemicals. Oil from the Gulf of Mexico OCS contributes to meeting domestic demand and enhances national economic security.

In 2014, the United States (U.S.) consumed 19.03 million barrels (MMbbl) of oil per day (USDOE, Energy Information Administration, 2015a) and 25.26 trillion cubic feet (Tcf) of natural gas per day (USDOE, Energy Information Administration, 2015b). Over the next 20 years, the Energy Information Administration expects the U.S. to rely on more oil and natural gas to meet its energy demands, even as alternative sources of energy provide an increasing share of U.S. energy needs. The Energy Information Administration projects that consumption of liquid fuels will decrease slightly through 2040, but consumption of natural gas would increase by a greater amount over the same period.

The surge in production from large onshore tight-formation plays has also impacted the U.S. energy market by keeping domestic natural gas prices far below benchmark prices in many other parts of the world, converting the U.S. into a net exporter of natural gas. Companies are planning and constructing liquefied natural gas (LNG) export terminals, hoping to take advantage of prices that can be more than twice the level of U.S. prices. Less expensive natural gas has also reduced manufacturing energy costs. Many companies are beginning or increasing U.S operations or returning manufacturing from overseas. This natural gas renaissance is helping to curb the long-term decline in U.S. manufacturing jobs and is providing a competitive advantage for the U.S. manufacturing industry. The advances in tight oil production also provide more timely responses to changing prices and other conditions, helping to mitigate market swings in supply and prices. Conversely, projects like those on the OCS provide a fairly stable source of oil and gas that is not as susceptible to changes in markets or early assumptions about undiscovered resources, prices, technology, and recovery rates. This overall stability allows for long-term planning for infrastructure and other needs.

Since the U.S. is expected to continue to rely on oil and natural gas to meet its energy needs, the proposed actions would contribute to meeting domestic demand. The OCS is a major long-term supplier of crude oil and natural gas, and the Gulf of Mexico OCS region has the greatest resource potential of the four OCS regions in the United States. Crude oil recovered from the OCS is of high importance to U.S refineries, especially along the Gulf Coast. In 2014, the Gulf of Mexico OCS produced 17 percent of domestic oil production and 5 percent of domestic natural gas production. For more details on national energy markets, refer to Chapter 4.3 of the *2017-2022 OCS Oil and Gas Leasing: Draft Proposed Program* (Draft Proposed Program) (USDOI, BOEM, 2015a).

1.3 OCS OIL AND GAS PROGRAM PLANNING AND DECISION PROCESS

BOEM produces NEPA documents for each of the major stages of energy development planning. From the overarching Five-Year Program EIS, through each of the NEPA documents for the energy lease sales, and followed by more site-specific reviews for exploration, development and production, and platform removal plans (**Figure 1-2**).

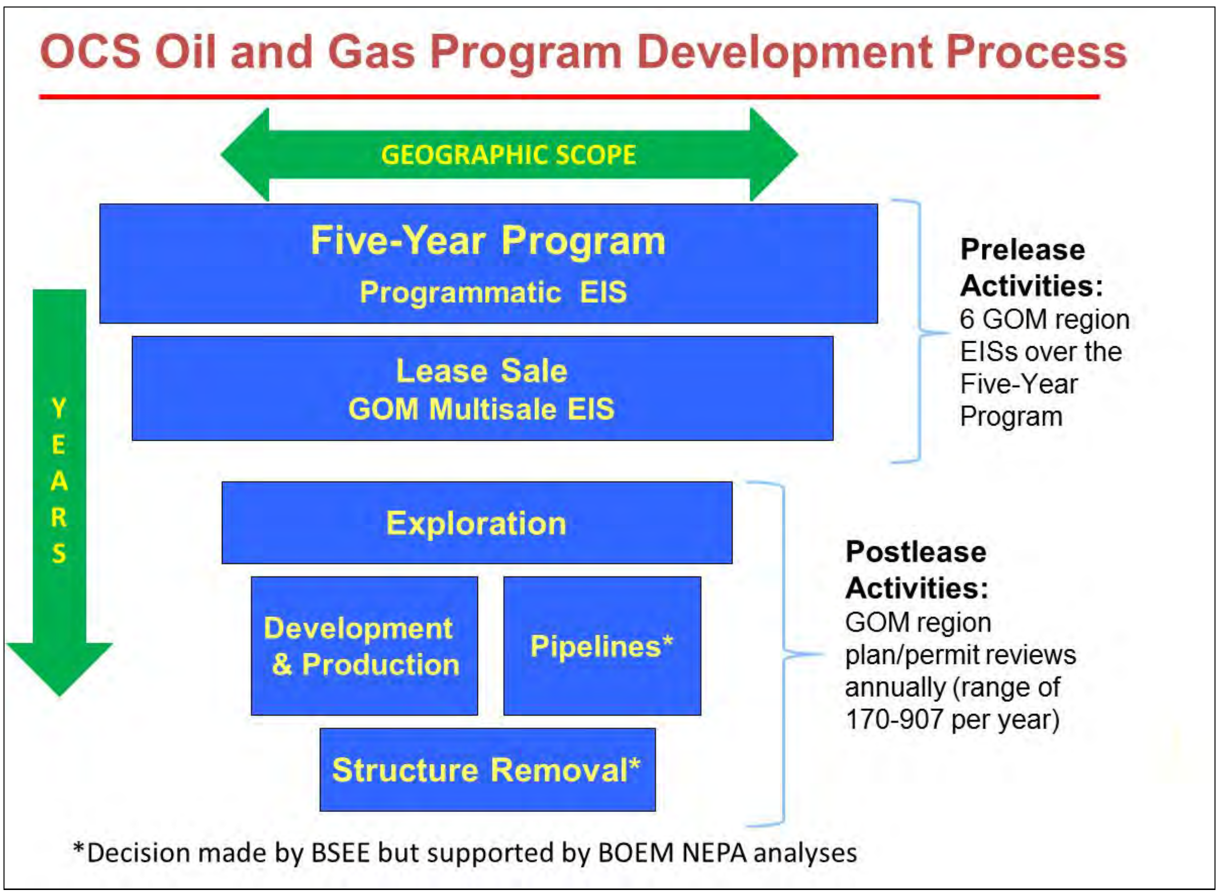

Figure 1-2. OCS Oil and Gas Program Development Process.

1.3.1 Prelease Process

BOEM has a two-stage Federal offshore prelease sale planning process:

(1) develop a Five-Year Program of proposed offshore lease sales for the OCS Program; and

(2) conduct an individual lease sale consultation and decision process for each lease sale on the approved Five-Year Program.

Due to the staged decisionmaking process in OCSLA, BOEM does a staged or tiered process in which NEPA documents are prepared that cover potential impacts associated with the various stages of the OCSLA process. This includes analyses at the Five-Year Program stage, proposed lease sale stage, exploration or development and production plan stage, and various permitting stages, including, but not limited to, drilling and decommissioning. At the lease sale stage, this is typically done through an EIS, which discusses postlease activities. However, at this stage, no activities beyond certain ancillary activities are actually authorized by the lease; therefore, there are few environmental impacts reasonably expected from the lease sale itself.

1.3.1.1 Five-Year Program of Proposed Offshore Lease Sales

As required by OCSLA, a new program—to cover the years 2017-2022—is under development. The Draft Proposed Program (USDOI, BOEM, 2015a) was the first proposal in the staged preparation process of the new Five-Year Program, which is a nationwide schedule of proposed lease sales. The Draft Proposed Program proposed a schedule of 14 potential lease sales in eight OCS planning areas: 10 lease sales in the three GOM planning areas; 1 lease sale each in the Chukchi Sea, Beaufort Sea, and Cook Inlet Planning Areas, offshore Alaska; and 1 lease sale in a portion of the combined Mid-Atlantic and South Atlantic Planning Areas. BOEM received hundreds of thousands of comments in response to the publication of the Draft Proposed Program and analyzed the comments as appropriate for the second proposal in the staged preparation process—the Five-Year Program. The Five-Year Program was released for public comment in March 2016 (USDOI, BOEM, 2016a).

The *2017-2022 OCS Oil and Gas Leasing Program: Programmatic Environmental Impact Statement* (Five-Year Program EIS) (USDOI, BOEM, 2016b) includes an analysis of the potential environmental impacts of a proposed action, the GOM proposed lease sales in the Five-Year Program. It also analyzes reasonable alternatives to the proposed lease sale schedule and the mitigating measures that may reduce or eliminate any potential impacts. On January, 29, 2015, BOEM released a Notice of Intent (NOI) to prepare the Programmatic EIS in conjunction with the release of the Draft Proposed Program. As a part of the NOI, BOEM solicited public input on the scope of the environmental analysis and on the alternatives and mitigating measures to be analyzed. BOEM received thousands of comments and analyzed and incorporated these as appropriate into the Programmatic EIS. The Draft Programmatic EIS was released for public comment in March 2016 (**Figure 1-3**).

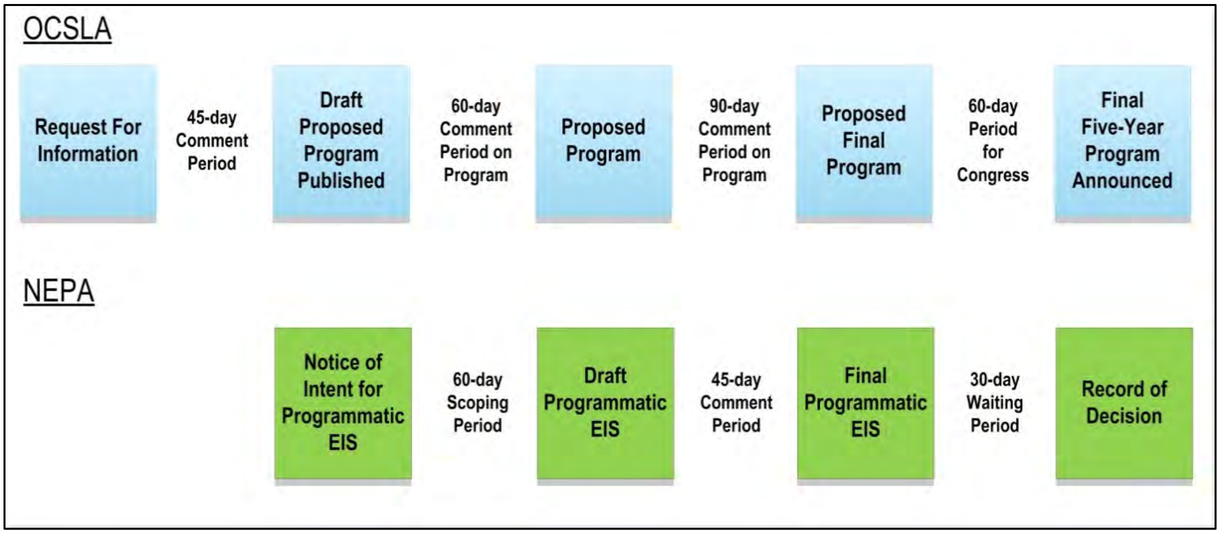

Figure 1-3. *Planning for the Five-Year Program.*

1.3.1.2 Individual Lease Sale Consultation and Decision Process

The development of the Five-Year Program also triggers region-specific NEPA reviews for the proposed lease sales (refer to **Figure 1-4**). Region-specific reviews are conducted by Program Area (i.e., the Gulf of Mexico, Alaska, and Atlantic OCS Regions) prior to lease sale decisions for those areas that are included in the Program; however, the NEPA process could be halted if a Program Area is removed from the Five-Year Program. (No lease sales are currently proposed in the Pacific Region.) In order for the Gulf of Mexico OCS Region to complete this NEPA review prior to the first proposed lease sale in the fall of 2017, BOEM initiates scoping for the proposed lease sales in the GOM soon after the Five-Year Program EIS process is initiated. This allows for the NEPA analysis for the GOM proposed lease sales to be tiered from the Five-Year Program EIS analysis.

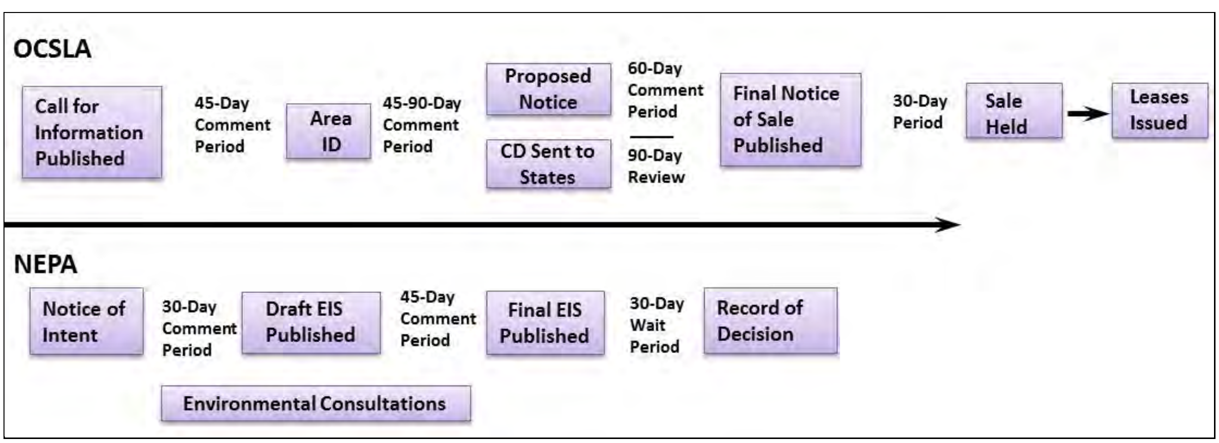

Figure 1-4. Planning for Regional OCS Oil and Gas Lease Sales.

Pursuant to the OCSLA staged leasing process, for each lease sale proposed in the Five-Year Program, BOEM makes individual decisions on whether and how to proceed with a proposed lease sale. Federal regulations allow for several related or similar proposals to be analyzed in one

EIS (40 CFR § 1502.4). Since each proposed lease sale and the projected activities related to such a lease sale are very similar, BOEM has decided to prepare a single EIS for the 10 proposed GOM lease sales in the Five-Year Program. However, as previously noted, OCSLA requires individual decisions to be made for each lease sale. Therefore, in order to make an informed decision on a single lease sale, the analyses contained in this Multisale EIS examine impacts from a single regionwide lease sale. A lease sale scenario, described in **Chapter 3**, includes all of the activities that could occur over a 50-year analysis period. The findings of these analyses can be applied individually to each of the subsequent proposed lease sales.

Unlike the 2012-2017 Five-Year Program in the GOM, BOEM does not plan to prepare a Supplemental EIS for every lease sale. However, given the long lead times necessary to complete an EIS or Supplemental EIS and the short timeframe between the proposed GOM lease sales in the Five-Year Program, BOEM plans to supplement this Multisale EIS on a regular basis to provide for more consistency and for planning purposes. Unless circumstances or information warrants an earlier Supplemental EIS, BOEM expects to issue a Supplemental EIS once a calendar year. An additional NEPA review (e.g., a Determination of NEPA Adequacy [DNA], an environmental assessment [EA] or, if determined necessary, a Supplemental EIS) will be conducted prior to the subsequent proposed GOM lease sales to address any relevant new information. Each subsequent supplemental review will tier from the previous NEPA documents in this series of reviews as illustrated in **Figure 1-5**. Informal and formal consultation with other Federal agencies, federally recognized Indian Tribes, the affected States, and all stakeholders may also be carried out as appropriate. Information requests will be issued soliciting input on subsequent GOM lease sales. This Multisale EIS will assist decisionmakers in making informed, future decisions regarding the approval of operations, as well as leasing.

Also, according to the Five-Year Program, any individual lease sale could still be scaled back during the prelease sale process to offer a smaller area should circumstances warrant. For example, an individual lease sale could offer an area that conforms more closely to the separate planning area model used in the 2012-2017 Five-Year Program. Therefore, the analyses in this Multisale EIS also include alternatives similar to past WPA, CPA, and EPA lease sale environmental reviews.

This Multisale EIS will be the NEPA document prepared for proposed Lease Sale 249. Subsequently, BOEM will prepare a supplemental NEPA document for each of the other proposed lease sales in the Five-Year Program. Respective NEPA documents will be completed before decisions are made on the subsequent lease sales. This Multisale EIS approach allows for subsequent NEPA analyses to focus on changes in the proposed lease sales and on new issues and information available since the publication of the previous NEPA document.

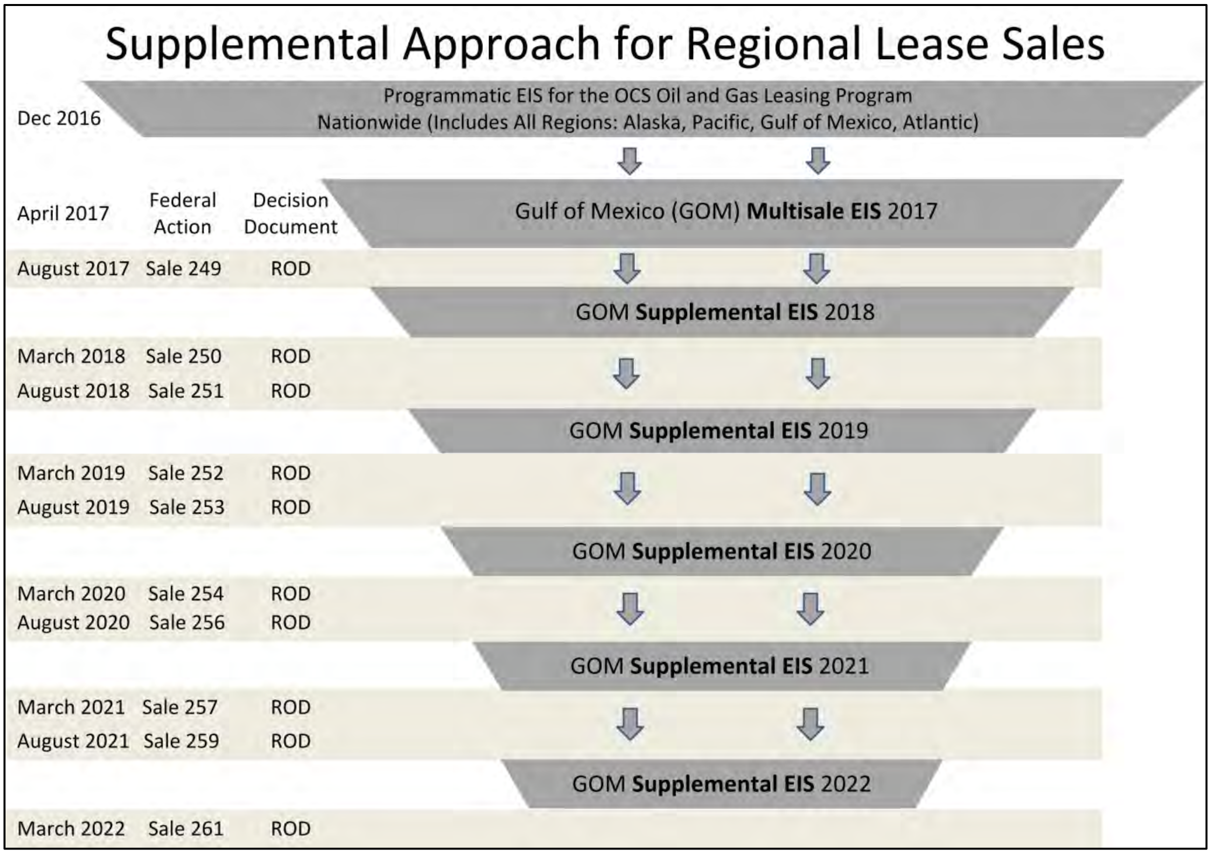

Figure 1-5. Supplemental Approach Showing the Tiering Relationships for Proposed Gulf of Mexico Lease Sales.

1.3.2 Gulf of Mexico Postlease Activities

BOEM and BSEE are responsible for managing, regulating, and monitoring oil and natural gas exploration, development, and production operations on the Federal OCS to promote the orderly development of mineral resources in a safe and environmentally sound manner. BOEM's regulations for oil, gas, and sulphur lease operations are specified in 30 CFR parts 550, 551, 554, and 556. The BSEE's regulations for oil, gas, and sulphur operations are specified in 30 CFR parts 250 and 254. Refer to **Appendix A** for descriptions of postlease activities, including the following: geological and geophysical (G&G) surveys; exploration and development plans; permits and applications; inspection and enforcement; pollution prevention, oil-spill response plans, and financial responsibility; air emissions; flaring and venting; hydrogen sulfide contingency plans; archaeological resources regulation; coastal zone management consistency review and appeals for postlease activities; best available and safest technologies, including at production facilities; personnel training and education; structure removal and site clearance; marine protected species NTLs; and the Rigs-to-Reefs program.

All plans for OCS oil- and gas-related activities (e.g., exploration and development plans) go through rigorous BOEM review and approval to ensure compliance with established laws and regulations before any project-specific activities can begin on a lease. Existing mitigating measures are incorporated and documented in plans submitted to BOEM. These measures may be implemented through, among other things, lease stipulations and project-specific requirements or conditions of approval. Conditions of approval are based on BOEM's and BSEE's technical and environmental evaluations of the proposed operations. Conditions may be applied to any OCS plan, permit, right-of-use and easement, or pipeline right-of-way grant.

Mitigating measures address concerns such as endangered and threatened species, geologic and manmade hazards, military warning and ordnance disposal areas, archaeological sites, air quality, oil-spill response planning, chemosynthetic communities, artificial reefs, operations in hydrogen sulfide (H_2S)-prone areas, and shunting of drill effluents in the vicinity of biologically sensitive features. Refer to **Appendix B** ("Commonly Applied Mitigating Measures") for more information on the mitigations that BOEM and BSEE often apply to permits and approvals. Operational compliance of the mitigating measures is enforced through BSEE's onsite inspection program.

BOEM and BSEE issue Notices to Lessees and Operators (NTLs) to provide clarification, description, or interpretation of a regulation; guidelines on the implementation of a special lease stipulation or regional requirement; or convey administrative information. A detailed listing of the current Gulf of Mexico OCS Region's NTLs is available through BOEM's Gulf of Mexico OCS Region's website at http://boem.gov/Regulations/Notices-Letters-and-Information-to-Lessees-and-Operators.aspx or through the Region's Public Information Office at 504-736-2519 or 1-800-200-GULF.

1.4 The Decision to be Made

BOEM will make an individual decision on whether and how to proceed with each proposed lease sale in the Five-Year Program. After completion of this Multisale EIS, BOEM will make a decision on proposed Lease Sale 249 (i.e., prepare a Record of Decision for Lease Sale 249 only). As discussed in **Chapter 1.3.1**, individual decisions will be made on each subsequent lease sale after completion of the appropriate supplemental NEPA documents.

1.5 Regulatory Framework

Federal laws mandate the OCS leasing program (i.e., OCSLA) and the environmental review process (i.e., NEPA). These regulations are intended to encourage orderly, safe, and environmentally responsible development of oil, natural gas, alternative energy sources, and other mineral resources on the OCS. BOEM consults with numerous federally recognized Indian Tribes and Federal and State departments and agencies that have authority to govern and maintain ocean resources pursuant to other Federal laws. As illustrated in **Figure 1-6**, BOEM's consultation partners for specific Federal regulations, several Federal regulations establish specific consultation and coordination processes with federally recognized Indian Tribes and Federal, State, and local agencies.

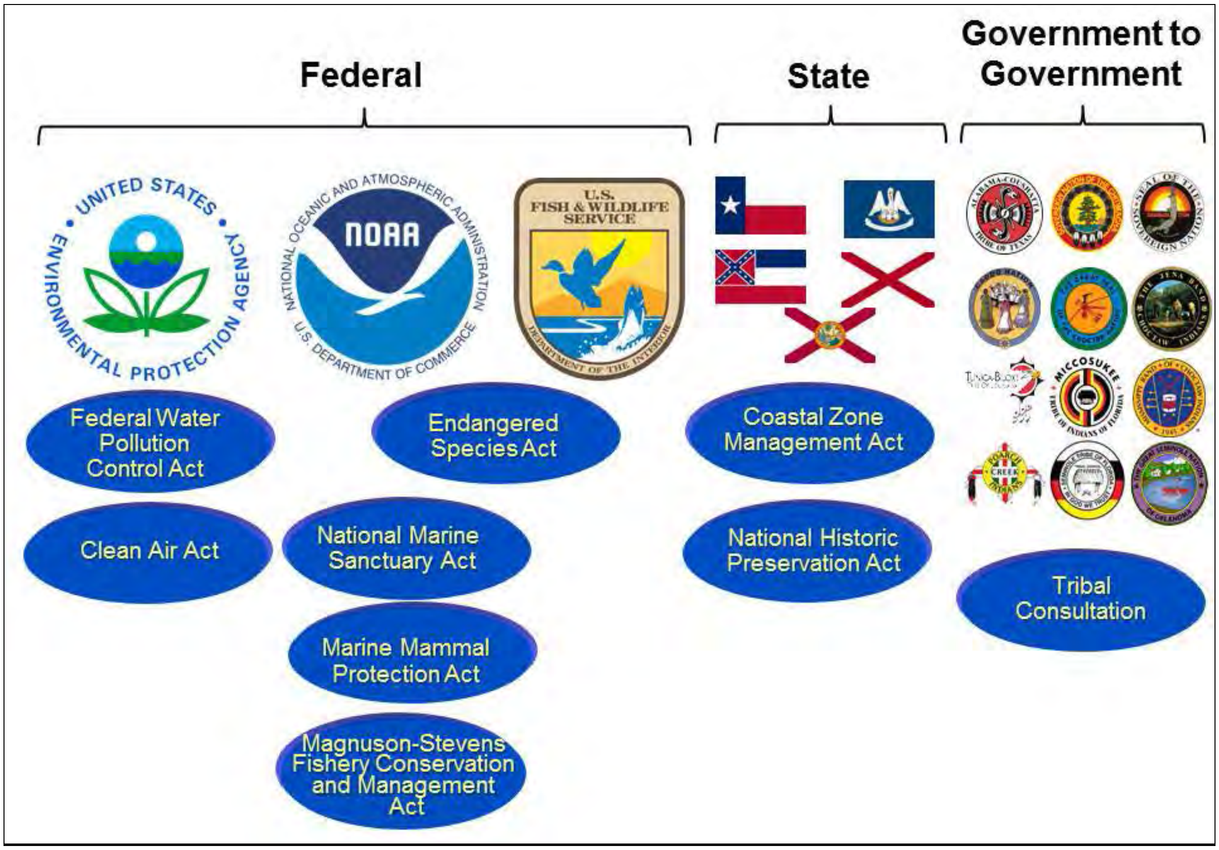

Figure 1-6. *BOEM's Consultation Partners for Specific Federal Regulations.*

Among these Federal entities are the U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (COE), U.S. Fish and Wildlife Service (FWS), and the National Oceanic and Atmospheric Administration (NOAA) through the National Marine Fisheries Service (NMFS). In addition to coordinating with Federal Government entities, BOEM coordinates and consults with any State governor or local government executives that may be affected by a particular lease, easement, or right-of-way. Each state, with the exception of Alaska, has developed and implemented a federally approved coastal management program pursuant to the Coastal Zone Management Act (16 U.S.C. §§ 1451 *et seq*.). The boundaries of each State's coastal zone are available at https://coast.noaa.gov/czm/media/StateCZBoundaries.pdf. A detailed description of major Federal laws and Executive Orders that are relevant to the OCS leasing process is provided in the *OCS Regulatory Framework* white paper, which can be found on BOEM's website (Cameron and Matthews, 2016). Chapter 3 of BOEM's *OCS Regulatory Framework* white paper identifies 43 major Federal laws and Executive Orders that are relevant to the OCS leasing process (Cameron and Matthews, 2016). BOEM also aims to establish government-to-government consultation with Tribal officials with regard to offshore oil- and gas-related activities in accordance with Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments." Federally recognized Indian Tribes are informed of proposed activities on the OCS and asked if they are interested in entering into consultation with BOEM to discuss the activities.

1.6 OTHER OCS OIL- AND GAS-RELATED ACTIVITIES

BOEM and BSEE have programs and activities that are OCS-related but not specific to the oil and gas leasing process or to the management of exploration, development, and production activities. These programs include environmental and technical studies, cooperative agreements with other Federal and State agencies for NEPA work, joint jurisdiction over cooperative efforts, inspection activities, and regulatory enforcement. BOEM also participates in industry research efforts and forums. The information collected through these efforts is used in support of the BOEM NEPA documents that inform Agency decisions.

Environmental Studies Program

BOEM promotes energy independence, environmental protection, and economic development through responsible management of OCS resources based on the best available science. To support this work and inform bureau policy decisions, BOEM's Environmental Studies Program develops, conducts, and oversees world-class scientific research specifically to inform policy decisions regarding development of OCS energy and mineral resources.

Through the Environmental Studies Program, BOEM is a leading contributor to the growing body of scientific knowledge about the marine and coastal environment. The Environmental Studies Program obtains information needed for NEPA assessment and the management of environmental and socioeconomic impacts on the human, marine, and coastal environments that may be affected by OCS oil and gas development. Research covers a broad range of disciplines, including physical oceanography, atmospheric sciences, biology, protected species, social sciences, economics, submerged cultural resources, and the environmental impacts of energy development. BOEM (and its predecessors) has funded more than $1 billion in research since the studies program was established in 1973 in accordance with Section 20 of the OCSLA. Technical summaries of more than 1,200 BOEM-sponsored environmental research projects and more than 3,400 research reports are publicly available online through the Environmental Studies Program Information System (ESPIS). For the latest information on BOEM's ongoing environmental studies work, go to http://www.boem.gov/studies. In the Gulf of Mexico OCS Region, over 350 studies for approximately $250 million have been completed and more than 900 reports and scientific papers have been produced. A complete list of all ongoing Gulf of Mexico OCS Region studies is available on the BOEM website. Each listing not only describes the research being conducted but also shows the institution performing the work, the cost of the effort, timeframe, and any associated publications, presentations, or affiliated websites.

BOEM incorporates findings from the studies program into its environmental reviews and NEPA documents, which are used to avoid, mitigate, or monitor the impact of energy and mineral resource development on the OCS. The BOEM's Gulf of Mexico OCS Region analysts use the ESP studies to prepare this document. While not all of the Gulf of Mexico OCS Region's studies are specifically referenced in this Multisale EIS, analysts used those that are relevant. Decisionmakers also use the information in ESP studies in managing and regulating exploration, development, and production activities on the OCS. This integrated approach of incorporating applied science to inform decisionmakers is illustrated in **Figure 1-7**.

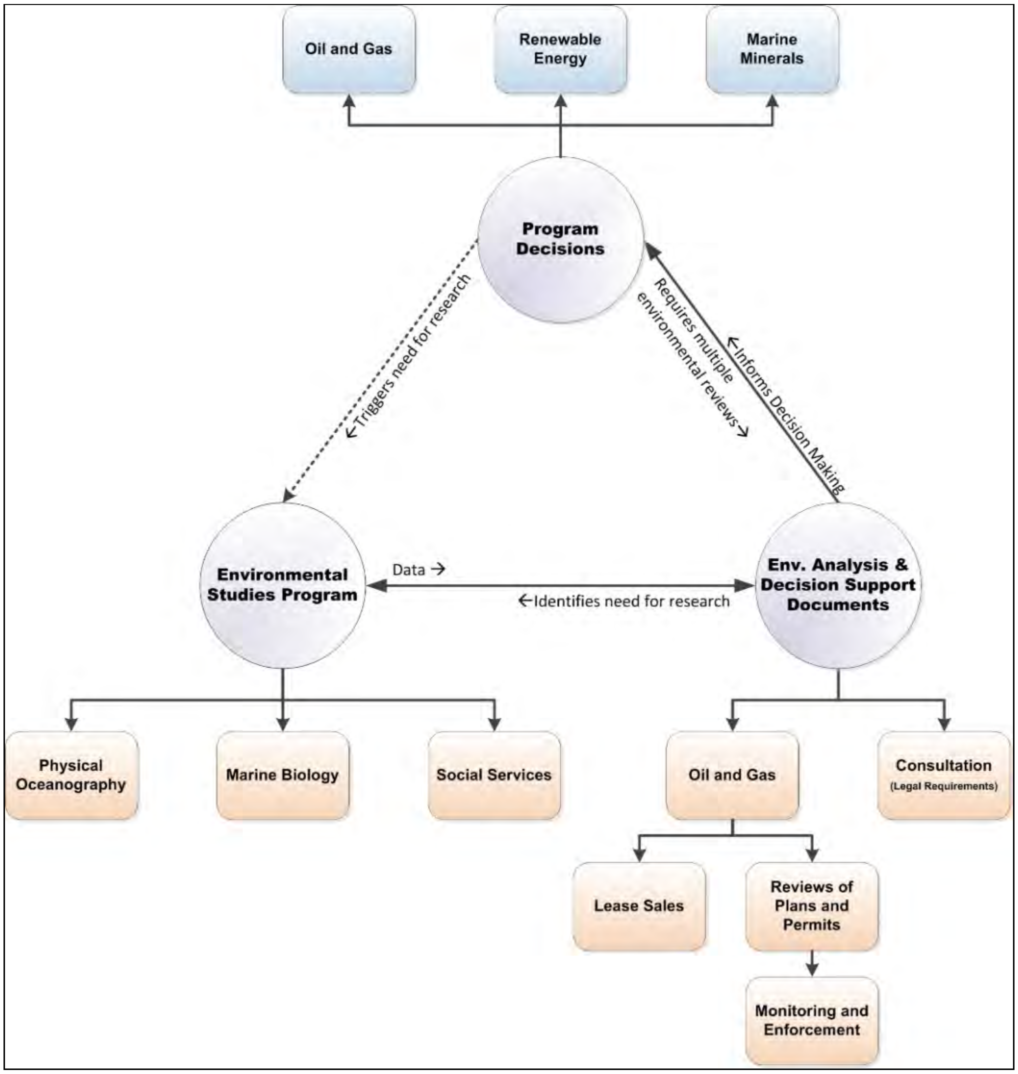

Figure 1-7. BOEM's Integrated Approach for Incorporating Applied Science into Decisionmaking.

Technology Assessment Program

The BSEE's Technology Assessment Program supports research associated with operational safety and pollution prevention. The Technology Assessment Program is comprised of two functional research activities: (1) operational safety and engineering research (topics such as air quality, decommissioning, and mooring and anchoring); and (2) other research (topics such as renewable energy and alternate use; Hurricanes Andrew, Ivan, Katrina, Rita, and Lili; and international activities). The Technology Assessment 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 promoting the use of the best available and safest technologies in Bureau regulations, rules, and operational guidelines.
- Research Catalyst—Promoting leadership in the fields of operational safety and pollution prevention in offshore energy extraction activities.
- International Regulations—Providing international cooperation for research and development initiatives to enhance the safety of offshore energy extraction activities and the development of appropriate regulatory program elements worldwide.

Interagency Agreements

Memoranda of Understanding under NEPA

The Council on Environmental Quality's (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 becomes a cooperating agency, the cooperating and lead agencies usually enter into a Memorandum of Understanding (MOU), previously called a Cooperating Agency Agreement. The MOU details the responsibilities of each participating agency. BOEM, as lead agency, has previously requested other Federal agencies to become cooperating agencies while other agencies have requested BOEM to become a cooperating agency (e.g., the Ocean Express Pipeline project). 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.

The NOI for this Multisale EIS included an invitation to other Federal agencies and State, Tribal, and local governments to consider becoming cooperating agencies in the preparation of this EIS. Consultation and coordination activities for this Multisale EIS are described in **Chapter 5**. In a letter dated September 8, 2015, the U.S. Environmental Protection Agency's (USEPA) Regions 4 and 6 requested cooperating agency status for the 2017-2022 Multisale EIS. On December 16, 2015, a Memorandum of Agreement between BOEM's Gulf of Mexico OCS Region and USEPA Regions 4 and 6 was initiated; this Memorandum of Agreement defines the roles and responsibilities for each agency (**Appendix C**).

Memorandum of Understanding and Memoranda of Agreement between BSEE and USCG

Since BSEE and USCG have closely related jurisdiction over different aspects of safety and operations on the OCS, the agencies have established a formal MOU that delineates lead responsibilities for managing OCS activities in accordance with OCSLA, as amended, and Oil Pollution Act of 1990. The latest MOU, dated November 27, 2012, supersedes the September 2004, December 1998, and August 1989 versions of the interagency agreement. The MOU is designed to minimize duplication and promote consistent regulation of facilities under the jurisdiction of both agencies.

Generally, the MOU identifies BSEE 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 certain aspects of safe operation of the facility, its systems, and equipment generally fall under the jurisdiction of the USCG. These include, among others, design of vessels, their sea-keeping characteristics, propulsion and dynamic positioning systems, supply and lightering procedures and equipment, utility systems, safety equipment and procedures, and pollution prevention and response procedures.

Memorandum of Agreement between BOEM and BSEE – Environmental and NEPA

The BOEM/BSEE Memorandum of Agreement establishes the working relationship between BOEM and BSEE for environmental review and enforcement for activities on the OCS. It is intended to minimize duplication of efforts, promote consistency in procedures and regulations, and resolve disputes. Under this Memorandum of Agreement, BSEE will serve as a cooperating agency on the BOEM's NEPA documents and may adopt NEPA analyses prepared by BOEM.

1.7 OTHER PERTINENT ENVIRONMENTAL REVIEWS OR DOCUMENTATION

BOEM is aware of other environmental reviews and studies relevant to the resources under consideration in this Multisale EIS. Notices of Intent were published in the *Federal Register* for the following reviews:

- *BOEM's Gulf of Mexico Geological and Geophysical Activities Programmatic EIS.* BOEM, with the National Oceanic and Atmospheric Administration's NMFS and BSEE as cooperating agencies, is preparing a Programmatic EIS to evaluate the potential environmental impacts of multiple G&G activities within Federal waters of the Gulf of Mexico's OCS and adjacent State waters. BOEM and the NMFS intend for that Programmatic EIS to provide the necessary documentation and analyses to support informed decisions regarding future OCSLA permit and Marine Mammal Protection Act (MMPA) authorization actions related to G&G activities on the OCS. In addition, the preparation of this Programmatic EIS will help to ensure compliance with other applicable laws and statutes such as the

Endangered Species Act (ESA), Magnuson-Stevens Fishery Conservation and Management Act, Coastal Zone Management Act (CZMA), and the National Historic Preservation Act (NHPA). The G&G Programmatic EIS establishes a framework for subsequent NEPA analyses for site-specific actions while identifying and analyzing appropriate mitigating measures to be used during future G&G activities on the OCS in support of the oil and gas, renewable energy, and marine mineral resource programs. The impacts of future site-specific actions will be addressed in subsequent NEPA evaluations, per the Council on Environmental Quality's regulations (40 CFR § 1502.20), by tiering from this programmatic evaluation. Public scoping for the Programmatic EIS was held from May 10-July 9, 2013, and the Draft Programmatic EIS is currently being developed.

- *NOAA's Flower Garden Banks National Marine Sanctuary Expansion EIS*. *In February 2015,* NOAA's Office of National Marine Sanctuaries announced that it will prepare a Draft EIS to consider possible expansion of the Flower Garden Banks National Marine Sanctuary. When the Flower Garden Banks National Marine Sanctuary was designated in 1992, the boundaries were established based on best available information regarding biologically sensitive habitats. Subsequent exploration in the northwestern Gulf of Mexico has identified other reefs, banks, and associated features that may be ecologically linked to the Flower Garden Banks National Marine Sanctuary. Although many of these areas have some level of protection through other designations, inclusion in the sanctuary would provide a comprehensive management framework to fill in the existing regulatory gaps and provide necessary protection to these critical habitats. BOEM, among other agencies, is a Cooperating Agency in the preparation of this Draft EIS.
- *NOAA's Natural Resource Damage Assessment Draft EIS*. In February 2016, the Federal and State natural resource trustee agencies (Trustees) issued a Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement (PDARP/PEIS) for public review. The PDARP/PEIS considers programmatic alternatives to restore natural resources, ecological services, and recreational use services injured or lost as a result of the *Deepwater Horizon* oil spill. The *Deepwater Horizon* oil spill's natural resource Trustees have developed restoration alternatives, comprised of various restoration types, to address injuries to natural resources and resource services resulting from the *Deepwater Horizon* oil spill. Criteria and evaluation standards under the Oil Pollution Act of 1990's natural resource damage assessment regulations guided the Trustees' consideration of programmatic restoration alternatives. The PDARP/PEIS also evaluates the environmental consequences of the restoration alternatives under NEPA.

Supporting technical information in previous NEPA reviews have been developed as standalone technical reports and are summarized and incorporated by reference as appropriate. These include the OCS regulatory framework and improvements since the *Deepwater Horizon* explosion, oil spill, and response; the catastrophic spill event analysis; and the essential fish habitat assessment. Subsequent updates to this information have been minimal and, therefore, BOEM has prepared separate technical reports, which will be updated as needed. This approach would be conducive to reducing the size of this Multisale EIS and future NEPA documents.

- *OCS Regulatory Framework* White Paper. Federal laws mandate the OCS leasing program (i.e., the OCSLA) and the environmental review process (i.e., the NEPA). In implementing its responsibilities under the OCSLA, BOEM and BSEE must consult with numerous Federal departments and agencies that have authority to govern and maintain ocean resources pursuant to other Federal laws. Among these Federal entities are the USCG, USEPA, COE, FWS, and the NOAA through the NMFS. Several Federal regulations establish specific consultation and coordination processes with Federal, State, and local agencies (i.e., the Coastal Zone Management Act of 1972 [CZMA], the Endangered Species Act of 1973 [ESA], the Magnuson-Stevens Fishery Conservation and Management Act, and the Marine Mammal Protection Act [MMPA]). These regulations have been discussed in past NEPA documents for oil and natural gas lease sales, such as *Gulf of Mexico OCS Oil and Gas Lease Sales: 2007-2012; Western Planning Area Lease Sales 204, 207, 210, 215, and 218; Central Planning Area Lease Sales 205, 206, 208, 213, 216, and 222, Final Environmental Impact Statement* (2007-2012 WPA/CPA Multisale EIS) (USDOI, MMS, 2007a). This report is available on BOEM's website (Cameron and Matthews, 2016).

- *Catastrophic Spill Event Analysis* White Paper. The August 16, 2010, CEQ report, prepared following the *Deepwater Horizon* explosion, oil spill, and response in the GOM, recommended that BOEM, formerly the Minerals Management Service (MMS) and Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), should "[e]nsure that NEPA [National Environmental Policy Act] documents provide decisionmakers with a robust analysis of reasonably foreseeable impacts, including an analysis of reasonably foreseeable impacts associated with low probability catastrophic spills for oil and gas activities on the Outer Continental Shelf" (CEQ, 2010). BOEM prepared a "Catastrophic Spill Event Analysis," which was included as Appendix B in the 2007-2012 WPA/CPA Multisale EIS. This analysis has been reviewed and updated, as appropriate, during each Supplemental EIS for the remaining GOM proposed lease sales through 2017. These subsequent updates have been minimal and, therefore, BOEM has prepared a separate technical report, which will be updated as needed. This evaluation is a robust analysis of the impacts from low-probability catastrophic spills and will be made available to all applicable decisionmakers including, but not limited to, the Secretary of the Department of the Interior for the Five-Year Program, the Assistant Secretary of Land and Minerals Management for an oil and gas lease sale, and the Regional Supervisors of the Gulf of Mexico OCS Region's Office of Environment and Office of Leasing and Plans. This report is also available on BOEM's website (USDOI, BOEM, 2016c).

- *Essential Fish Habitat Assessment* White Paper. The 2017-2022 Programmatic EFH Assessment for the Gulf of Mexico ("EFH Assessment") is a stand-alone analysis that addresses BOEM's obligation under Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1855(b)) to consult with the U.S. Department of Commerce regarding actions that may adversely affect essential fish habitat. The EFH Assessment also informs many of the analyses documented in this Multisale EIS. The Federal actions addressed in the EFH Assessment are proposed Gulf of Mexico Lease Sales 249-254, 256, 257, 259, and 261 and related activities, such as G&G activities and decommissioning operations. Lease sales would offer for lease some or all unleased blocks in the WPA, CPA, and EPA proposed lease sale areas for oil and gas exploration and recovery operations. A proposed action would provide for the issuance of permits to conduct G&G survey activities between the coastline and the seaward extent of the Exclusive Economic Zone of the GOM. Decommissioning operations encompass many component activities: (1) equipment and vessel mobilization and target preparation; (2) underwater structural-member severance (nonexplosive and explosive methods); (3) post-severance salvage; and (4) final site-clearance verification. These types of activities all have the potential to impact fish and EFH. The EFH Assessment serves as the initiation of a Programmatic Consultation by BOEM's Gulf of Mexico OCS Region with the U.S. Department of Commerce on OCS oil- and gas-related activities for 2017-2022. Based on the most recent and best available information, BOEM will also continue to evaluate and assess risks to managed species and identified EFH in upcoming environmental compliance documentation under NEPA and other statutes. Information relevant to EFHs is incorporated and analyzed in this Multisale EIS in **Chapter 4.2** (Water Quality), **Chapter 4.3** (Coastal Habitats), **Chapter 4.4** (Deepwater Benthic Communities), **Chapter 4.5** (*Sargassum* and Associated Communities), and **Chapter 4.6** (Live Bottom Habitats) (USDOI, BOEM, 2016d).

1.8 FORMAT AND ORGANIZATION OF THE MULTISALE EIS

In an effort to thoroughly explain all the environmental consideration and mitigations that are involved in BOEM's assessment of the potential environmental consequences of OCS oil- and gas-related activities, BOEM recognizes that past NEPA reviews have become encyclopedic in nature. To more closely align with CEQ's guidance regarding EIS format, a major goal in preparing this Multisale EIS includes increasing the readability of the document for decisionmakers and the public, and shortening the document by providing relevant and appropriate information needed to assess the effects of the proposed actions and alternatives. A major focus for preparing this Multisale EIS has been on clear and concise writing, using graphics to emphasize major concepts where appropriate, and placing more detailed and technical supporting information in the appendices and incorporating it by reference. The remaining chapters in this Multisale EIS are described below.

- **Chapter 2** describes the potential lease sale options and the alternatives, including the proposed action, being analyzed in this Multisale EIS; discusses the potential mitigating measures (pre- and postlease), including the proposed stipulations, and the issues considered and not considered in the analysis; and discusses the deferred alternatives and provides a broad comparison of impacts by alternative.
- **Chapter 3** describes all the potentially occurring actions associated with a single lease for the Five-Year Program and the cumulative activities that provide a framework for detailed analyses of the potential impacts analyzed in **Chapter 4**. Exploration and development scenarios describe the infrastructure and activities that could potentially affect the biological, physical, and socioeconomic resources in the GOM. It 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. It also includes a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors.
- **Chapter 4** describes the affected environment and the potential impacts of a single lease sale and each alternative by resource. Analysis of the alternatives includes routine activities, accidental events, cumulative impact analysis, incomplete or unavailable information, and conclusions for each resource.
- **Chapter 5** describes the consultation and coordination efforts used in preparing this Multisale EIS. This includes a description of the scoping process, activities, and results; cooperating agencies; distribution of the EIS; consultations with Federal and State agencies under the Coastal Zone Management Act, Endangered Species Act, the Magnuson-Stevens Fishery Conservation and Management Act, and the National Historic Preservation Act; and government-to-government consultation and coordination.
- **Chapter 6** includes all the citations referred to throughout this Multisale EIS.
- **Chapter 7** is a list of all the preparers of this Multisale EIS.
- **Chapter 8** is a glossary of terms.
- Finally, to improve the readability of this Multisale EIS, more detailed supporting information has been placed in the **Appendices**.

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

What's In This Chapter

- This Multisale EIS will be the NEPA document used to support a decision on proposed Lease Sale 249.
- The analyses in the Multisale EIS are also relevant to proposed Lease Sales 250-254, 256, 257, 259, and 261.
- Alternative A: A single proposed lease sale offering all available unleased blocks within the WPA, CPA, and EPA portions of the proposed lease sale area with exceptions as outlined in **Chapter 2.2.2**.
- Alternative B: A single proposed lease sale offering all available unleased blocks within the CPA and EPA but not within the WPA portion of the proposed lease sale area with exceptions.
- Alternative C: A single proposed lease sale offering all available unleased blocks within the WPA but not within the CPA/EPA portions of the proposed lease sale area with one exception.
- Alternative D: Alternative A, B, or C with the option to exclude any available unleased blocks subject to the Topographic Features Stipulation, Live Bottom (Pinnacle Trend) Stipulation, and/or Blocks South of Baldwin County, Alabama Stipulation.
- Alternative E: Cancellation of a single proposed lease sale.
- Alternatives not analyzed include the following:
  - follow the 2012-2017 Five-Year Program leasing schedule, including separate lease sales for the EPA;
  - add additional buffer zones to further protect sensitive environments, species, or the view from shores;
  - exclude the WPA and CPA;
  - add more measures to reduce the potential impacts to sperm whale high-use areas; and
  - delay the proposed lease sales until the state of recovery of the GOM following the *Deepwater Horizon* explosion, oil spill, and response is known.
- The issues that most impact the decision to lease are reviewed in this Multisale EIS, including impacts to air and water quality, biological resources, recreation, land use, economics, and environmental justice.
- A comparison of alternatives and impact summaries is presented.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

2.1 MULTISALE NEPA ANALYSIS

As authorized under 40 CFR § 1502.4, one EIS is allowed to analyze related or similar proposals. This Multisale EIS addresses 10 proposed regionwide oil and gas lease sales encompassing all three planning areas in the U.S. portion of the Gulf of Mexico OCS (**Figure 1-1**), as scheduled in the Five-Year Program (USDOI, BOEM, 2016a). However, as previously noted in **Chapter 1.3.1.2**, the OCSLA requires individual decisions to be made for each lease sale. Therefore, in order to make an informed decision on a single proposed lease sale, the analyses contained in this Multisale EIS examine impacts from a single regionwide proposed lease sale (i.e. proposed Lease Sale 249).

For analysis purposes, a proposed action is presented as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors for the proposed lease sale area. Each of the proposed lease sales is expected to be within the scenario ranges for the proposed lease sale area analyzed in this Multisale EIS; therefore, a proposed action is also representative of proposed Lease Sales 249-254, 256, 257, 259, and 261. Each proposed action includes existing regulations and lease stipulations. This EIS will be the only NEPA document prepared for proposed Lease Sale 249. An additional NEPA review (a Determination of NEPA Adequacy, an EA or, if determined necessary, a Supplemental EIS) will be conducted prior to each of the remaining proposed lease sales to address any relevant new information. Informal and formal consultations with other Federal agencies, the affected States, federally recognized Indian Tribes, and the public will be carried out to assist in the determination of whether or not the information and analyses in this Multisale EIS are still valid. Specifically, information requests such as NOIs and request for public comment will be issued soliciting input on subsequent proposed lease sales (refer to **Chapter 1.3.1.2**).

Agencies are encouraged to tier their environmental impact statements to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review.

The supplemental approach for regional lease sales is intended to focus the NEPA/EIS process on updating subsequent lease sale NEPA reviews to address any relevant significant new information and/or issues since publication of the previous lease sale NEPA document from which it tiers (**Figure 1-5**) This tiering approach process also lessens duplication and saves resources. The scoping process for this document is described in **Chapter 5**. As mandated by NEPA, this Multisale EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environment.

Any subsequent NEPA reviews will tier from this Multisale EIS and will summarize and incorporate the material by reference. Because any subsequent reviews will be prepared for a proposed action that “is, or is closely similar to, one which normally requires the preparation of an EIS” (40 CFR § 1501.4(e)(2)), the review will be made publicly available.

If a Supplemental EIS is necessary (40 CFR § 1502.9), it will also tier from this Multisale EIS and will summarize and incorporate the material by reference. The analysis will focus on addressing the new issue(s) and/or concern(s). The Supplemental EIS will include a discussion of the purpose of the Supplemental EIS, a description of the proposed action(s) and alternatives, a comparison of the proposed alternatives, a description of the affected environment, potentially affected resources, an analysis of new impacts, and new information not addressed in this Multisale EIS. The Supplemental EIS will also include an updated discussion of associated BOEM coordination and consultations. As discussed further in **Chapter 1.7**, an analysis of the impacts of low-probability catastrophic spills has been prepared as a BOEM white paper and is incorporated by reference (*Catastrophic Spill Event Analysis* white paper; USDOI, BOEM, 2016c).

2.2 Lease Sale Options, Alternatives, Mitigating Measures, and Issues

BOEM is evaluating a preferred option and alternative options for a schedule of proposed lease sales in the Gulf of Mexico OCS Region under the Five-Year Program, which takes into account the mature and active nature of this region. The preferred option (Option 1 in the Five-Year Program) proposes a new approach to lease sales in the GOM by proposing two annual lease sales across the GOM that would include all available unleased blocks not subject to Congressional moratoria. Option 2 in the Five-Year Program follows the recent historical trend of BOEM holding separate annual lease sales in the WPA and CPA and periodic lease sales in the area of the EPA not subject to moratoria. Option 2 would be similar to the approach used in the 2012-2017 Five-Year Program. Below is a description of the lease sale options considered in this Multisale EIS followed by a range of alternatives to the proposed action that can be considered for selection under either lease sale option for any given lease sale throughout the 2017-2022 Five-Year Program.

2.2.1 Lease Sale Options in the Five-Year Program

Five-Year Program Option 1 (Preferred Alternative Identified in the Five-Year Program): A total of 10 proposed lease sales during the Five-Year Program, with 1 lease sale in 2017; 2 lease sales each year in 2018, 2019, 2020, and 2021; and 1 lease sale in 2022 offering all available unleased blocks not subject to Congressional moratorium in the combined WPA, CPA, and EPA in each proposed lease sale. This has been identified as BOEM's preferred option; however, this does not mean that another option may not be selected in the Record of Decision.

Option 1: 2017-2022 Proposed Gulf of Mexico Lease Sale Schedule	
Lease Sale Number	Year
249	2017
250 and 251	2018
252 and 253	2019
254 and 256	2020
257 and 259	2021
261	2022

The regionwide lease sale approach would provide greater flexibility for industry, including responding to changing conditions (including Mexico's new plan to offer offshore licenses every September starting in 2015); would better balance workload within BOEM; and would allow more frequent opportunities to bid on rejected, relinquished, or expired blocks. Also, any individual lease sale could still be scaled back during the prelease sale process to conform more closely to the separate planning area model used in the 2012-2017 Five-Year Program, if conditions warranted such an approach. In addition, Option 1 could facilitate better planning to explore pools that may straddle the U.S.-Mexico boundary. Other possible advantages of implementing this option would be the potential to prepare one EIS and combined Endangered Species Act (ESA) consultations (e.g., 1 biological opinion), which could result in cost savings and a shorter timeline for completion of the process. More frequent lease sales may expedite and increase the present value of leasing and tax revenues. More frequent lease sales, however, could reduce the time available for companies to update their information and develop improved value estimates for the remaining available unleased blocks.

Five-Year Program Option 2: Five annual lease sales beginning in 2017 in the WPA offering all available unleased blocks and five annual lease sales beginning in 2018 in the combined CPA and EPA offering all available unleased blocks not subject to Congressional moratorium pursuant to the Gulf of Mexico Energy Security Act of 2006 (GOMESA). This approach would be very similar to the 2012-2017 Five-Year Program and proposed actions in the 2012-2017 WPA/CPA Multisale EIS (USDOI, BOEM, 2012), differing by combining the CPA and EPA for five of the proposed lease sales rather than holding separate, less frequent, lease sales for the EPA. This would make the available unleased blocks within the EPA portion of the proposed lease sale area available more frequently than in the 2012-2017 Five-Year Program. Potential advantages of implementing this option would be that stakeholders are accustom to this frequency of sales, companies assessing and evaluating prospects would have additional time to analyze and prepare bidding and exploration strategies, and BOEM would have more time to prepare and analyze new information. However, this option would offer less frequent opportunities to bid on rejected, relinquished, or expired blocks and could reduce the flexibility for industry to explore pools that may straddle the U.S.-Mexico boundary.

Option 2: 2017-2022 Proposed Gulf of Mexico Lease Sale Schedule			
Lease Sale Area	Year	Lease Sale Area	Year
WPA	2017	CPA/EPA	2018
WPA	2018	CPA/EPA	2019
WPA	2019	CPA/EPA	2020
WPA	2020	CPA/EPA	2021
WPA	2021	CPA/EPA	2022

2.2.2 Description of the Alternatives for This Multisale EIS

The discussions below outline the alternatives that are considered for this environmental analysis. These suggested alternatives have been derived from both the historical comments submitted to BOEM and its predecessors and the EIS-specific scoping performed for this analysis.

2.2.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Alternative A would allow for a proposed regionwide lease sale encompassing all three planning areas within the U.S. portion of the Gulf of Mexico OCS for any given lease sale in the Five-Year Program. This is BOEM's preferred alternative. This alternative would offer for lease all available unleased blocks within the WPA, CPA, and EPA portions of the proposed lease sale area for oil and gas operations (**Figure 2-1**), with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006 (discussed in the *OCS Regulatory Framework* white paper [Cameron and Matthews, 2016]);

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap; and

(3) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary (i.e., the boundary as of the publication of this Multisale EIS).

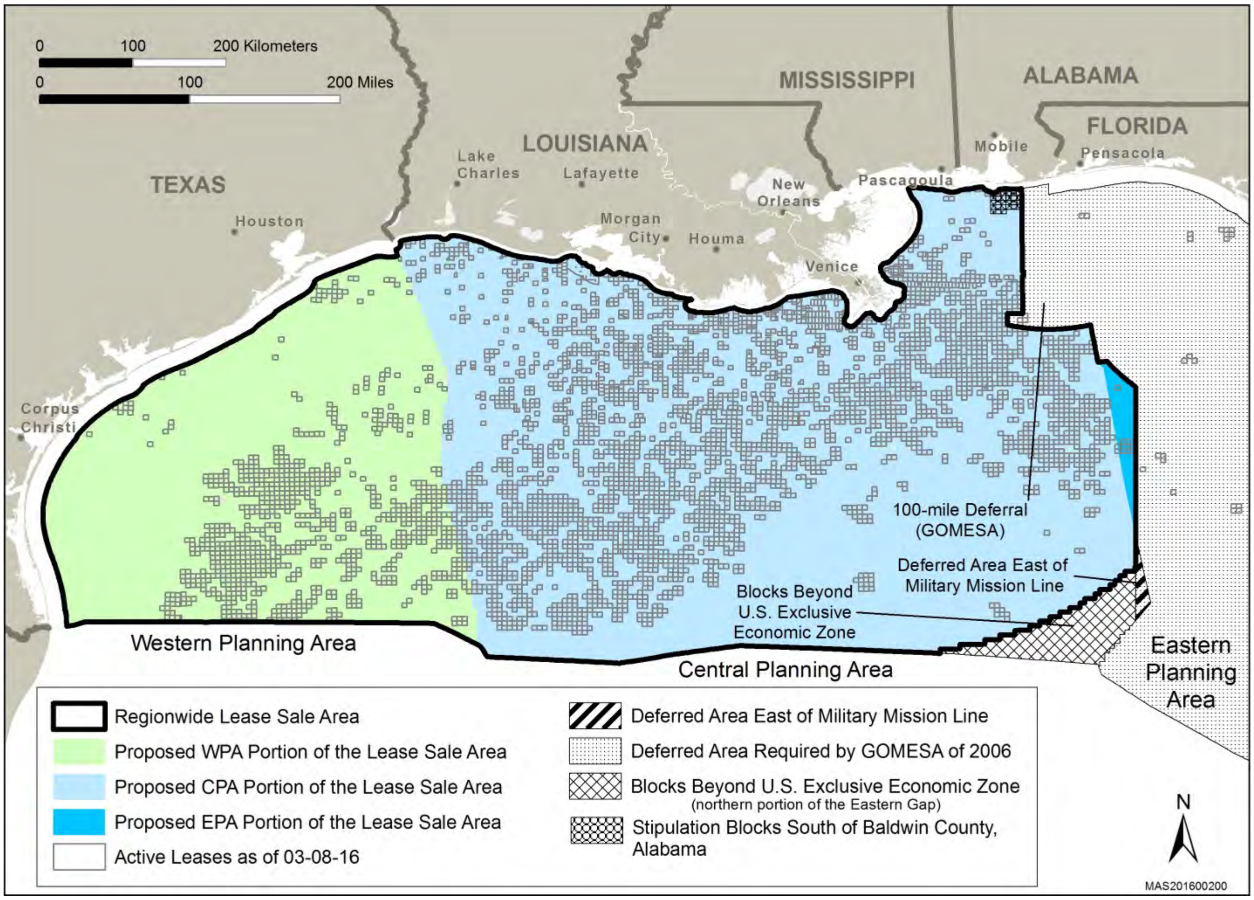

Figure 2-1. Proposed Regionwide Lease Sale Area, Encompassing the Available Unleased Blocks within All Three Planning Areas (a total of approximately 92.2 million acres with approximately 72.5 million acres available for lease as of March 2016).

The WPA begins 3 marine leagues (9 nautical miles [nmi]; 10.36 miles [mi]; 16.67 kilometers [km]) offshore Texas and extends seaward to the limits of the United States' jurisdiction over the continental shelf (often referred to as the Exclusive Economic Zone) in water depths up to approximately 3,346 m (m) (10,978 feet [ft]). The proposed WPA lease sale area encompasses about 28.58 million ac. As of March 2016, approximately 23.6 million ac of the proposed WPA lease sale area are currently unleased.

The CPA begins 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama, and extends seaward to the limits of the United States' jurisdiction over the continental shelf (often referred to as the Exclusive Economic Zone) in water depths up to approximately 3,346 m (10,978 ft). The area is south of eastern Alabama and western Florida; the nearest point of land is 125 mi (201 km) northwest in Louisiana. The proposed CPA lease sale area encompasses about 63 million ac of the total CPA area of 66.45 million ac. As of March 2016, approximately 48.3 million ac of the proposed CPA lease sale area are currently unleased.

The proposed EPA lease sale area covers approximately 657,905 ac and includes those blocks previously included in the EPA Lease Sales 225 and 226 areas, which is bordered by the

CPA boundary on the west and the Military Mission Line (86º41' W. longitude) on the east. The area is south of eastern Alabama and western Florida; the nearest point of land is 125 mi (201 km) northwest in Louisiana. As of March 2016, approximately 595,475 ac of the proposed EPA lease sale area are currently unleased.

A regionwide lease sale would offer approximately 92.2 million ac, with approximately 72.5 million ac available for lease as of March 2016. Leasing information related to all three planning areas is updated monthly and can be found on BOEM's website at http://www.boem.gov/Gulf-of-Mexico-Region-Lease-Map/.

In general, a regionwide lease sale, which would include all available unleased blocks in all three planning areas, would represent 1.2-3.8 percent of the total OCS Program production in the GOM based on barrels of oil equivalent resource estimates. The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a typical proposed regionwide lease sale are 0.211-1.118 billion barrels of oil (BBO) and 0.547-4.424 trillion cubic feet (Tcf) of gas (refer to **Table 3-1**).

The analyses of impacts summarized below in **Chapter 2.3** and described in detail in **Chapter 4** for each resource 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 **Chapter 3**. A proposed lease sale includes proposed lease stipulations designed to reduce environmental risks; these stipulations are discussed in **Chapter 2.2.4.1**.

2.2.2.2 Alternative B—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

*A*lternative B would allow for a proposed lease sale encompassing the CPA and EPA within the U.S. portion of the Gulf of Mexico OCS (**Figure 2-2**). Available blocks within the WPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the CPA and EPA portions of the proposed lease sale area as those planning area portions are described in Alternative A for oil and gas operations, with the following exceptions:

(1) whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of 2006 (discussed in the *OCS Regulatory Framework* white paper [Cameron and Matthews, 2016]); and

(2) blocks that are adjacent to or beyond the United States' Exclusive Economic Zone in the area known as the northern portion of the Eastern Gap.

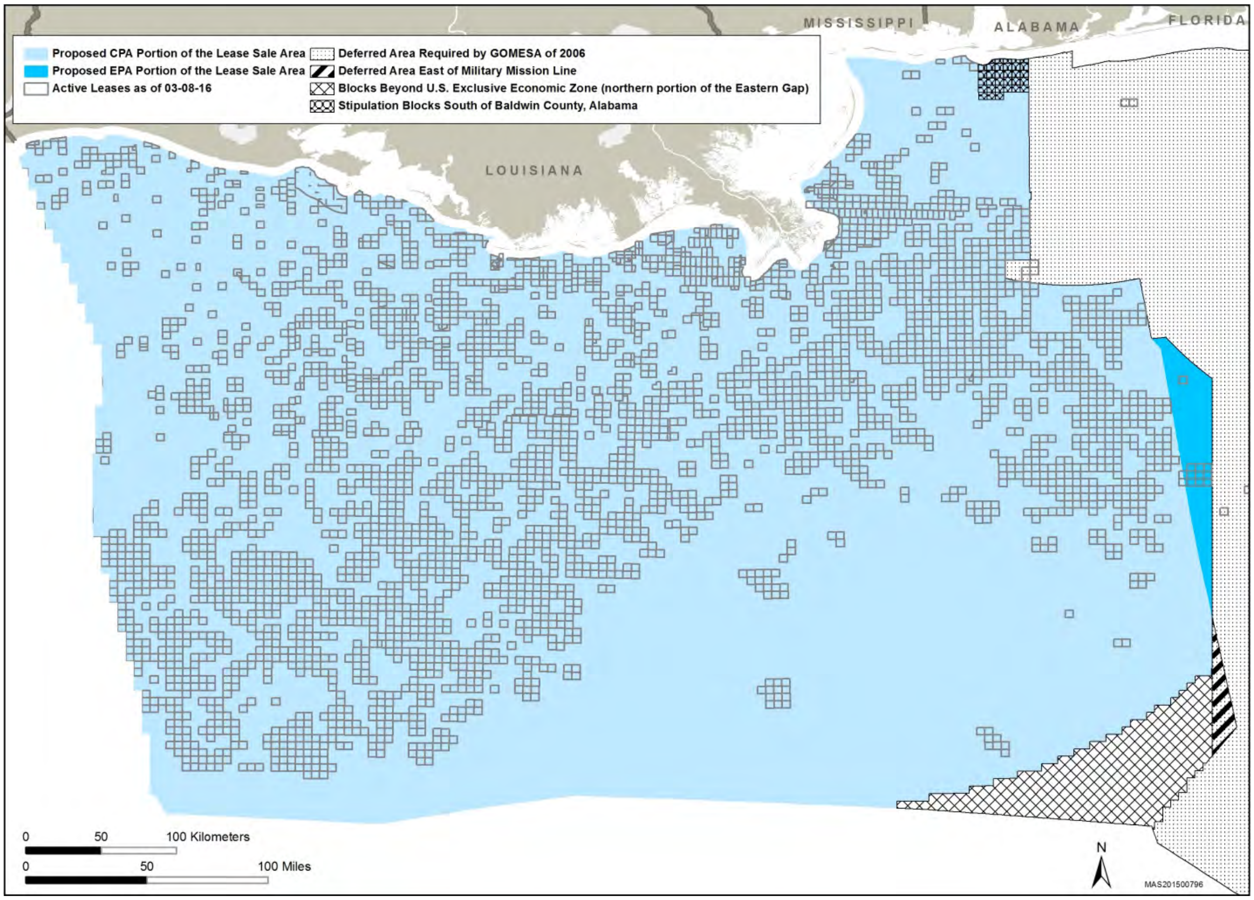

Figure 2-2. Proposed Lease Sale Area for Alternative B, Excluding the Available Unleased Blocks in the WPA (a total of approximately 66.45 million ac with approximately 48.3 million ac available for lease as of March 2016).

In general, a lease sale that would include all available unleased blocks in the CPA and EPA would represent approximately 2.0-3.6 percent of the total OCS Program production in the GOM based on barrels of oil equivalent resource estimates. The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed lease sale under Alternative B are 0.185-0.970 BBO and 0.44-3.672 Tcf of gas (refer to **Table 3-1**).

The analyses of impacts summarized below in **Chapter 2.3** and described in detail in **Chapters 4.1-4.14** for each resource 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 **Chapter 3**. A proposed lease sale includes proposed lease stipulations designed to reduce environmental risks; these stipulations are discussed in **Chapter 2.2.4.1**.

2.2.2.3 Alternative C—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Alternative C would allow for a proposed lease sale encompassing the WPA within the U.S. portion of the Gulf of Mexico OCS (**Figure 2-3**). Available blocks within the CPA and EPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the WPA portion of the proposed lease sale area for oil and gas operations, with the following exception:

(1) whole and partial blocks within the boundary of the Flower Garden Banks National Marine Sanctuary (i.e., the boundary as of the publication of this Multisale EIS).

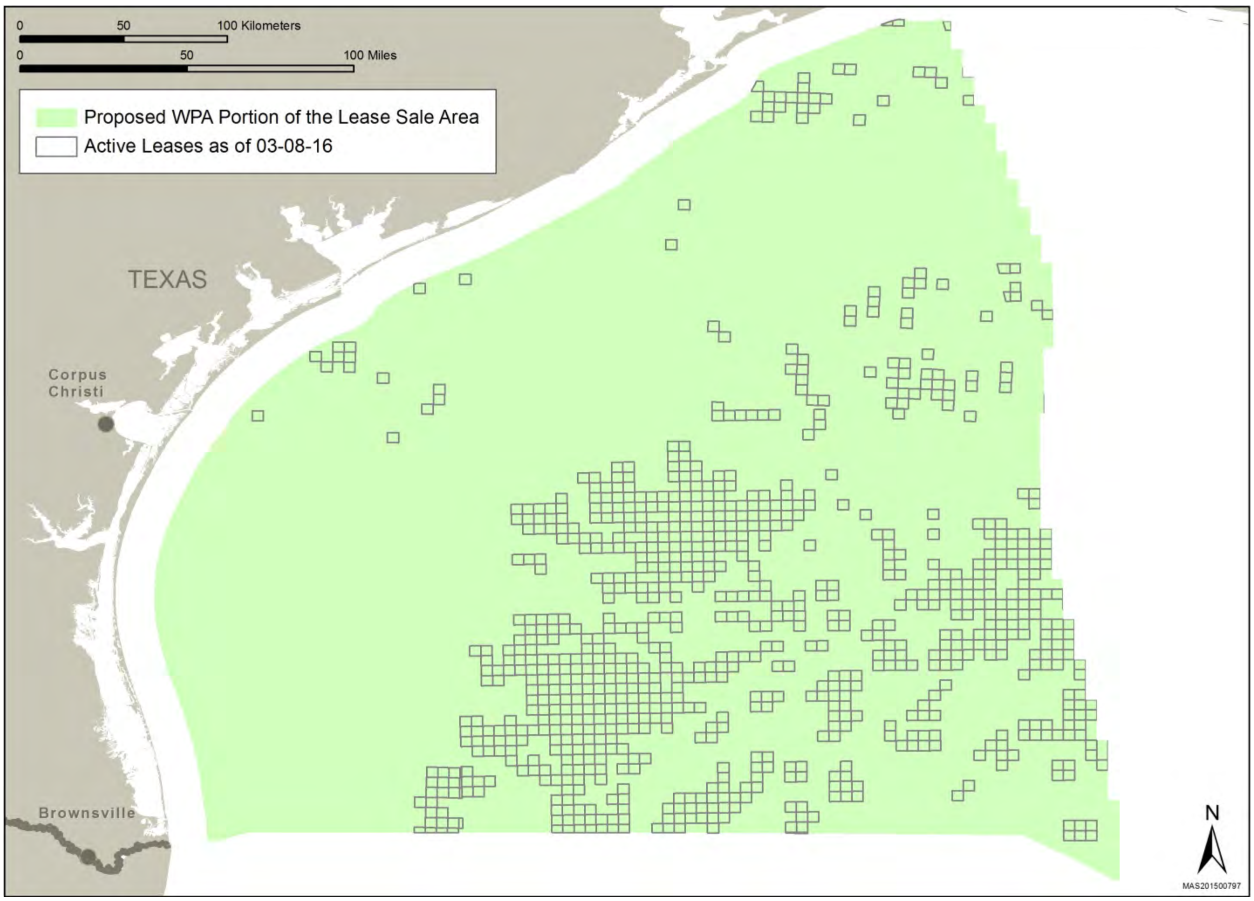

Figure 2-3. Proposed Lease Sale Area for Alternative C, Excluding the Available Unleased Blocks in the CPA and EPA (a total of approximately 28.58 million ac with approximately 23.6 million ac available for lease as of March 2016).

The proposed Alternative C lease sale area encompasses virtually all of the WPA's approximately 28.58 million ac as that planning area is described as a subset of Alternative A. In general, a lease sale that would include all available unleased blocks in the WPA as Alternative B would represent approximately 0.35-0.6 percent of the total OCS Program production in the GOM based on barrels of oil equivalent resource estimates. The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed lease sale offering only WPA available blocks are 0.026-0.148 BBO and 0.106-0.752 Tcf of gas (refer to **Table 3-1**).

The analyses of impacts summarized below in **Chapter 2.3** and described in detail in **Chapter 4** for each resource 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 **Chapter 3**. A proposed lease sale includes proposed lease stipulations designed to reduce environmental risks; these stipulations are discussed in **Chapter 2.2.4.1**.

2.2.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D could be combined with any of the Action alternatives above (i.e., Alternatives A, B, or C) and would allow the flexibility to offer leases under any alternative with additional exclusions. Under Alternative D, the decisionmaker could exclude from leasing any available unleased blocks subject to any one and/or a combination of the following stipulations:

- Topographic Features Stipulation;
- Live Bottom (Pinnacle Trend) Stipulation; and
- Blocks South of Baldwin County, Alabama, Stipulation (not applicable to Alternative C).

This alternative considered blocks subject to these stipulations because these areas have been emphasized in scoping, can be geographically defined, and adequate information exists regarding their ecological importance and sensitivity to OCS oil- and gas-related activities.

A total of 207 blocks within the CPA and 160 blocks in the WPA are affected by the Topographic Features Stipulation (**Figure 2-4**). There are currently no identified topographic features protected under this stipulation in the EPA. The Live Bottom Stipulation covers the pinnacle trend area of the CPA, affecting a total of 74 blocks (**Figure 2-4**). More details on the blocks affected by the Topographic Features Stipulation and the pinnacle trend blocks subject to the Live Bottom Stipulation can be found at http://www.boem.gov/Biologically-Sensitive-Areas-List/. Maps indicating the areas affected by the Topographic Features Stipulation, which is routinely applied to leases in the vicinity of certain geographic features, can be found at http://www.boem.gov/Topographic-Features-Stipulation-Map-Package/.

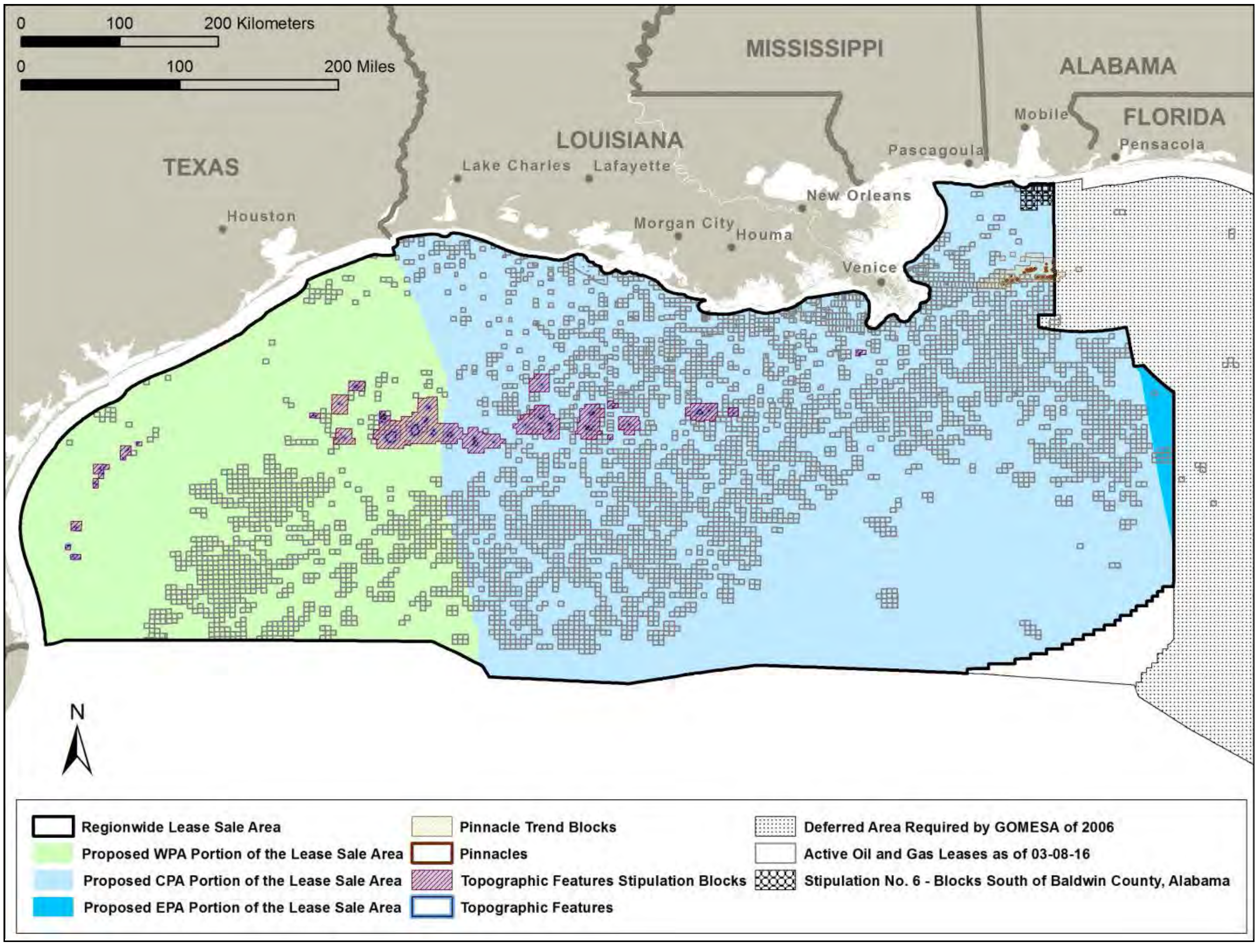

Figure 2-4. Identified Topographic Features, Pinnacle Trend, and Blocks South of Baldwin County, Alabama, Stipulation Blocks in the Gulf of Mexico.

Figure 2-5 illustrates one example of the blocks that would be excluded under this alternative (shaded in blue). For this example, under Alternative D, there would be 15 blocks eliminated from the proposed lease sale area. Any production that could potentially result from these blocks would not be realized. Should the decisionmaker decide instead to adopt Alternatives A, B, or C and apply the Topographic Features Stipulation, the 15 blocks (that would have been eliminated from potential exploration and development under Alternative D) would be made available but with mitigations applied to avoid or minimize impacts to the features.

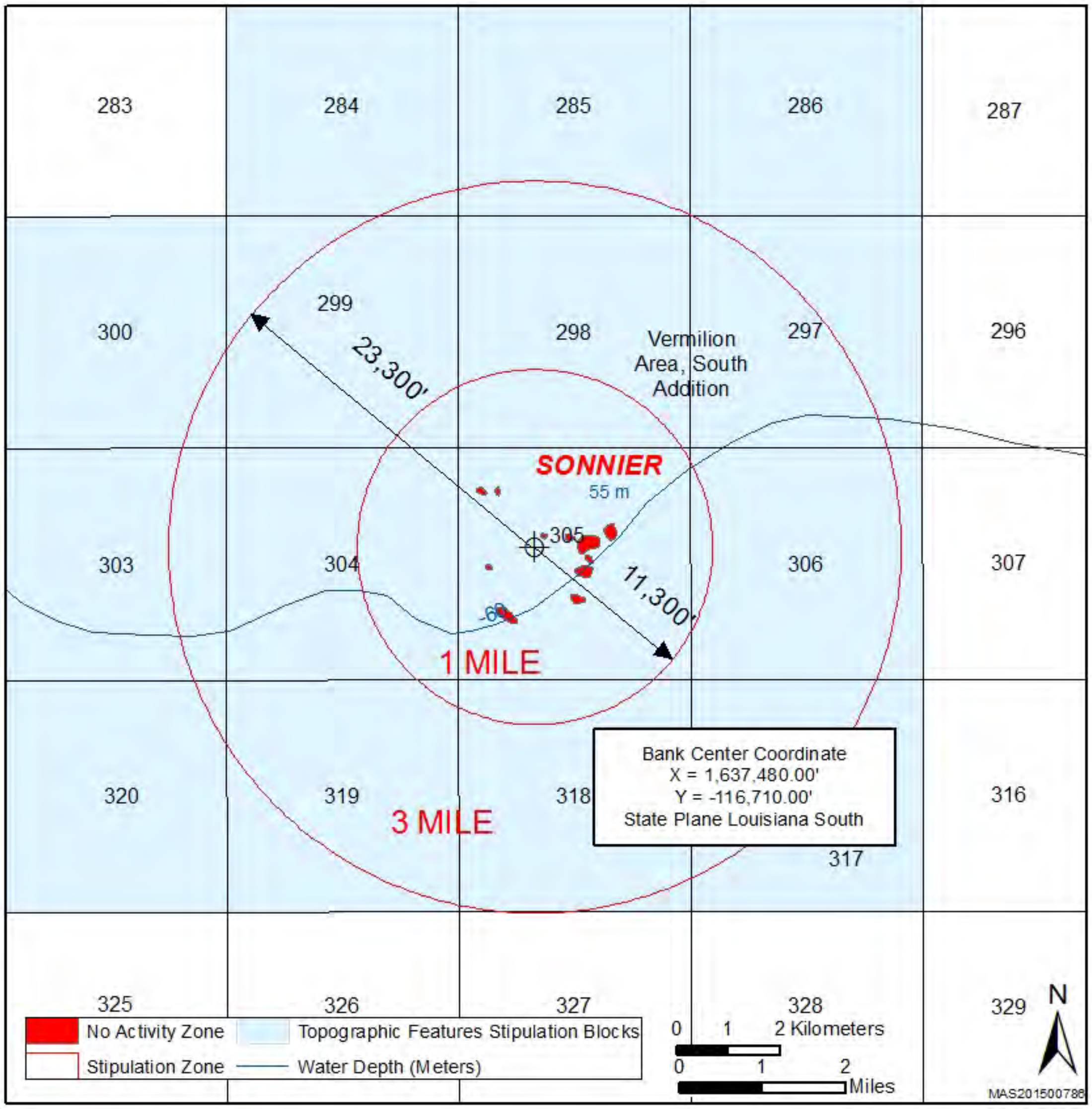

Figure 2-5. Example of Excluded Blocks under Alternative D.

As of the publication of this Multisale EIS, the Blocks South of Baldwin County, Alabama, Stipulation (herein referred to as the Baldwin County Stipulation Blocks) applies to a total of 32 blocks (Mobile 826-830, 869-874, 913-918, 957-962, 1001-1006, and Viosca Knoll 33-35) within 15-mi (24 km) of Baldwin County, Alabama (representing less than 1% of the total number of blocks to be offered under Alternative A or B). The intent of excluding these blocks would be to mitigate the visual impacts of concern raised by the Governor of Alabama on previous EISs, as well as on the 2017-2022 Five-Year Program from which this Multisale EIS tiers. The stipulation, however, has been continually adopted in annual CPA lease sales since 1999 and has been considered satisfactorily responsive to the concern of the Governor of Alabama. The stipulation specifies requirements for consultation that lessees must follow when developing plans for fixed structures (refer to **Appendix D**) while still allowing leasing and OCS oil- and gas-related operations in the area, which could not occur with the no-leasing buffer. If any of the action alternatives are selected, BOEM expects this stipulation to be analyzed and decided on during each individual lease sale stage in the Five-Year Program; therefore, no visual impacts would be expected to occur should the stipulation be applied.

Alternative D, if adopted, would prevent any OCS oil- and gas-related activity whatsoever in the affected blocks; thus, it would eliminate any potential direct impacts to the biota of those blocks from OCS oil- and gas-related activities, which otherwise could be conducted within the blocks. Under Alternative D, the number of blocks that would become unavailable for lease represents only a small percentage of the total number of blocks to be offered under Alternative A, B, or C (<4%, even if blocks subject to all three stipulations were excluded). Therefore, Alternative D could reduce offshore infrastructure and activities by up to 4 percent when chosen in conjunction with Alternative A, B, or C. However, it is also possible (and BOEM believes more reasonable to expect) that Alternative D would only shift the location of offshore infrastructure and activities farther from these sensitive zones and not lead to a reduction in offshore infrastructure and activities. The regional impact levels for all resources, except for the topographic features and live bottoms, would be similar to those described under Alternative A, B, or C. All of the assumptions (including the other potential mitigating measures) and estimates would remain the same as described for Alternatives A, B, C. The analyses of impacts summarized below in **Chapter 2.3** and described in detail in **Chapter 4** for each resource 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. The exclusion of this small subset of available unleased blocks would likely reduce exploration, development, and production flexibility and, therefore, could result in adverse economic effects (e.g., reduced royalties). A detailed discussion of the development scenario and major related impact-producing factors is included in **Chapter 3**.

2.2.2.5 Alternative E—No Action

Alternative E is the cancellation of a single proposed lease sale. The opportunity for development of the estimated oil and gas that could have resulted from a proposed action (i.e., a single lease sale) or alternative to the proposed action, as described above, would be precluded or postponed to a future lease sale. Any potential environmental impacts resulting from a proposed lease sale would not occur or would be postponed. Cancellation of a proposed lease sale, however, would not stop all OCS oil- and gas-related activities. Activities related to previously issued leases and permits (as well as those that may be issued in the future under a separate decision) related to the OCS oil and gas program would continue. If a lease sale were to be cancelled, the resulting development of oil and gas would most likely be postponed to a future lease sale; therefore, the overall level of OCS oil- and gas-related activity would only be reduced by a small percentage, if any. Therefore, the cancellation of a proposed lease sale would not significantly change the environmental impacts of overall OCS oil- and gas-related activity. However, the cancellation of a proposed lease sale may result in direct economic impacts to the individual companies. Revenues collected by the Federal Government (and thus revenue disbursements to the States) would also be adversely affected.

The analyses of impacts summarized below in **Chapter 2.3** and described in detail in **Chapter 4** for each resource 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 **Chapter 3**.

2.2.3 Alternatives and Deferrals Considered but Not Analyzed in Detail

BOEM evaluated a range of alternatives to ensure that all reasonable alternatives have been considered in this Multisale EIS. Below are the alternatives that have been considered but eliminated from detailed study with a brief discussion of the reasons for eliminating them.

Previous Multisale Schedule

This alternative would maintain the approach taken in the 2012-2017 Five-Year Program, which consisted of 12 lease sales in total, including 5 annual lease sales beginning in 2017 in the WPA offering all available unleased blocks, 5 annual lease sales beginning in 2018 in the CPA offering all available unleased blocks, and 2 lease sales in the EPA in 2014 and 2016 offering all available unleased blocks. No CPA or EPA blocks that are subject to Congressional moratorium pursuant to GOMESA would be included for leasing consideration.

While lease sales in the GOM have historically been separate annual lease sales in the CPA and WPA and periodic lease sales in the EPA as appropriate, significant recent energy reforms in Mexico have the potential to meaningfully change how exploration and development decisions are made in the GOM. By scheduling lease sales offering all available unleased blocks in the GOM, BOEM is providing more frequent opportunities to bid on rejected, relinquished, or expired OCS lease blocks, as well as facilitating better planning to explore resources that may straddle the U.S.-Mexico boundary. Furthermore, any individual lease sale could be scaled back to conform more closely to the traditional separate planning area model should circumstances warrant.

This Multisale EIS considers Alternatives B and C, which were similar to the previous lease sale approach of having lease sales for each planning area. Alternative B differs only in that the EPA would be combined with the CPA into a single lease sale (similar to how the two EPA lease sales in the 2012-2017 Five-Year Program were held concurrently with CPA lease sales). Because this alternative is outside the scope of the lease sale decision rather than at the Five-Year Program stage and as Alternatives B and C are similar to what was considered under the 2012-2017 WPA/CPA Multisale EIS, this alternative was not considered for further analysis.

Additional Buffers

BOEM has considered a suite of alternatives that would implement additional buffer zones around potential areas of concern. Each of these is briefly discussed below, including the reasons why these additional buffer area alternatives have not been carried forward for full analysis.

- BOEM is aware of NOAA's proposal to expand the boundaries of the Flower Garden Banks National Marine Sanctuary (FGBNMS) and has considered an alternative that would exclude all blocks subject to that expansion from oil and gas leasing. The NOAA has issued an NOI to prepare an EIS for the proposed expansion, and BOEM is working as a cooperating agency on that EIS. The proposed expansion, however, is in the early stages of planning and the alternatives for the proposed expansion are not complete. Therefore, the proposed expansion of the FGBNMS is a NOAA decision that remains too speculative at this time to include in this Multisale EIS. Such an analysis would prejudge the NOAA decisionmaking process and be duplicative of the EIS being prepared by that agency. However, BOEM considered the areas proposed under the FGBNMS expansion in the analysis of other alternatives and resources in the 2012-2017 WPA/CPA Multisale EIS, as well as in all Supplemental EISs for the previous 2012-2017 Five-Year Program. BOEM has existing protective measures in the Topographic Features Stipulation that currently protect the features, even those outside of the current boundaries but proposed for inclusion in NOAA's expansion. In addition, BOEM protects topographic features and the surrounding habitat by conducting site-specific, case-by-case reviews of plans and permit applications in order to distance bottom-disturbing activities from sensitive habitat. Thus, should NOAA decide in the future to expand the boundaries of the FGBNMS, the only potential effect on OCS oil- and gas-related activities in the future would be a likely reduction of the impacts already considered and analyzed in the EISs. For all of these reasons, BOEM believes it is premature at this point to include the proposed expansion as a specific alternative in this Multisale EIS. If, as NOAA's proposals for the FGBNMS become less speculative or reach fruition in new boundaries and use plans, BOEM will consider whether the proposed action and alternatives evaluated in future NEPA documents related to OCS leasing should be modified.

- During scoping, the Save the Manatee Club requested an alternative that would impose a buffer around those blocks in the EPA that are subject to Congressional moratorium pursuant to GOMESA. The Save the Manatee Club noted that, even though leasing is not allowed in these areas of the EPA, previous experiences such as the *Deepwater Horizon* explosion, oil spill, and response demonstrate that these areas are still at risk to potential impacts. The GOMESA bans oil and gas leasing within 125 mi (201 km) of the Florida coastline in the EPA and in a portion of the CPA until 2022. For an analysis of a low-probability catastrophic spill, such as the *Deepwater Horizon* explosion and oil spill, refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c). Such an event, however, is not considered reasonably foreseeable as a result of a proposed action. Additionally, the comments did not offer any well-defined buffer areas and/or reasoning to support such a buffer.

The key to managing risk is to implement a rigorous regulatory regime to ensure that postlease drilling activities are conducted in a safe manner. It is at this stage that detailed information regarding a specific proposed action is available for review, including reservoir characteristics, infrastructure designs, and features to ensure safety and reduce environmental risk. BOEM has implemented a suite of regulatory changes following the *Deepwater Horizon* explosion, oil spill, and response. These are discussed in detail in **Chapter 3.2 and Appendix A**. For these reasons, BOEM concluded that an alternative including an additional buffer around the EPA was not warranted for detailed analysis.

- The National Park Service (NPS) requested an alternative that considered a no-leasing buffer within 15 mi (24 km) of the Gulf Islands National Seashore (GUIS). As noted in **Chapter 1.1**, the purpose of the proposed Federal actions is to offer for lease those areas that may contain economically recoverable oil and gas resources in accordance with the OCSLA (67 Stat. 462), as amended (43 U.S.C. §§ 1331 *et seq*.). Over time, using adaptive management practices, BOEM and its predecessors have proactively developed a suite of mitigating measures that are applied at the prelease or postlease phases of the oil and gas program to avoid and protect fixed biologically and culturally sensitive features, which includes the GUIS (Gulf Islands National Seashore Information to Lessees and Operators [ITL]). This ITL ensures that postlease plans submitted by lessees of whole and partial lease blocks within the first 12 mi (19 km) of Federal waters near the GUIS are reviewed by BOEM in order to minimize visual impacts from development operations on these blocks. The lease blocks that would be subject to the Gulf Islands National Seashore ITL are illustrated in **Figure 2-6**. This is consistent with the NPS's proposed management strategy for maintaining optimal night sky viewing conditions, which include cooperating with partners to minimize intrusion of artificial light into the night scene in the national seashore and evaluating the impacts on the night sky caused by national seashore facilities (USDOI, NPS, 2011).

  Based on historical leasing patterns, the proposed actions would likely only minimally contribute to the existing disturbances from OCS and non-OCS sources. To be more specific, there are currently 11 producing platform complexes (fixed platforms and caissons) within 7-15 mi (11-24 km) of the GUIS offshore the States of Louisiana, Mississippi, and Alabama. Some OCS platforms are visible on the horizon. Numerous OCS structures and wells have existed within 3-7 mi (5-11 km) of Petit Bois Island over the years. Many of these platforms have been removed and only three structures are currently within 7-10 mi (11-16 km) of Petit Bois Island, which is a designated wilderness area.

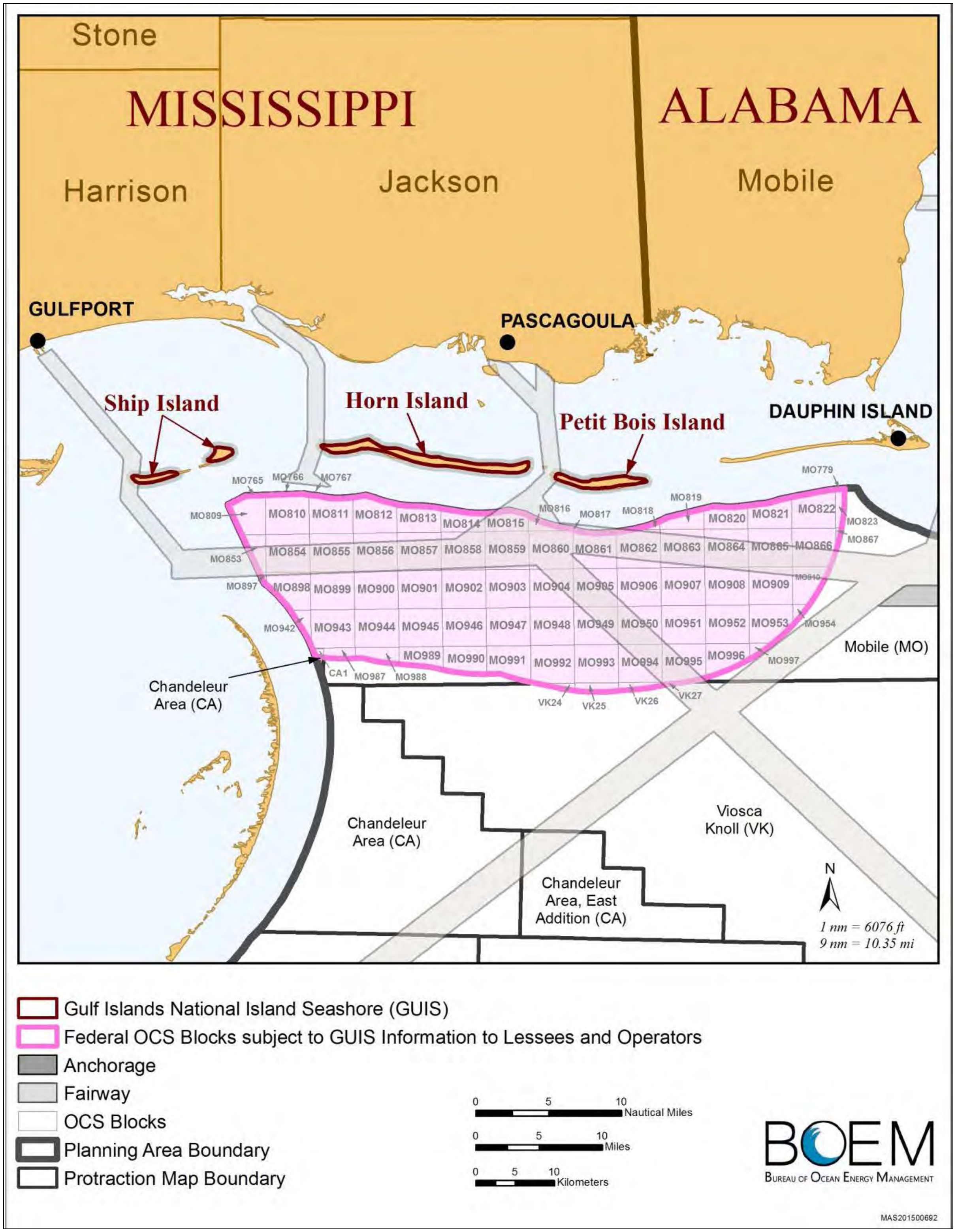

Figure 2-6. Federal OCS Blocks Subject to the Gulf Islands National Seashore Information to Lessees and Operators.

Section 8(g) of the OCSLA, as amended, requires a "fair and equitable" distribution of revenues between the Federal Government and a coastal state for Federal lease blocks within 3 mi (5 km) of the seaward boundary of the State that may contain oil and gas reservoirs underlying both OCS and submerged State tidelands. Due to the location of the GUIS, the proposed buffer area includes blocks off the coasts of Louisiana, Mississippi, and Alabama, and could result in reduced revenue sharing for those States as a result of the alternative being chosen. Consultation with the Governor of each State is required at the time of soliciting nominations for the leasing of OCS lands wholly or partially within the 3 mi (5 km) mentioned above. The GOMESA enhances the revenue sharing provisions for the four Gulf oil- and gas-producing States of Alabama, Louisiana, Mississippi, and Texas, and their coastal political subdivisions, which are to be used for coastal conservation, restoration, and hurricane protection.

Even without the presence of oil and gas activities in State waters and on the Federal OCS, there is substantial vessel traffic in this area due to the presence of federally designated shipping safety fairways and anchorage areas to provide unobstructed approaches for vessels using U.S. ports (33 CFR part 166). These visual impacts would remain ongoing and unaffected by the proposed actions. Because of the environmental protection measures already implemented by BOEM and BSEE through the established ITL for the subject area, this alternative was not analyzed in detail in this Multisale EIS.

To exclude the additional buffer areas proposed above from potential oil and gas exploration and development would not achieve the desired goal of reducing risk in the search for offshore oil and gas resources. The purpose of and need for the oil and gas leasing program is to help meet the Nation's energy needs by developing those resources in a manner consistent with environmental protection and the laws and policies of affected States. Additional buffers would result in a scenario where there would be little to no change in the assessment of potential environmental damage and safety concerns on the OCS; however, there could be adverse effects to the economic benefits of a lease sale. Based on the information presented above, BOEM has determined that an alternative that would impose the proposed buffer areas will not decrease the risk associated with drilling, would not achieve the desired goal of reducing risk or environmental impacts, and may be detrimental to the recovery of OCS oil and gas resources in the long term. It does not meet the purpose of and need for the proposed actions and, therefore, these alternatives have not been retained for detailed analysis.

Lease Sale Offering Only EPA Available Unleased Blocks

This alternative would allow for a proposed lease sale encompassing the EPA within the U.S. portion of the Gulf of Mexico OCS. Available unleased blocks within the CPA and WPA would ***not*** be considered under this alternative. This alternative would offer for lease all available unleased blocks within the EPA portion of the proposed lease sale area for oil and gas operations with the exception of whole and portions of blocks deferred by the Gulf of Mexico Energy Security Act of

2006. During scoping, the Save the Manatee Club requested NEPA analysis of the EPA in a separate process. The Save the Manatee Club noted that the EPA has unique environmental and cultural resources, and has heretofore only been minimally impacted by drilling operations in the Gulf of Mexico. Any potential impacts to resources exclusive or more prevalent to the EPA (e.g., manatees and Gulf sturgeon) have been considered in the alternatives analyses.

The proposed EPA portion of the lease sale area covers approximately 657,905 ac and includes those blocks previously included in the EPA Lease Sales 225 and 226 areas, which is bordered by the CPA boundary on the west and the Military Mission Line (86º41′ W. longitude) on the east. The area is south of eastern Alabama and western Florida; the nearest point of land is 125 mi (201 km) northwest in Louisiana. As of March 2016, approximately 595,475 ac (70%) and 162 lease blocks of the proposed EPA lease sale area are currently unleased. From a leasing perspective, it is less practical to conduct separate lease sales for the EPA due to its size (i.e., the number of blocks available for lease) and considering the leasing history in this area. Although recent leasing in the EPA has been minimal, providing these blocks more frequently through a regionwide approach would more effectively balance Agency workload and provide greater flexibility to industry, including the ability to respond to the significant recent energy reforms in Mexico that have the potential to meaningfully change how exploration and development decisions are made in the GOM.

Although the majority of the EPA is unavailable for leasing through June 30, 2022, under GOMESA, there are existing leases in the planning area. Thirteen lease sales have been held in this planning area as it has been configured over the years, and 105 wells have been drilled, with significant discoveries of natural gas. However, there has been no production from the wells in the planning area as currently configured. Lease Sale 224 in March 2008 resulted in leases being awarded on 36 OCS blocks with bonuses totaling $64.7 million in the small area available for leasing consideration. The most recent lease sale held in the same small area was Lease Sale 225 in March 2014, and no bids were received. One lease sale remains on the 2012-2017 Five-Year Program schedule for 2016.

Regionwide OCS Lease Sale with Additional Mitigating Measures for Sperm Whale High-Use Areas

Sperm whales, protected under the ESA, often concentrate in the deepwater area offshore the Mississippi River delta, especially in the vicinity of the Mississippi Canyon and adjacent continental slope. During scoping for the 2017-2022 Five-Year Program EIS, the Center for Biological Diversity requested special consideration of the Mississippi Canyon area to protect potential important sperm whale habitat. This was not analyzed as an alternative because current long-term biological data do not support the need for exclusion or additional mitigations beyond what currently exists. A full analysis of marine mammals, including sperm whales, can be found in **Chapter 4.9.1**.

Delay Leasing Until the State of the Gulf of Mexico Environmental Baseline is Known

This suggested alternative would address comments raised that the state of recovery of the Gulf of Mexico environmental baseline following the *Deepwater Horizon* explosion, oil spill, and response has not yet been fully determined and that BOEM should delay leasing until missing information is known, or at least for several years. The basis for this alternative is the concern that additional leasing could contribute to an incremental increase in the chance of another low-probability catastrophic oil spill or that cumulative impacts could have devastating environmental effects on an ecosystem that is still recovering from a previous event. It should be noted that, because of the dynamic nature of the Gulf of Mexico, the environmental baseline is not static and is constantly changing due to a variety of natural and anthropogenic factors. This would be true even if the *Deepwater Horizon* explosion, oil spill, and response had not occurred, and it remains to be seen if many impacts of the *Deepwater Horizon* explosion, oil spill, and response can be identified and studied in isolation from the other ongoing and systemic processes in the Gulf of Mexico. This Multisale EIS has taken into account that there remains incomplete information and that an Agency will likely never have complete and perfect information available to it at the time of a decision, and indeed that is the purpose of 40 CFR § 1502.22 of the CEQ regulations, which allows an agency to evaluate the information that is available and proceed in light of incomplete or unavailable information. It should also be noted that this option of delaying leasing is already incorporated into the No Action Alternative that is analyzed in this Multisale EIS. At the time of the lease-sale decision, the Assistant Secretary for Land and Minerals Management can choose the No Action Alternative for any of the lease sales covered in this Multisale EIS. This would result in a delay of leasing, potentially until the next scheduled lease sale in the current Five-Year Program or beyond, where again the Assistant Secretary for Land and Minerals Management can choose the No Action Alternative.

In addition, credible scientific data regarding the potential short-term and long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response on Gulf of Mexico resources is becoming available but remains incomplete at this time. It could be many years before this information becomes available via the Natural Resource Damage Assessment (NRDA) process, BOEM's Environmental Studies Program, and numerous studies by other Federal and State agencies and academia. Nonetheless, the subject-matter experts that prepared this Multisale EIS acquired and used new scientifically credible information that was available, determined that additional information was not available absent exorbitant expenditures or could not be obtained regardless of cost in a timely manner, and where gaps remained, exercised their best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information. This approach complies with the requirements of §1502.22 of the CEQ regulations regarding how agencies should address incomplete or unavailable information.

The references for **Chapters 1-5** are dominated by scientific research. In the vast majority of these references, the methods used to conduct the research are spelled out. These references are publicly available and the "scientific methodologies of research and modeling" would be too extensive to detail in an EIS. However, in numerous places in this Multisale EIS, where it was considered important, specific methodologies were summarized. For example, the use of *in-situ* fluorescence and oxygen measurements as proxies for oil concentration and biodegradation to track the subsurface plume of oil from the *Deepwater Horizon* explosion and oil spill was included in this Multisale EIS where appropriate.

In addition, BOEM's catastrophic analysis, *Catastrophic Spill Event Analysis* white paper, provides more information about general impacts of a low-probability catastrophic oil spill (USDOI, BOEM, 2016c). A low-probability catastrophic oil spill is not reasonably foreseeable and not part of a proposed action; however, it should be noted that the catastrophic analysis is intended to be a general overview of the potential effects of a catastrophic spill and to complement the substantive analyses of accidental events (noncatastrophic) presented in the main body of the EIS. As such, the *Catastrophic Spill Event Analysis* white paper should be read with the understanding that further detail about oil impacts from more reasonably foreseeable accidents on a particular resource can be found in the main body of this Multisale EIS or previous relevant NEPA documents. Given the above, BOEM has determined that this suggested alternative does not require additional analysis in this Multisale EIS, distinct and apart from the No Action Alternative already considered.

2.2.4 Mitigating Measures

Mitigating measures considered in this NEPA document rely primarily on avoiding an impact altogether by not allowing certain actions or parts of an action.

The NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences and to take actions that protect, restore, and enhance the environment. Agencies are required to identify and include in an EIS those appropriate mitigating measures not already included in the proposed action or alternatives. The CEQ regulations (40 CFR § 1508.20) define mitigation as follows:

- Avoidance—Avoiding an impact altogether by not taking a certain action or part of an action.
- Minimization—Minimizing impacts by limiting the intensity or magnitude of the action and its implementation.
- Restoration—Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
- Maintenance—Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
- Compensation—Compensating for the impact by replacing or providing substitute resources or environments.

BOEM considers the use of mitigation at all phases of energy development and planning, from the overarching Five-Year Program EIS, through each of the NEPA documents for the lease sales, and followed by more site-specific reviews for exploration, development and production, and platform removal plans (**Figure 1-2**). Through this approach, BOEM is able to analyze impacts and mitigations that are ripe for consideration at the appropriate time. Mitigations can be applied at the prelease stage, typically through applying lease stipulations or at the postlease stage by applying site-specific mitigating measures to plans, permits, and/or authorizations. BOEM assigns site-specific mitigation by imposing conditions of approval on a plan, permit, or authorization.

2.2.4.1 Proposed Prelease Mitigating Measures (Stipulations)

The potential lease stipulations and mitigating measures included for analysis in this Multisale EIS were developed as a result of numerous scoping efforts for the continuing OCS Program in the Gulf of Mexico. The 10 lease stipulations described below would be considered at the prelease stage, as applicable, to any proposed lease sale. These measures will be considered for adoption by the ASLM under authority delegated by the Secretary of the Interior. The analysis of any stipulations for any particular alternative 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 proposed lease sale will be described in the Record of Decision for that proposed lease sale. **Appendix D** provides a more detailed analysis of the 10 lease stipulations and their effectiveness.

Topographic Features Stipulation

The topographic features located in the WPA and CPA provide habitat for coral-reef-community organisms (**Chapter 4.1.1.6**). There are currently no identified topographic features protected under this stipulation in the EPA. The OCS oil- and gas-related activities resulting from a proposed action could have a severe, even lethal, impact on or near these communities if the Topographic Features Stipulation is not adopted and such activities are not otherwise mitigated. The blocks affected by the Topographic Features Stipulation are shown in **Figure 2-4**.

BOEM and its predecessors have protected topographic features since 1973 through the use of the Topographic Features Stipulation.

The stipulation establishes No Activity Zones at the topographic features. Outside the No Activity Zones, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted. 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 would prevent or minimize damage to the biota of the banks from routine OCS oil- and gas-related activities resulting from a proposed action, while allowing the development of nearby oil and gas resources, specifically as discussed in **Appendix D**.

Live Bottom (Pinnacle Trend) Stipulation

For the purpose of this stipulation, “live bottom areas” are defined as seagrass communities or those areas that contain biological assemblages consisting of sessile invertebrates such 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. Live bottom features may include pinnacle trend features, low-relief features, or potentially sensitive biological features. This stipulation would be applied to protect both pinnacle trend features (i.e., Live Bottom [Pinnacle Trend] Stipulation) and/or low-relief features (i.e. Live Bottom [Low Relief] Stipulation); however, blocks subject to the Live Bottom (Low Relief) Stipulation are not included as part of the proposed action for this Multisale EIS. The Live Bottom (Pinnacle Trend) Stipulation would protect live bottom features (Pinnacle Trend features) from routine OCS oil- and gas-related activity by distancing bottom-disturbing activity (e.g., anchors, chains, cables, and wire ropes) 30 m (100 ft) from hard bottoms/pinnacles. The Live Bottom (Pinnacle Trend) Stipulation is intended to protect live bottom features (Pinnacle Trend features) from damage and, at the same time, provide for the recovery of potential oil and gas resources.

Military Areas Stipulation

> *BOEM has effectively managed and avoided space-use conflicts with military activities in the Gulf of Mexico since the early 1970s.*

The Military Areas Stipulation has been applied to all blocks leased in military areas since 1977 and reduces potential impacts, particularly in regards to safety, but it does not reduce or eliminate the actual physical presence of OCS oil- and gas-related operations in areas where military operations are conducted. The stipulation contains a “hold harmless” clause (holding the U.S. Government harmless in case of an accident involving military operations) and requires lessees to coordinate their activities with appropriate local military contacts. **Figure 2-7** shows the military warning areas in the Gulf of Mexico.

Figure 2-7. Military Warning Areas and Eglin Water Test Areas in the Gulf of Mexico.

Evacuation Stipulation

This stipulation would be a part of any lease in the easternmost portion of the CPA and all blocks leased in the EPA portion of the proposed lease sale area resulting from a proposed action. An evacuation stipulation has been applied to all blocks leased in these areas since 2001. The Evacuation Stipulation is designed to protect the lives and welfare of offshore oil and gas personnel. The OCS oil- and gas-related activities have the potential to occasionally interfere with specific requirements and operating parameters for the lessee's activities in accordance with the military stipulation clauses contained herein. If it is determined that the operations will result in interference with scheduled military missions in such a manner as to possibly jeopardize the national defense or to pose unacceptable risks to life and property, then a temporary suspension of operations and the evacuation of personnel may be necessary.

Coordination Stipulation

This stipulation would be a part of any lease in the easternmost portion of the CPA and all blocks leased in the EPA portion of the proposed lease sale area resulting from a proposed action. A coordination stipulation has been applied to all blocks leased in these areas since 2001. The Coordination Stipulation is designed to increase communication and cooperation between military authorities and offshore oil and gas operators. Specific requirements and operating parameters are established for the lessee's activities in accordance with the military stipulation clauses. For instance, if it is determined that the operations will result in interference with scheduled military missions in such a manner as to possibly jeopardize the national defense or to pose unacceptable risks to life and property, then certain measures become activated and the OCS oil- and gas-related operations may be curtailed in the interest of national defense.

Blocks South of Baldwin County, Alabama, Stipulation

This stipulation would be included only on leases on blocks south of and within 15 mi (24 km) of Baldwin County, Alabama. The stipulation specifies requirements for consultation that lessees must follow when developing plans for fixed structures. The stipulation has been continually adopted in annual CPA lease sales since 1999. It has been considered satisfactorily responsive to the concern of the Governor of Alabama and was adopted in each of the CPA lease sales in the 2002-2007 and 2007-2012 Five-Year Programs.

Protected Species Stipulation

The Protected Species Stipulation has been applied to all blocks leased in the GOM since December 2001. This stipulation was developed in consultation with the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NMFS and the U.S. Department of the Interior, FWS in accordance with Section 7 of the Endangered Species Act, and it is designed to minimize or avoid potential adverse impacts to federally protected species.

United Nations Convention on the Law of the Sea Royalty Payment Stipulation

If the United States becomes a party to the 1982 United Nations Convention on the Law of the Sea (UNCLOS) prior to or during the life of a lease issued by the United States on a block or portion of a block located beyond its Exclusive Economic Zone as defined in UNCLOS and subject to such conditions that the Senate may impose through its constitutional role of advice and consent, then the royalty payment lease provisions will apply to the lease so issued, consistent with Article 82 of UNCLOS.

Below Seabed Operations Stipulation

The Below Seabed Operations Stipulation language is intended to be lease sale-specific language and would incorporate maps of the potentially affected blocks containing rights-of-use and easements. This stipulation is designed to minimize or avoid potential space-use conflicts with moored and/or floating production facilities that have already been granted rights-of-use and easements in particular OCS blocks.

Stipulation on the Agreement Between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico (Transboundary Stipulation)

The "Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico" (Agreement) was signed on February 20, 2012, and entered into force on July 18, 2014. The stipulation has been applied to blocks or portions of blocks located wholly or partially within the 3 statute miles (4.8 km) of the maritime or continental shelf boundary with Mexico. The stipulation incorporates by reference the Agreement and notifies lessees that, among other things, activities in this boundary area will be subject to the Agreement and that approval of plans, permits, and unitization agreements will be conditioned upon compliance with the terms of the Agreement. A copy of the Agreement can be found on BOEM's website at http://www.boem.gov/BOEM-Newsroom/Library/Boundaries-Mexico.aspx.

Summary

These measures would be considered for adoption by the ASLM at the prelease stage, as applicable, under authority delegated by the Secretary of the Interior. The analysis of any stipulations for any particular alternative 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. Mitigating 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 related to leases issued as a result of a lease sale, will undergo a NEPA review, and additional project-specific mitigations applied as conditions of plan approval at the postlease stage. The BSEE has the authority to monitor and enforce these conditions under 30 CFR part 250 subpart N and may seek remedies and penalties from any operator that fails to comply with those conditions, stipulations, and mitigating measures.

2.2.4.2 Prelease Mitigating Measures (Stipulations) by Alternative

Table 2-1 indicates what stipulations could be applied for each alternative. Alternative D would consider the same stipulations as Alternative A, B, or C, as applicable, with the exception of removing the Topographic Features and Live Bottoms (Pinnacle Trend) Stipulations since all blocks subject to these stipulations would not be made available. Since Alternative E is the cancellation of a proposed lease sale no stipulations would apply.

Table 2-1. Applicable Stipulations by Alternative. (Stipulations that would apply to specific lease blocks under any given alternative are marked with an X. Stipulations that would not apply are marked "–". Because Alternative E would cancel a proposed lease sale, no leasing activities would occur and, therefore, no stipulations would apply.)

Stipulation	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Topographic Features	X	X	X	–	–
Live Bottoms	X	X	–	–	–
Military Areas	X	X	X	X	–
Evacuation	X	X	–	See A, B, or C	–
Coordination	X	X	–	See A, B, or C	–
Blocks South of Baldwin County, Alabama	X	X	–	See A, B, or C	–
Protected Species	X	X	X	X	–
United Nations Convention on the Law of the Sea Royalty Payment	X	X	X	X	–
Below Seabed Operations	X	X	–	See A, B, or C	–
Transboundary	X	X	X	X	–

2.2.4.3 Postlease Mitigating Measures

Mitigating measures are a standard part of BOEM's program to ensure that operations are always conducted in an environmentally sound manner.

This chapter discusses mitigating measures that could be applied by BOEM during site-specific plan and/or permit reviews. Mitigating measures have been proposed, identified, evaluated, or developed through previous BOEM lease sale NEPA reviews and analyses. Many of these mitigating measures have been adopted and incorporated into regulations and/or as guidelines governing OCS exploration, development, and production activities. All plans for OCS oil- and gas-related activities (e.g., exploration and development plans, pipeline applications, and structure-removal applications) go through rigorous BOEM review and approval to ensure compliance with established laws and regulations. Existing mitigating measures must be incorporated and documented in plans submitted to BOEM. Operational compliance of the mitigating measures is enforced through BSEE's onsite inspection program.

Mitigating measures are a standard part of BOEM's program to ensure that the operations are always conducted in an environmentally sound manner (with an emphasis on avoiding or minimizing any adverse impact of routine operations on the environment). For example, certain measures ensure site clearance, and survey procedures are carried out to determine potential snags to commercial fishing and avoidance of archaeological sites and biologically sensitive areas such as pinnacles, topographic features, and chemosynthetic communities.

Some BOEM-identified mitigating measures are incorporated into OCS oil- and gas-related operations through cooperative agreements or efforts with industry and State and Federal agencies. These mitigating measures include NMFS's Observer Program to protect marine mammals and sea turtles during explosive removals, labeling operational supplies to track possible sources of debris or equipment loss, development of methods of pipeline landfall to eliminate impacts to beaches or wetlands, and beach cleanup events.

Site-specific mitigating measures are also applied by BOEM during plan and permit reviews. BOEM realized that many of these site-specific mitigations were recurring and developed a list of "standard" mitigations. There are currently over 120 standard mitigations. The wording of a standard mitigation is developed by BOEM in advance and may be applied whenever conditions warrant. Standard mitigation text is revised as often as is necessary (e.g., to reflect changes in regulatory citations, agency/personnel contact numbers, and internal policy). Categories of site-specific mitigations include the following: air quality; archaeological resources; artificial reef material; chemosynthetic communities; Flower Garden Banks; topographic features; hard bottoms/pinnacles/potentially sensitive biological features; military warning areas and Eglin Water Test Areas; hydrogen sulfide; drilling hazards; remotely operated vehicle surveys; geophysical survey reviews; and general safety concerns. Site-specific mitigation "types" include the following: advisories; conditions of approval; hazard survey reviews; inspection requirements; notifications; post-approval submittals; and safety precautions. In addition to standard mitigations, BOEM may also apply nonrecurring mitigating measures that are developed on a case-by-case basis. Refer to **Appendix B** ("Commonly Applied Mitigating Measures") for more information on the mitigations that BOEM and BSEE typically apply to plans and/or permits.

BOEM is continually revising applicable mitigations to allow the Gulf of Mexico OCS Region to more easily and routinely track mitigation compliance and effectiveness. A primary focus of this effort is requiring post-approval submittal of information within a specified timeframe or after a triggering event (e.g., end of operations reports for plans, construction reports for pipelines, and removal reports for structure removals).

2.2.5 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 (Council on Environmental Quality, 1981). The analysis in the EIS can then show the degree of change from the present conditions for each issue to the actions related to a proposed action.

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

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

2.2.5.1 Issues to be Analyzed

The following issues relate to potential impact-producing factors and the resources and activities that could be affected by OCS exploration, development, production, and transportation activities.

Accidental Events: Concerns were raised related to the potential impact of oil spills, including the *Deepwater Horizon* explosion, oil spill, and response, on the marine and coastal environments, specifically regarding the potential effects of oil spills on tourism, emergency response capabilities, spill prevention, effect of winds and currents on the transport of oil spills, accidental discharges from both deepwater losses of well control and pipeline ruptures, and oil spills resulting from past and future hurricanes. Other concerns raised over the years of scoping were the 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, 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.

After the *Deepwater Horizon* explosion, oil spill, and response, BOEM prepared a "Catastrophic Spill Event Analysis," which was previously included as an appendix to the 2012-2017 WPA/CPA Multisale EIS and the subsequent Supplemental EISs. This analysis has since been published as an independent white paper and can be found on BOEM's website (USDOI, BOEM, 2016c). The purpose of this technical analysis is to assist BOEM in the preparation of robust environmental analyses of the proposed actions. The CEQ guidance addresses impacts with catastrophic consequences in the context of evaluating reasonably foreseeable significant adverse effects in an EIS when they address the issue of incomplete or unavailable information (40 CFR § 1502.22). "'Reasonably foreseeable' impacts include impacts which have catastrophic consequences even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason" (40 CFR § 1502.22(b)(4)). Therefore, this analysis, which is based on credible scientific evidence, identifies the most likely and most significant impacts from a high-volume blowout and oil spill that continues for an extended period of time. Such a catastrophic event is not reasonably foreseeable and not part of a proposed action; but, in line with CEQ guidance (CEQ, 2010), the reasonably foreseeable impacts that could result in the exceedingly unlikely event that such a spill were to occur are analyzed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c). The scenario and impacts discussed in this analysis should not be confused with the scenario and impacts anticipated to result from routine activities or more reasonably foreseeable smaller accidental events of a proposed action.

Drilling Fluids and Cuttings: Specific concerns related to drilling fluids include mercury, synthetic-based drilling fluids (SBFs) and large volumes of industrial chemicals necessary for deepwater drilling operations, and potential for persistence of drilling muds and cuttings. Other concerns raised over the years of scoping were potential smothering of benthic communities by offshore disposal of drilling fluids and cuttings, the use and disposal of drilling fluids include potential spills of oil-based drilling fluids (OBFs), onshore disposal of OBFs, the fate and effects of SBFs 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: Lighting was raised as a specific concern. Concerns raised over the years of scoping were the potential effects of the presence of drilling rigs and platforms, service vessels, helicopters, trash and debris, and flaring on visual aesthetics.

Air Emissions: The potential effects of emissions of combustion gases from platforms, drill rigs, service vessels, and helicopters have been raised as an issue over the years of scoping. Also under consideration are the flaring of produced gases during extended well testing and the potential impacts of the transport of production with associated hydrogen sulfide (H_2S).

Water Quality Degradation: Issues related to water quality degradation raised over the years of scoping most often were 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 raised over the years of scoping include storage and disposal of trash and debris, and trash and debris on recreational beaches.

Structure and Pipeline Emplacement: Some of the issues raised over the years of scoping 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 raised over the years of scoping about the abandonment of operations include how a platform is removed, the potential impacts of explosive severance and removals on marine organisms, the remaining operational debris snagging fishing nets, and site-clearance procedures.

OCS Oil- and Gas-Related Support Services, Activities, and Infrastructure: Specific issues were damage to coastal infrastructure by past hurricane activity and the vulnerability of coastal infrastructure to damage from future hurricanes. Concerns raised over the years of scoping include activities related to the shore-based support of the development and production plan include vessel and helicopter traffic and emissions, 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, including demands on public services and tourism. Issues raised from years of scoping include impacts on employment, population fluctuations, effects on land-use impacts to low-income or minority populations, and cultural impacts.

Geological and Geophysical Activities: Specific issues were noise impacts related to seismic airgun surveys on marine mammals, sea turtles, fisheries, and other resources. Other concerns include vessel strikes with marine mammals and sea turtles, as well as concerns regarding potential space-use conflicts.

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 consideration of the extensive safety improvements implemented since the *Deepwater Horizon* explosion, oil spill, and response; noise from platforms, vessels, and helicopters; turbidity as a result of seafloor disturbance or discharges; and damage to biota and habitats.

Resource Topics Analyzed in This Multisale EIS: The analyses in **Chapters 4.1-4.5** address the issues and concerns identified above under the following resource topics:

- Air Quality
- Water Quality (Coastal and Offshore)
- Coastal Habitats (Estuarine Systems and Coastal Barrier Beaches and Associated Dunes)
- Deepwater Benthic Communities (Chemosynthetic and Deepwater Coral)
- *Sargassum* and Associated Communities
- Live Bottoms (Topographic Features, Pinnacles, and Low-Relief Features)
- Fishes and Invertebrate Resources
- Birds
- Protected Species (ESA Listed Marine Mammals, Sea Turtles, Beach Mice, Protected Birds, and Protected Corals)
- Commercial Fisheries
- Recreational Fishing
- Recreational Resources
- Archaeological Resources (Historic and Prehistoric)
- Human Resources and Land Use (Land Use and Coastal Infrastructure, Economic Factors, and Social Factors, Including Environmental Justice)

2.2.5.2 Issues Considered but Not Analyzed

As previously noted, the CEQ 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 this Multisale EIS. The following categories were considered not to be significant issues related to a proposed action or 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 U.S. Department of the Interior and/or BOEM's 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. For example, the Louisiana Department of Natural Resources, Office of Coastal Management requested in their scoping comments that this Multisale EIS make provisions for compensatory mitigation for all lease sale impacts. Such comments are forwarded to the appropriate program offices for their consideration. Programmatic issues including expansion of the proposed lease sale area, administrative boundaries, and royalty relief have been considered in the preparation of the Draft Five-Year Program EIS (USDOI, BOEM, 2016b).

Revenue Sharing

A number of comments were received on previous EISs from State and local governments, interest groups, and the general public stating that locally affected communities should receive an increased share of revenues generated by the OCS oil and gas leasing program. In particular to the GOM, Louisiana reiterated continued concerns that Louisiana's coastal wetlands are disproportionately bearing the impacts from OCS oil- and gas-related activities and that BOEM should make provisions for appropriate compensatory mitigation related to OCS lease sale activities.

Comments and concerns that relate to the use and distribution of revenues are issues under the direction of the U.S. Congress or the Department of the Interior and their guiding regulations, statutes, and laws.

On October 1, 2010, the revenue collection function of the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEM's predecessor) became the independent Office of Natural Resource Revenue. The Office of Natural Resource Revenue distributes revenues collected from Federal mineral leases to special-purpose funds administered by Federal agencies, to States, and to the General Fund of the U.S. Department of the Treasury. Legislation and regulations provide formulas for the disbursement of these revenues. With the enactment of GOMESA, the Gulf producing States (i.e., Texas, Louisiana, Mississippi, and Alabama) and their coastal political subdivisions (CPSs) were granted an increased share of offshore oil and gas revenue. Beginning in FY 2007, and thereafter, Gulf producing States and their CPSs received 37.5 percent of the qualified OCS revenue from new leases, including bonus bids, rentals, and production royalty, issued in the 181 Area in the EPA and in the 181 South Area, which is located from 100 mi (161 km) offshore from the Alabama-Florida State line and over 285 mi (459 km) from Tampa, Florida. Beginning in FY 2016 and through 2055, Gulf producing States and their CPSs will receive 37.5 percent and the Land and Water Conservation Fund will receive 12.5 percent of qualified OCS revenue from new leases in the existing areas available for leasing, subject to a $500 million cap. The remaining 50 percent of qualified OCS revenues and revenues exceeding the $500 million cap will be distributed to the U.S. Treasury.

The socioeconomic benefits and impacts to local communities are analyzed in **Chapter 4.14.3**.

2.3 Comparison of Impacts by Alternative

Table 2-2 provides a comparison of expected impact levels by alternative and is derived from the analysis of each resource in **Chapter 4**. The impact level ratings have been specifically tailored and defined for each resource within the **Chapter 4** impact analysis. BOEM has concluded that the selection of Alternative E would result in no additional discernible impacts to the resources analyzed; therefore, Alternative E ratings were not included. Cumulative impacts of current and past activities, however, would continue to occur under Alternative E.

Table 2-2. Alternative Comparison Matrix.

Impact Level Key				
Beneficial	Negligible	Minor	Moderate	Major
Resource	Alternative A	Alternative B	Alternative C	Alternative D
Air Quality	Minor	Minor	Minor	Minor
Water Quality	Minor	Minor	Minor	Minor
Estuarine Systems	Minor	Negligible	Negligible	Negligible to Minor

Impact Level Key				
Beneficial	Negligible	Minor	Moderate	Major

Resource	Alternative A	Alternative B	Alternative C	Alternative D
Coastal Barrier Beaches and Associated Dunes	Negligible	Negligible	Negligible	Negligible
Deepwater Benthic Communities	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Sargassum and Associated Communities	Negligible	Negligible	Negligible	Negligible
Live Bottoms: Topographic Features	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Live Bottoms: Pinnacles and Low-Relief Features	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Fishes and Invertebrate Resources	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Birds	Moderate	Moderate	Moderate	Moderate
Protected Species: Marine Mammals	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Sea Turtles	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Beach Mice	Negligible	Negligible	Negligible	Negligible
Protected Birds	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Protected Corals	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Commercial Fisheries	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor
Recreational Fishing	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Recreational Resources	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor
Archaeological Resources	Negligible	Negligible	Negligible	Negligible
Human Resources and Land Use: Land Use and Coastal Infrastructure	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major
Economic Factors	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Social Factors (including Environmental Justice)	Minor	Minor	Minor	Minor

BOEM has concluded that the selection of Alternative E would result in no additional discernible impacts to the resources analyzed; however, cumulative impacts of current, past and reasonably foreseeable future activities could continue to occur.

2.4 SUMMARY OF IMPACTS

Presented here is an overall summary of impacts for each resource with a more detailed analysis of impacts for each resource from the proposed action, as presented in **Chapter 4**.

2.4.1 Air Quality

Air quality is the degree at which the ambient air is free of pollution; it is assessed by measuring the pollutants in the air. To protect public health and welfare, the Clean Air Act established national ambient air quality standards for certain common and widespread pollutants. The seven common "criteria pollutants" are particle pollution (also known as particulate matter, $PM_{2.5}$ and PM_{10}), carbon monoxide (CO); nitrogen dioxide (NO_2); sulfur dioxide (SO_2); lead (Pb); and ozone (O_3). Air emissions from OCS oil and gas development in the Gulf of Mexico would arise from emission sources related to drilling and production with associated vessel support, flaring and venting, decommissioning, fugitive emissions, and oil spills. Associated activities that take place as a result of a proposed action support and maintain the OCS oil and gas platform sources. Air emissions from non-OCS oil- and gas-related emissions in the Gulf of Mexico would arise from emission sources related to State oil and gas programs, onshore industrial and transportation sources, and natural events. Since the primary National Ambient Air Quality Standards are designed to protect human health, BOEM focuses on the impact of these activities on the States, where there are permanent human populations.

Based on Year 2008 and Year 2011 OCS emission inventories, postlease 1-hour NO_x modeling, and past studies, emissions of pollutants into the atmosphere from routine activities and accidental events associated with the OCS Program are projected to be **minor**. Additionally, reductions in emissions have been achieved through the use of low sulfur fuels, catalytic reduction, and other efforts. The incremental contribution of a single regionwide proposed lease sale to the cumulative impacts would be **minor** for any of the action alternatives. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a regionwide proposed lease sale would be very small. The cumulative contribution to visibility impairment from a regionwide proposed lease sale is also expected to be very small. A full analysis of air quality can be found in **Chapter 4.1**.

2.4.2 Water Quality

Water quality is a term used to describe the condition or environmental health of a waterbody or resource, reflecting its particular biological, chemical, and physical characteristics and the ability of the waterbody to maintain the ecosystems it supports and influences. It is an important measure for both ecological and human health. The impacts of OCS Program-related routine operational discharges (**Chapter 3.1.5.1**) on water quality are short term and localized, and are therefore considered **negligible**. The potential impacts from OCS Program-related oil spills on water quality after mitigation are also short term and are considered **minor**. This is because after removal of most free product, the residual oil dissipates quickly through dispersion and weathering; however, secondary impacts to water quality may occur, such as the introduction of additional hydrocarbon into the dissolved phase through the use of dispersants and the sinking of hydrocarbon residuals from burning. The impacts from a proposed action are a small addition to the cumulative impacts on water quality when compared with inputs from hypoxia, potentially leaking shipwrecks, chemical weapon and industrial waste dumpsites, natural oil seeps, and natural turbidity. The incremental contribution of the routine activities and accidental events associated with a proposed action to the cumulative impacts on water quality is expected to be **minor** for any of the action alternatives. A full analysis of water quality can be found in **Chapter 4.2**.

2.4.3 Coastal Habitats

2.4.3.1 Estuarine Systems (Wetlands and Seagrasses/Submerged Vegetation)

The estuarine system is the transition zone between freshwater and marine environments. It can consist of many habitats, including wetlands and submerged vegetation. The impacts to these habitats from routine activities associated with a proposed action are expected to be **negligible** due to the projected low probability for any new pipeline landfalls (0-1 projected), the minimal contribution to the need for maintenance dredging, and the mitigating measures expected to be used to further reduce these impacts (e.g., the use of modern techniques such as directional drilling). Overall, impacts to estuarine habitats from oil spills associated with activities related to a proposed action would be expected to be **minor** because of the distance of most postlease activities from the coast, the expected weathering of spilled oil over that distance, the projected low probability of large spills near the coast, the resiliency of wetland vegetation, and the available cleanup techniques. Cumulative impacts to estuarine habitats are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities outlined in **Chapter 4.3.1** and human and natural impacts. Development pressures in the coastal regions of the GOM have been largely the result of tourism and residential beach-side development, and this trend is expected to continue. Storms will continue to impact the coastal habitats and have differing impacts. The incremental contribution of a proposed action to the cumulative impacts on estuarine habitats is expected to be **negligible** to **minor** depending on the selected alternative. A full analysis of estuarine habitats can be found in **Chapter 4.3.1**.

2.4.3.2 Coastal Barrier Beaches and Associated Dunes

The coastal barrier beaches and associated dunes are those beaches and dunes that line the coast of the northern GOM, including both barrier islands and beaches on the mainland. The impacts to coastal barrier beaches and dunes from routine activities associated with a proposed action are expected to be **negligible** due to the minimal number of projected onshore pipelines, the minimal contribution to vessel traffic and to the need for maintenance dredging, and the mitigating measures that would be used to further reduce these impacts. The greater threat from an oil spill to coastal beaches is from a coastal spill as a result of a nearshore vessel accident or pipeline rupture, and cleanup activities. Overall, impacts to coastal barrier beaches and dunes from oil spills associated with OCS oil- and gas-related activities related to a proposed action would be expected to be **minor** because of the distance of most of the resulting activities from the coast, expected weathering of spilled oil, projected low probability of large spills near the coast, and available cleanup techniques. Cumulative impacts to coastal barrier beaches and dunes are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities outlined in **Chapter 4.3.2** and other human and natural impacts. Development pressures in the coastal regions of the GOM have been largely the result of tourism and residential beach-side development, and this trend is expected to continue. Efforts to stabilize the GOM shoreline have adversely impacted coastal beach landscapes. Storms will continue to impact the coastal habitats and have differing impacts. The incremental contribution of a proposed action to the cumulative impacts on estuarine habitats is expected to be **negligible** to **minor** depending on the selected alternative. A full analysis of coastal barrier beaches and associated dunes can be found in **Chapter 4.3.2**.

2.4.4 Deepwater Benthic Communities

BOEM defines “deepwater benthic communities” as including both chemosynthetic communities (chemosynthetic organisms plus seep-associated fauna) and deepwater coral communities (deepwater coral plus associated fauna). These communities are typically found in water depths of 984 ft (300 m) or deeper throughout the GOM, although deepwater benthic habitats are relatively rare compared with ubiquitous soft bottoms.

The OCS oil- and gas-related, impact-producing factors for deepwater benthic communities can be grouped into three main categories: (1) bottom-disturbing activities; (2) drilling-related sediment and waste discharges; and (3) noncatastrophic oil spills. These impact-producing factors have the potential to damage individual deepwater habitats and disrupt associated benthic communities if insufficiently distanced or otherwise mitigated. However, impacts from individual routine activities and accidental events are usually temporary, highly localized, and expected to impact only small numbers of organisms and substrates at a time. Moreover, use of the expected site-specific plan reviews/mitigations will distance activities from deepwater benthic communities, greatly diminishing the potential effects. Therefore, at the regional, population-level scope of this analysis and assuming adherence to all expected regulations and mitigations, impacts from reasonably foreseeable routine activities and accidental events are expected to be **negligible** to **minor** for any of the action alternatives. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS and non-OCS cumulative effects experienced by live bottom habitats. The OCS oil- and gas-related cumulative impacts to deepwater benthic communities are estimated to be **negligible** to **minor**. A full analysis of deepwater benthic communities can be found in **Chapter 4.4**.

2.4.5 *Sargassum* and Associated Communities

Sargassum in the GOM is comprised of *S. natans* and *S. fluitans* (Lee and Moser, 1998; Stoner, 1983; Littler and Littler, 2000) and is characterized by a brushy, highly branched thallus with numerous leaf-like blades and berrylike pneumatocysts (Coston-Clements et al., 1991; Lee and Moser, 1998; Littler and Littler, 2000). The *Sargassum* cycle is truly expansive, encompassing most of the western Atlantic Ocean and the Gulf of Mexico with the growth, death, and decay of these plant and epiphytic communities, which may play a substantial role in the global carbon cycle.

Several impacting factors can affect *Sargassum*, including vessel-related operations, oil and gas drilling discharges, operational discharges, accidental spills, non-OCS oil- and gas-related vessel activity, and coastal water quality. Routine vessel operations and accidental events that occur during drilling operations or vessel operations, and oiling due to an oil spill were the impact-producing factors that could be reasonably expected to impact *Sargassum* populations in the GOM. All of these impact-producing factors would result in the death or injury to the *Sargassum* plants or to the organisms that live within or around the plant matrix. However, the unique and transient characteristics of the life history of *Sargassum* and the globally widespread nature of the plants and animals that use the plant matrix buffer against impacts at any given location. Impacts to the overall population of the *Sargassum* community are therefore expected to be **negligible** from either routine activities or reasonably foreseeable accidental events for any of the action alternatives. The incremental impact of OCS oil- and gas-related activities on the population of *Sargassum* would be **negligible** and would not result in cumulative impacts to the population. Impacts from changing water quality would be much more influential on *Sargassum* than OCS development and would still occur without the presence of OCS oil- and gas-related activities. A full analysis of *Sargassum* and associated communities can be found in **Chapter 4.5**.

2.4.6 Live Bottoms

2.4.6.1 Topographic Features

Defined topographic features (**Chapter 4.6.1**) are a subset of GOM live bottom habitats that are large enough to have an especially important ecological role, with specific protections defined in the proposed Topographic Features Stipulation. Within the Gulf of Mexico, BOEM has identified 37 topographic features where some degree of protection from oil and gas development may be warranted based on geography and ecology. Of all the possible impact-producing factors, it was determined that bottom-disturbing activities associated with drilling, exploration, and vessel operations were the only impact-producing factors from routine activities that could be reasonably expected to substantially impact topographic features. The impact-producing factors resulting from accidental events include bottom-disturbing activities from drilling, exploration, and vessel operations as well as the release of sediments and toxins released during drilling. Oil spill-related activities were also considered to be a substantial source of potential impact to topographic features.

Adherence to the Topographic Features Stipulation (detailed in **Appendix D)** would assist in preventing most of the potential impacts on topographic feature communities by increasing the distance of OCS oil- and gas-related activities from these features. Should this stipulation be applied to any future lease sale, as it has been historically, the impacts of a proposed action to topographic features from routine activities and accidental events would be **negligible**. The incremental contribution of a proposed action to the cumulative impacts on topographic features is expected to be **negligible** with adherence to the proposed Topographic Features Stipulation. Impacts ranging from **negligible** to **moderate** may still be expected from non-OCS oil- and gas-related activities depending on factors such as fishing and pollution; however, the incremental impact of the proposed activities should not result in an augmentation of the expected impacts. Additionally, because of the areal extent of the 37 topographic features, any localized impacts at one topographic feature does not preclude that impacts will occur at other topographic features. A full analysis of topographic features can be found in **Chapter 4.6.1**.

2.4.6.2 Pinnacles and Low-Relief Features

The Pinnacle Trend is an approximately 64 x 16 mi (103 x 26 km) area in water depths of about 200-650 ft (60-200 m). It is in the northeastern portion of the CPA at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and De Soto Canyon (**Figures 2-4 and 4-16**). Outside of the Pinnacle Trend, low-relief, live bottom epibenthic communities occur in isolated locations in shallow waters (<984 ft; 300 m) throughout the GOM wherever there is suitable hard substrate and other physical conditions (e.g., depth, turbidity, etc.) for development. Hard bottom habitats occur throughout the GOM but are relatively rare compared with ubiquitous soft bottoms.

The impact-producing factors for pinnacles and low-relief live bottom features can be grouped into three main categories: (1) bottom-disturbing activities; (2) drilling-related sediment and waste discharges; and (3) oil spills. These impact-producing factors have the potential to damage individual deepwater habitats and disrupt associated benthic communities if insufficiently distanced or otherwise mitigated. At the broad geographic and temporal scope of this analysis, and assuming adherence to all expected lease stipulations and typically applied regulations and mitigations, routine activities are expected to have largely short-term localized and temporary effects. Although accidental events have the potential to cause severe damage to specific live bottom communities, the number of such events is expected to be very small. Therefore, at the regional, population-level scope of this analysis, impacts from reasonably foreseeable routine activities and accidental activities are expected to be **negligible** to **minor**. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS and non-OCS cumulative effects experienced by live bottom habitats. The OCS oil- and gas-related cumulative impacts to live bottom communities are estimated to be **negligible.** A full analysis of pinnacles and low-relief features can be found in **Chapter 4.6.2**.

2.4.7 Fish and Invertebrate Resources

The distribution of fishes and invertebrates vary widely and species may be associated with different habitats at various life stages discussed further in **Chapter 4.7**. The impact-producing factors affecting these resources are anthropogenic sound, bottom-disturbing activities, habitat modification, and accidental oil spills. The impacts from routine activities, excluding infrastructure emplacement, would be expected to be **negligible** or **minor** due to short-term localized effects. The installation of OCS oil- and gas-related infrastructure constitutes a long-term modification of the local habitat and is hypothesized to have resulted over the life of the program in **moderate** changes in the distribution of some species. Although this effect is not necessarily adverse and infrastructure is expected to be decommissioned and sites restored to natural habitat, the cumulative impact over the life of the OCS Program is spatiotemporally extensive. Accidental spills have been historically low-probability events and are typically small in size. The expected impact to fishes and invertebrate resources from accidental oil spills is **negligible**. Commercial and recreational fishing are expected to have the greatest direct effect on fishes and invertebrate resources, resulting in impact levels ranging from **negligible** for most species to potentially **moderate** for some targeted species (e.g., hogfish spp., gray triggerfish, and greater amber jack [*Seriola dumerili*]). The analysis of OCS oil- and gas-related and non-OCS oil- and gas-related routine activities, accidental events, and cumulative impacts indicates the overall impact to fishes and invertebrate resources would range from **negligible** to **moderate** for different species for any of the action alternatives. A full analysis of fish and invertebrate resources can be found in **Chapter 4.7**.

2.4.8 Birds

The affected birds include both terrestrial songbirds and many groups of waterbirds. Routine impacts to coastal, marine, and migratory birds that were considered include routine discharges and wastes, noise, platform severance with explosives (barotrauma), geophysical surveys with airguns, platform presence and lighting, construction of OCS oil- and gas-related onshore facilities, and pipeline landfalls. The impacts to birds from OCS oil-and gas-related routine activities are similar wherever they may occur in the GOM, and all are considered **negligible** to **minor**. Negligible impacts would be little to no impacts that are measured or measurable for a population. No mortality of a flock or large population would occur, and no overall disturbance-causing changes in behavioral patterns would be expected. Minor impacts would occur when one of the two following conditions are met: (1) flocks or large populations of birds would experience stimuli or impact-producing factors and would be disturbed or otherwise affected overall, resulting in acute behavioral changes; however, these impacts would be short-term and reversible; and (2) one or more incidents where one or more individuals experience injury or mortality may occur, but with no measured or measurable impact on a large population. Accidental impacts to birds are caused by oil spills, spill cleanup, and emergency air emissions. Seabirds may not always experience the greatest impacts from a spill but may take longer for populations to recover because of their unique population ecology (demography). Some species of seabirds can have a clutch size of just one egg, and they have relatively long life spans and often have delayed age at first breeding. Impacts for overall accidental events would therefore be expected to be **moderate**. The overall impacts from routine and accidental activities resulting from a proposed action are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). However, other seabirds such as gulls have larger clutches (laughing gulls usually have three eggs/clutch except in the tropics) and may recover quite quickly. This conclusion is based on the incremental contribution of a proposed action to the cumulative OCS oil- and gas-related and non-OCS oil- and gas-related impacts. A full analysis of coastal and migratory birds can be found in **Chapter 4.8**.

2.4.9 Protected Species

2.4.9.1 Marine Mammals

The Gulf of Mexico marine mammal community is diverse and distributed throughout the GOM, with the greatest abundances and diversity of species inhabiting oceanic and OCS waters. The major potential impact-producing factors affecting marine mammals in the GOM as a result of cumulative past, present, and reasonably foreseeable OCS energy-related activities are decommissioning activities, operational discharges, G&G activities, noise, transportation, marine debris, and accidental oil-spill and spill-response activities. Accidental events that involve large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (i.e., days, weeks, or months), pose an increased likelihood of impacting marine mammal populations inhabiting GOM waters. While accidental events have the potential to impact marine mammal species, the number of such events is expected to be very small.

At the regional, population-level scope of this analysis, impacts from reasonably foreseeable routine activities and accidental events are expected to be **negligible** to **moderate** for any of the action alternatives. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall OCS and non-OCS cumulative effects experienced by marine mammal populations. The incremental contribution of a proposed action to the cumulative impacts to marine mammal populations, depending upon the affected species and their respective population estimate, even when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response; non-OCS oil- or gas-related factors; and the minimization of the OCS oil- or gas-related impacts through lease stipulations and regulations, would be expected to be **negligible**. A full analysis of marine mammals can be found in **Chapter 4.9.1**.

2.4.9.2 Sea Turtles

Five sea turtle species have been listed and are present throughout the northern GOM; however, only Kemp's ridley and loggerheads commonly nest on beaches in the GOM. Because of expected mitigations (e.g., BOEM and BSEE proposed compliance with NTLs under the proposed Protected Species Stipulation and conditions of approval on postlease activities), routine activities (e.g., noise or transportation) and accidental events (e.g., oil spills) related to a proposed action are not expected to have long- term adverse effects on the size and productivity of any sea turtle species or populations in the northern GOM. Lethal effects could occur from chance collisions with OCS oil- and gas-related service vessels or ingestion of accidentally released plastic materials from OCS oil- and gas-related vessels and facilities. However, there have been no reports to date on such incidences. Most routine activities and accidental events as a result of a proposed action are therefore expected to have **negligible** to **moderate** impacts. For example, a minor impact might be a behavioral change in response to noise while a moderate impact might be a spill contacting an individual and causing injury or mortality.

Historically, intense harvesting of eggs, loss of suitable nesting beaches, and fishery-related mortality have led to the rapid decline of sea turtle populations. Anthropogenic actions continue to pose the greatest threat to sea turtles since their listing under the ESA, as well as different natural threats including climate change and natural disasters. Cumulative impacts to sea turtles would be expected to be **negligible** as a result of a proposed action. Population-level impacts are not anticipated. A full analysis of sea turtles can be found in **Chapter 4.9.2**.

2.4.9.3 Beach Mice

The four subspecies of beach mouse (*Peromyscus polionotus* ssp.) are small coastal rodents that are only found along beaches in parts of Alabama and northwest Florida. Beach mice rely on dune systems as favorable habitat for foraging and maintaining burrows. Due to the distance between beach mouse habitat and OCS oil- and gas-related activities, routine impacts are not likely to affect beach mouse habitat except under very limited situations. Pipeline emplacement or construction, for example, could cause temporary degradation of beach mouse habitat; however, these activities are not expected to occur in areas of designated critical habitat. Accidental oil spills and associated spill-response efforts are not likely to impact beach mice or their critical habitat because the species live above the intertidal zone where contact is less likely. Habitat loss from non-OCS oil- and gas-related activities (e.g., beachfront development) and predation have the greatest impacts to beach mice. The overall analyses of impact-producing factors associated with the routine activities, accidental events, and cumulative impacts of OCS oil- and gas-related and non-OCS oil- and gas-related activities on beach mice concluded that impacts from a proposed action would be **negligible** for any of the action alternatives. A full analysis of beach mice can be found in **Chapter 4.9.3**.

2.4.9.4 Protected Birds

Protected birds are species or subspecies listed under the ESA by the FWS as threatened or endangered due to the decrease in their population sizes or loss of habitat; therefore, a proposed action could have a greater impact. BOEM is undergoing consultation with the FWS to minimize the potential impacts to ESA-listed species. Impacts from routine activities, which include discharges and wastes affecting air and water quality, noise, and possibly artificial lighting, would be **negligible** to protected birds. The listed bird species considered are typically coastal birds and would not be exposed to much of the oil and gas activities. Waste discharges to air or water produced as a result of routine activities are regulated by the USEPA and BOEM and are subject to limits to reduce potential impacts; therefore, due to precautionary requirements and monitoring, the impacts to protected birds would be **negligible** for any of the action alternatives. The major impact-producing factors resulting from accidental events associated with a proposed action that may affect protected birds include accidental oil spills and response efforts and marine debris. In the case of an accidental oil spill, impacts would be **negligible** to **moderate** depending on the magnitude and spatiotemporal proximity of such an event. Major impacts could occur if a large oil spill occurred with direct contact to a protected bird species or if the habitat became contaminated resulting in mortality of a listed species. Marine debris produced by OCS oil- and gas-related activities as a result of accidental disposal into the water may affect protected birds by entanglement or ingestion. Due to the regulations prohibiting the intentional disposal of items, impacts would be expected to be **negligible,** however, impacts may scale up to **moderate** if the accidental release of marine debris caused mortality of a listed bird. Overall, BOEM would expect **negligible** to **moderate** impacts to protected birds considering routine, accidental and cumulative impacts for any of the action alternatives. A full analysis of protected birds can be found in **Chapter 4.9.4**.

2.4.9.5 Protected Corals

Elkhorn, staghorn, boulder star, lobed star, and mountainous corals are listed by the NMFS as threatened due to the decrease in their population sizes; therefore, impacts from a proposed action could have a higher level than realized by other coral species. BOEM understands this and is undergoing consultation for these species to minimize the potential impacts. Though the listed species are protected, they would have the same impacts from a proposed action as other coral species. Without effective mitigations, the proposed action could directly impact coral habitat within the GOM. Assuming adherence to all expected lease stipulations and other postlease, protective restrictions and mitigations, the routine activities related to a proposed action are expected to have mostly short-term localized and temporary effects because the site-specific survey information and distancing requirements described in NTL 2009-G39 will allow BOEM to identify and protect live bottom features (which protected corals may inhabit) from harm by proposed OCS oil- and gas-related activities during postlease reviews. While accidental events have the potential to cause severe damage to specific coral communities, the number of such events is expected to be small. Further, many of the protected corals occur in the Flower Garden Banks National Marine Sanctuary, which, under the current boundaries, is not proposed for future leasing under any of the alternatives in this Multisale EIS. Therefore, the incremental contribution of activities resulting from a proposed action to the overall cumulative impacts to protected corals is expected to be **negligible** to **minor** for any of the action alternatives. Proposed OCS oil- and gas-related activities would contribute incrementally to the overall OCS and non-OCS cumulative impacts experienced by corals. A full analysis of protected corals can be found in **Chapter 4.9.5**.

2.4.10 Commercial Fisheries

A proposed action could affect commercial fisheries by affecting fish populations or by affecting the socioeconomic aspects of commercial fishing. The impacts of a proposed action on fish populations are presented in **Chapter 4.7**. Routine activities such as seismic surveys, drilling activities, and service-vessel traffic can cause space-use conflicts with fishermen. Structure emplacement could have positive or negative impacts, depending on the location and species. For example, structure emplacement prevents trawling in the associated area and, thus, could impact the shrimp fishery. On the other hand, production platforms can facilitate fishing for reef fish such as red snapper and groupers. Accidental events, such as oil spills, could cause fishing closures and have other impacts on the supply and demand for seafood. However, accidental events that could arise from a proposed action would likely be small and localized. A proposed action would be relatively small when compared with the overall OCS Program, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, Federal and State fisheries management strategies, and other non-OCS oil- and gas-related factors. Therefore, the incremental contribution of a proposed action to the cumulative impacts to commercial fisheries would range from **beneficial** to **minor** for any of the action alternatives. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access. Alternative E would prevent these impacts from occurring, although commercial fisheries would still be subject to the impacts from the OCS Program, as well as the impacts from non-OCS sources. A full analysis of commercial fisheries can be found in **Chapter 4.10**.

2.4.11 Recreational Fishing

The Gulf's extensive estuarine habitats (**Chapter 4.3.1**), live bottom habitats (**Chapter 4.6**), and artificial substrates (including artificial reefs, shipwrecks, and oil and gas platforms) support several valuable recreational fisheries. Alternatives A-D can affect recreational fishing by affecting fish populations or by affecting the socioeconomic aspects of recreational fishing. The impacts of Alternatives A-D on fish populations are presented in **Chapter 4.7**. Vessel traffic can cause space-use conflicts with anglers. Structure emplacement generally enhances recreational fishing, although this positive effect will be offset during decommissioning unless a structure were maintained as an artificial reef. Accidental events, such as oil spills, can cause fishing closures and can affect the aesthetics of fishing in an area. However, accidental events that could arise would likely be small and localized. Alternatives A-D should also be viewed in light of overall trends in OCS platform decommissioning, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternatives A-D on recreational fisheries are expected to be **negligible** to **minor**. A full analysis of recreational fishing can be found in **Chapter 4.9.11**.

2.4.12 Recreational Resources

Alternatives A-D would contribute to the negligible to minor aesthetic impacts and space-use conflicts that arise due to the broader OCS Program. These conflicts arise due to marine debris, the visibility of platforms, and vessel traffic. Structure emplacements can have positive impacts on recreational fishing and diving because platforms often act as artificial reefs. Oil spills can negatively affect beaches and other coastal recreational resources. Alternatives A-D should also be viewed in light of economic trends, as well as various non-OCS oil- and gas-related factors that can cause space-use conflicts and aesthetic impacts, such as commercial and military activities. Because of the relatively small contribution of any given lease sale under any of the proposed action alternatives to the overall OCS Program, in addition to other non-OCS oil- and gas-related activities, the various impacts are expected to be **beneficial** to **minor**. A full analysis of recreational resources can be found in **Chapter 4.12**.

2.4.13 Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are capable of providing scientific or humanistic understanding of past human behavior, cultural adaptation, and related topics through the application of scientific or scholarly techniques, such as controlled observation, contextual measurement, controlled collection, analysis, interpretation, and explanation (30 CFR § 250.105). Archaeological resources are primarily impacted by any activity that directly disturbs or has the potential to disturb the seafloor. For the OCS Program, this includes the placement of drilling rigs and production systems on the seafloor; pile driving associated with platform emplacement; pipeline placement and installation; the use of seismic receiver nodes and cables; the dredging of new channels, as well as maintenance dredging of existing channels; anchoring activities; post-decommissioning activities including trawling clearance; and the masking of archaeological resources from industry-related infrastructure and debris.

Regardless of which planning area a proposed lease sale is held, the greatest potential impact to an archaeological resource as a result of a proposed action under any of the action alternatives is site-specific and would result from direct contact between an offshore activity or accidental event and a site. Archaeological surveys, where required prior to an operator beginning OCS oil- and gas-related activities on a lease, are expected to be effective at identifying possible archaeological sites. A proposed action’s postlease activities, including the drilling of wells and installation of platforms, installation of pipelines, anchoring, and removal of platforms and other structures installed on the seafloor and site clearance activities, as well as accidental events such as loss of debris, may result in **negligible** to **major** impacts to archaeological sites.

There is no acceptable threshold of negative cumulative impacts to archaeological sites. Identification, evaluation, and avoidance or mitigation of archeological resources is expected to result in **negligible**, long-term cumulative impacts to archeological resources; however, if an archaeological site were to be impacted, impacts may range from **negligible** to **major**. A full analysis of archaeological resources can be found in **Chapter 4.13**.

2.4.14 Human Resources and Land Use (Including Environmental Justice)

2.4.14.1 Land Use and Coastal Infrastructure

Oil and gas exploration, production, and development activities on the OCS are supported by an expansive onshore network of coastal infrastructure that includes hundreds of large and small companies. Because OCS oil- and gas-related activities are supported by this long-lived, expansive onshore network, a proposed action is not expected to produce any major impacts to land use and coastal infrastructure. The impacts of reasonably foreseeable accidental events such as oil spills, chemical and drilling fluid spills, and vessel collisions are not likely to last long enough to adversely affect overall land use or coastal infrastructure in the analysis area. In the cumulative analysis, activities relating to all past, present, and future OCS oil- and gas-related activities and State oil and gas production are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks. Non-OCS oil- and gas-related factors contribute substantially to the cumulative impacts on land use and coastal infrastructure, while there is only a small incremental contribution of a proposed lease sale. For any of the action alternatives, the cumulative impacts on land use and coastal infrastructure could range from **negligible** to **major** depending on the specifics of each situation, whether the impacts are measurable, how long the impacts would last, and the size of the affected geographic area as defined in **Chapter 4.14.1**. A full analysis of land use and coastal infrastructure can be found in **Chapter 4.14.1**.

2.4.14.2 Economic Factors

A proposed action would lead to beneficial impacts arising from industry expenditures, government revenues, corporate profits, and other market impacts. Some of these impacts would be concentrated along the Gulf Coast, while others would be widely distributed. A proposed action would also lead to negative economic impacts arising from accidental events and other sources. There would be some differences in economic impacts among Alternatives A-D, corresponding to the differences in the scales and distributions of likely activities. Alternatives A-D should be viewed in light of the OCS Program, as well the numerous forces that can affect energy markets and the overall economy. Most of the incremental economic impacts of a proposed action are forecast to be positive, although there would be some **negligible** to **minor** adverse impacts due to oil spills and to the effects on industries that compete with the offshore oil and gas industry for resources. A full analysis of economic factors can be found in **Chapter 4.14.2**.

2.4.14.3 Social Factors (Including Environmental Justice)

Potential social impacts resulting from a proposed action would occur within the larger socioeconomic context of the GOM region. The affected environment of the analysis area is quite large geographically and in terms of population (133 counties and parishes with over 22.7 million residents). The impacts from routine activities related to a proposed action are expected to be **negligible**, widely distributed, and to have little impact because of the existing extensive and widespread support system for the petroleum industry and its associated labor force. Outside of a low-probability catastrophic oil spill, which is not reasonably foreseeable and not part of a proposed action, any potential accidental events are not likely to be of sufficient scale or duration to have adverse and disproportionate long-term impacts for people and communities in the analysis area. Non-OCS oil- and gas-related factors, which include all human activities, natural events, and processes, actually contribute more to cumulative impacts than do factors related to OCS oil- and gas-related activities alone. When considered with existing and projected routine activities and cumulative impacts and the potential accidental events, the incremental contributions of a proposed action and the OCS Program to social impacts are expected to be **minor** for any of the action alternatives. The oil and gas industry in the GOM region is expansive and long-lived over several decades with substantial infrastructure in place to support both onshore and offshore activities. BOEM’s scenario estimates call for 0-1 new gas processing plant and 0-1 new pipeline landfall over the 50-year life of a single proposed action. Impacts to GOM populations from a proposed action would be immeasurable for environmental justice since these low-income and minority communities are located onshore, distant from Federal OCS oil- and gas-related activities. Also, since these vulnerable populations are located within the larger context of onshore and State-regulated nearshore oil and gas activities that are connected to downstream infrastructure over which BOEM has no regulatory authority, BOEM has determined that a proposed action would not produce environmental justice impacts in the GOM region. A full analysis of social factors and an environmental justice determination can be found in **Chapter 4.14.3**.

CHAPTER 3

IMPACT-PRODUCING FACTORS AND SCENARIO

What's in This Chapter

BOEM develops scenarios that describe OCS oil- and gas-related routine activities and accidental events from a single lease sale, the OCS oil and gas cumulative activities of multiple lease sales, and the non-OCS oil- and gas-related activities and/or events.

- Routine activities for a single lease sale include the following:
  - Exploration and Delineation – geological and geophysical surveys, and drilling exploration and delineation wells.
  - Offshore Development and Production – drilling production wells, infrastructure emplacement, and work-overs and abandonment of wells.
  - Transport – resource transportation (e.g., pipelines and tankers) as well as service transportation (e.g., service vessels and helicopters).
  - Discharges and Wastes – includes operational wastes produced by facilities and vessels, and the disposal of wastes.
  - Decommissioning and Removal.
  - Coastal Infrastructure – information on all the types of infrastructure that supports the offshore oil and gas industry (e.g., construction, transport, and processing facilities).
  - Air Emissions.
  - Noise – the types of noise routinely produced during a lease.
  - New and Unusual Technology – the technologies that have evolved to meet the technical, environmental, and economic challenges of deepwater development.
- Accidental events for a single lease sale could include the following (analyses based on historical data and trends):
  - Oil Spills – information on coastal and offshore spills.
  - Losses of Well Control – the process of a loss of well control event.
  - Accidental Air Emissions – instances that might result in accidental air emissions, including hydrogen sulfide (H_2S).
  - Pipeline Failures – instances that might result in a pipeline failure (e.g., hurricanes).
  - Vessel and Helicopter Collisions – instances that might result in a vessel or helicopter collision and the history of these incidences.
  - Chemical and Drilling-Fluid Spills – instances that might result in a chemical or drilling-fluid spill.
  - Spill Response – the spill-response requirements and initiatives, offshore response, containment, and cleanup technology, and the activities involved in an onshore response and cleanup.
- Cumulative activities include the following:
  - Cumulative OCS Oil and Gas Program – all activities (i.e., the routine activities projected to occur and the accidental events that could occur, as listed above) from past, proposed, and future lease sales.
  - Non-OCS Oil- and Gas-Related Activities – impact-producing factors that are considered in a broader context and that take into account the broad range of other activities taking place within the proposed lease sale area.

3 IMPACT-PRODUCING FACTORS AND SCENARIO

This chapter describes the offshore infrastructure and activities (impact-producing factors) associated with Alternative A or a regionwide proposed action (i.e., a typical lease sale that would result from a proposed action), which would encompass all acreage available for lease within the

WPA, CPA, and EPA (not under moratorium) that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico. This chapter also describes the offshore infrastructure and activities associated with two alternatives that would offer proposed lease sales by individual planning area, which would consist of a single lease sale for all acreage available for lease and not under moratorium either within the CPA and EPA combined (Alternative B) or the WPA (Alternative C). Under Alternative D, the number of blocks that would become unavailable for lease represents only a small percentage (<4%) of the total number of blocks to be offered under Alternative A, B, or C. Therefore, Alternative D could reduce offshore infrastructure and activities by up to 4 percent when chosen in conjunction with Alternative A, B, or C. However, it is also possible that Alternative D would only shift the location of offshore infrastructure and activities farther from sensitive topographic zones and not lead to a reduction in offshore infrastructure and activities. Refer to **Chapter 2.2.2.4** for more information on Alternative D. In addition, **Chapter 3.3.1** describes the Cumulative OCS Oil and Gas Program scenario or activity resulting from past and future lease sales in the GOM that could potentially affect the biological, physical, and socioeconomic resources of the GOM within the WPA, CPA, and EPA.

A scenario describes the offshore activities that could occur for a single lease sale under each alternative. BOEM's Gulf of Mexico OCS Region developed these scenarios to support the detailed analyses of the proposed lease sales' potential impacts whether regionwide or for individual planning areas, as defined in the alternatives in **Chapter 2.2.2**. Each scenario is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production for offshore and onshore activities and facilities. The scenario for each alternative is defined 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. These scenarios are only approximate since future factors such as the economic climate, the availability of support facilities, and pipeline capacities are all unknown. The scenarios used in this Multisale 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 a BOEM 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.

BOEM projects that the overwhelming majority of the oil and natural gas fields discovered as a result of each alternative would reach the end of their economic life within a time span of 50 years following a lease sale. Therefore, activity levels are not projected beyond 50 years for this Multisale EIS. Although unusual cases exist where activity on a lease may continue beyond 50 years, our forecasts indicate that the significant activities associated with exploration, development, production, and abandonment of leases in the GOM occur well within the 50-year analysis period. Exploration and development activity forecasts become increasingly more uncertain as the length of time of the forecast increases and the number of influencing factors increases. The forecasts used to develop the proposed actions and OCS oil and gas scenarios are based on resource estimates developed by BOEM in 2015, published data and information, and historical activity and discovery trends in the GOM.

BOEM uses a series of spreadsheet-based data analyses tools to develop the forecasts of oil and gas exploration, discovery, development, and production activity for each alternative scenario presented in this Multisale EIS. The analyses incorporate all relevant historical activity and infrastructure data, and the resulting forecasts are analyzed and compared with actual historical data to ensure that historical precedent and recent trends are reflected in each activity forecast.

BOEM is confident that the analysis methodology, with adjustments and refinements based on recent activity levels, adequately project Gulf of Mexico OCS oil and gas-related activities in both the short term and the long term for the Multisale EIS analyses.

Each alternative single sale scenario is based on the following factors:

- recent trends in the amount and location of leasing, exploration, and development activity;
- estimates of undiscovered, unleased, economically recoverable oil and gas resources in each water-depth category and each planning area;
- existing offshore and onshore oil and/or gas infrastructure;
- published data and information;
- industry information;
- oil and gas technologies and the economic considerations and environmental constraints of these technologies.

The Five-Year Program currently establishes one lease sale the first and last calendar year of the 2017-2022 Five-Year Program, and two lease sales per calendar year during the 3 other years. Historically, these lease sales have alternated between one single CPA lease sale (Alternative B) and one single WPA lease sale (Alternative C) per year. There were only two EPA lease sales in the previous Five-Year Program (2012-2017). However, Alternative A, which covers all planning areas in one regionwide lease sale, has not previously been analyzed and historic trend data are limited. As a result, Alternative A covers a broad range of offshore infrastructure and activities. BOEM projects that a lease sale could potentially be as large as the highest historic CPA lease sale and the highest historic WPA lease sale combined, or it could be as small as the smallest WPA lease sale. For a proposed action under Alternative A, the majority of the activity is assumed to remain in the CPA.

When analyzing hydrocarbon resources by planning area across the GOM, regardless of the alternative, the majority of oil and gas resources are located within the boundaries of the CPA.

Therefore, for a proposed action under Alternative A, which would encompass all acreage available for lease within the WPA, CPA, and EPA, the majority of the activity would still be located in the CPA. An analysis of the scenario forecast for Alternative A suggests that a maximum of 88 percent of the oil production and associated activity and 83 percent of the gas production and associated activity is forecasted to occur within the CPA/EPA. A maximum of 13 percent of the oil production and associated activity and 19 percent of the gas production and associated activity from Alternative A is forecasted to occur within the WPA.

The average activity level associated with a proposed lease sale is expected to vary based on a number of factors, including the price of oil, resource potential, cost of development, and resource availability (e.g., drill rig availability). The scenario information presented throughout this text is expressed as a range from a low oil-price case scenario to a high oil-price case scenario. Because the low and high oil-price case scenarios are used to create the range in scenario oil and gas activity, this may result in ranges of percentages appearing reversed (larger number first) as the proportion of activity levels may shift between the scenarios. For example, the larger proportion of a given activity or impact-producing factor may occur in the low oil-price case scenario, thus creating a range with a larger number in the low oil-price case scenario (e.g., 40-6%). This format is used because this scenario range represents that 40 percent of wells would be drilled on the continental shelf in the low case and 6 percent in the high case, and though this is technically 6-40 percent of the wells, the placement of the 40-6 percent more accurately reflects the low and high oil-price case scenarios.

Finally, it is important to note that a single lease sale, no matter which alternative is selected, would represent only a small proportion and small contribution to past, present, and future activity as a result of the overall forecasted Cumulative OCS Oil and Gas Program scenario or activity forecasted to occur between 2017 and 2086.

Single Lease Sale (2017-2066)	Percent of Production of a Single Lease Sale in Relation to		
	Cumulative Production Regionwide (2017-2086)	Cumulative Production in the CPA/EPA (2017-2086)	Cumulative Production in the WPA (2017-2086)
Alternative A	1.2-4.2%	–	–
Alternative B	1.0-3.6%	1.2-4.4%	–
Alternative C	0.2-0.6%	–	1.2-3.5%

Note: Alternative D could reduce production values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

Specific projections for activities associated with a single lease sale under each alternative are discussed in the following scenario sections.

3.1 IMPACT-PRODUCING FACTORS AND SCENARIO—ROUTINE OPERATIONS

3.1.1 Resource Estimates and Timetables

A single lease sale scenario was developed for each alternative and is used to assess the potential impacts of a proposed lease sale within the geographic ranges of each alternative. The resource estimates for each alternative 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) the estimates of the portion or percentage of these resources assumed to be leased, discovered, developed, and produced as a result of a proposed action and each alternative. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed and the results are reported as a range of values corresponding to different probabilities of occurrence. The estimates of the portion of the resources assumed to be leased, discovered, developed, and produced as a result of each alternative are based upon logical sequences of events that incorporate past experience, current conditions, and foreseeable development strategies. BOEM used historical databases and information derived from oil and gas exploration and development activities to develop each scenario. The undiscovered, unleased, conventionally recoverable resource estimates for each alternative are expressed as ranges from low to high. This range provides a reasonable expectation of oil and gas production anticipated from a single lease sale held as a result of each alternative based on an actual range of historic observations.

Table 3-1 presents the projected oil and gas production for a single lease sale under each alternative and for the Cumulative OCS Oil and Gas Program (2017-2086). As stated above, the number of blocks that would become unavailable for lease under Alternative D represents only a small percentage (<4%) of the total number of blocks to be offered under Alternative A, B, or C. Therefore, Alternative D could reduce offshore infrastructure and activities by up to 4 percent when chosen in conjunction with Alternative A, B, or C. However, it is also possible that Alternative D would only shift the location of offshore infrastructure and activities farther from sensitive topographic zones and not lead to a reduction in offshore infrastructure and activities. Refer to **Chapter 2.2.2.4** for more information on Alternative D. To analyze impact-producing factors for a proposed action and each alternative, the geographic ranges of each alternative were divided into offshore subareas based upon ranges in water depth. **Figure 3-1** 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 major impact-producing factors of a single lease sale (including the number of exploration and delineation wells, production platforms, and development wells) projected to develop and produce the estimated oil and gas resources for Alternatives A, B, and C are given in **Table 3-2**. This table shows the distribution of these factors by offshore subareas for each alternative. **Table 3-2** also includes estimates of the major impact-producing factors related to the projected levels of exploration, development, and production activity.

Table 3-1. Projected Oil and Gas in the Gulf of Mexico OCS.

Reserve/Resource Production	Lease Sale (2017-2066)	OCS Cumulative (2017-2086)
Alternative A: Regionwide OCS Lease Sale		
Oil (BBO)	0.211-1.118	15.482-25.806
Gas (Tcf)	0.547-4.424	57.875-108.513
Alternative B: Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area (or the CPA/EPA Portion of the Proposed Lease Sale Area)		
Oil (BBO)	0.185-0.970	13.707-22.152
Gas (Tcf)	0.441-3.672	46.328-84.009
Alternative C: Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area (or the WPA Portion of the Proposed Lease Sale Area)		
Oil (BBO)	0.026-0.148	1.775-3.654
Gas (Tcf)	0.106-0.752	11.547-24.504

BBO = billion barrels of oil.
Tcf = trillion cubic feet.

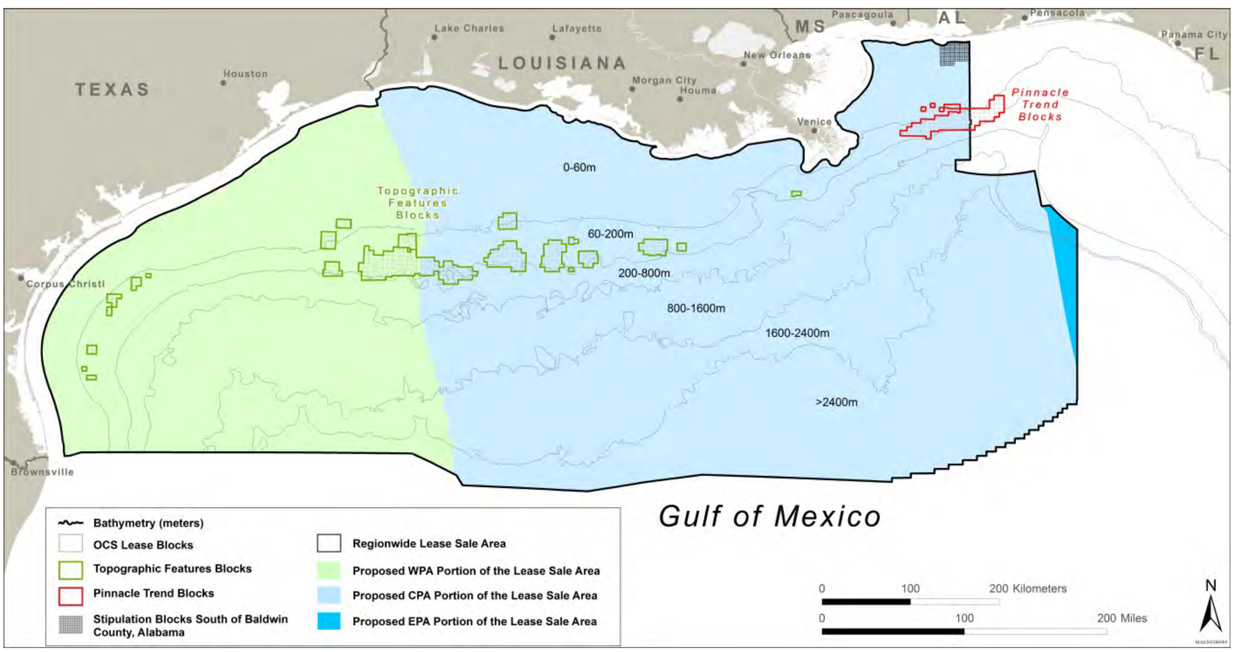

Figure 3-1. Offshore Subareas in the Gulf of Mexico.

Table 3-2. Offshore Scenario Activities Related to a Single Lease Sale for Alternative A, B, or C from 2017 through 2066.

Activity	Alternative[1]	Offshore Subareas (m)[2]						Totals[3]
		0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Exploration and Delineation Wells	A	24-634	8-300	5-11	6-15	5-8	5-16	53-984
	B	20-570	5-293	2-8	2-10	2-2	2-10	33-893
	C	4-64	2-7	2-3	3-5	3-6	3-6	17-91
Development and Production Wells[4]	A Total	14-326	7-220	7-95	13-51	10-37	10-38	61-767
	B Total	10-282	4-211	4-78	10-35	9-31	9-34	46-671
	C Total	4-44	4-9	4-17	4-16	3-6	3-4	22-96
	A Oil	1-35	0-23	3-46	6-22	5-19	4-19	19-164
	B Oil	1-32	0-23	2-38	5-18	4-16	4-17	16-144
	C Oil	0-5	0-1	2-9	1-5	1-4	1-3	5-27
	A Gas	1-35	0-23	3-46	6-22	5-19	4-19	19-164
	B Gas	5-169	2-120	0-17	1-7	1-6	1-7	10-326
	C Gas	2-27	2-6	0-4	1-7	0-1	0-1	5-46
Installed Production Structures	A	8-183	4-85	1-4	1-3	1-2	1-3	16-280
	B	7-158	3-81	1-3	1-2	1	1-2	14-247
	C	3-25	2-4	1	1	1	1	9-33
Production Structures Removed Using Explosives	A	6-130	3-63	0	0	0	0	9-193
	B	5-112	2-60	0	0	0	0	7-172
	C	2-18	2-3	0	0	0	0	4-21
Total Production Structures Removed	A	8-183	4-85	1-4	1-3	1-2	1-3	16-280
	B	7-158	3-81	1-3	1-2	1	1-2	14-247
	C	3-25	2-4	1	1	1	1	9-33
Length of Installed Pipelines (km)[5]	A	59-527	53-417	53-327	78-358	59-275	53-240	355-2,144
	B	40-395	34-336	33-240	55-233	50-227	42-210	254-1,641
	C	20-132	20-81	20-88	24-125	10-48	11-31	105-505
Service-Vessel Trips (1,000's round trips)	A	9-265	4-126	6-51	7-38	7-26	7-36	43-541
	B	8-229	3-120	6-39	6-26	6-15	6-25	38-452
	C	3-36	2-6	6-13	6-13	6-12	6-11	30-89
Helicopter Operations (1,000's round trips)	A	52-2,131	34-1,409	8-71	8-53	8-36	8-53	122-3,750
	B	43-1,848	26-1,426	8-53	8-36	8-18	8-36	105-3,415
	C	17-299	17-71	8-18	8-18	8-18	8-18	70-440

[1] Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information. Alternative A would a regionwide lease sale, Alternative B would be the CPA/EPA portions of the lease sale area, and Alternative C would be the WPA portion of the lease sale area.

[2] Refer to **Figure 3-1**.

[3] Subareas totals may not add up to the planning area total because of rounding.

[4] Development and Production Wells includes some exploration wells that were re-entered and completed. These wells were removed from the Exploration and Delineation well count.

[5] Projected length of pipelines does not include length in State waters.

3.1.2 Exploration and Delineation

The timeline for exploration and delineation activities during the life of a “typical” lease are shown in **Figure 3-2**. A lease may range in length depending on hydrocarbon reserve production on the lease.

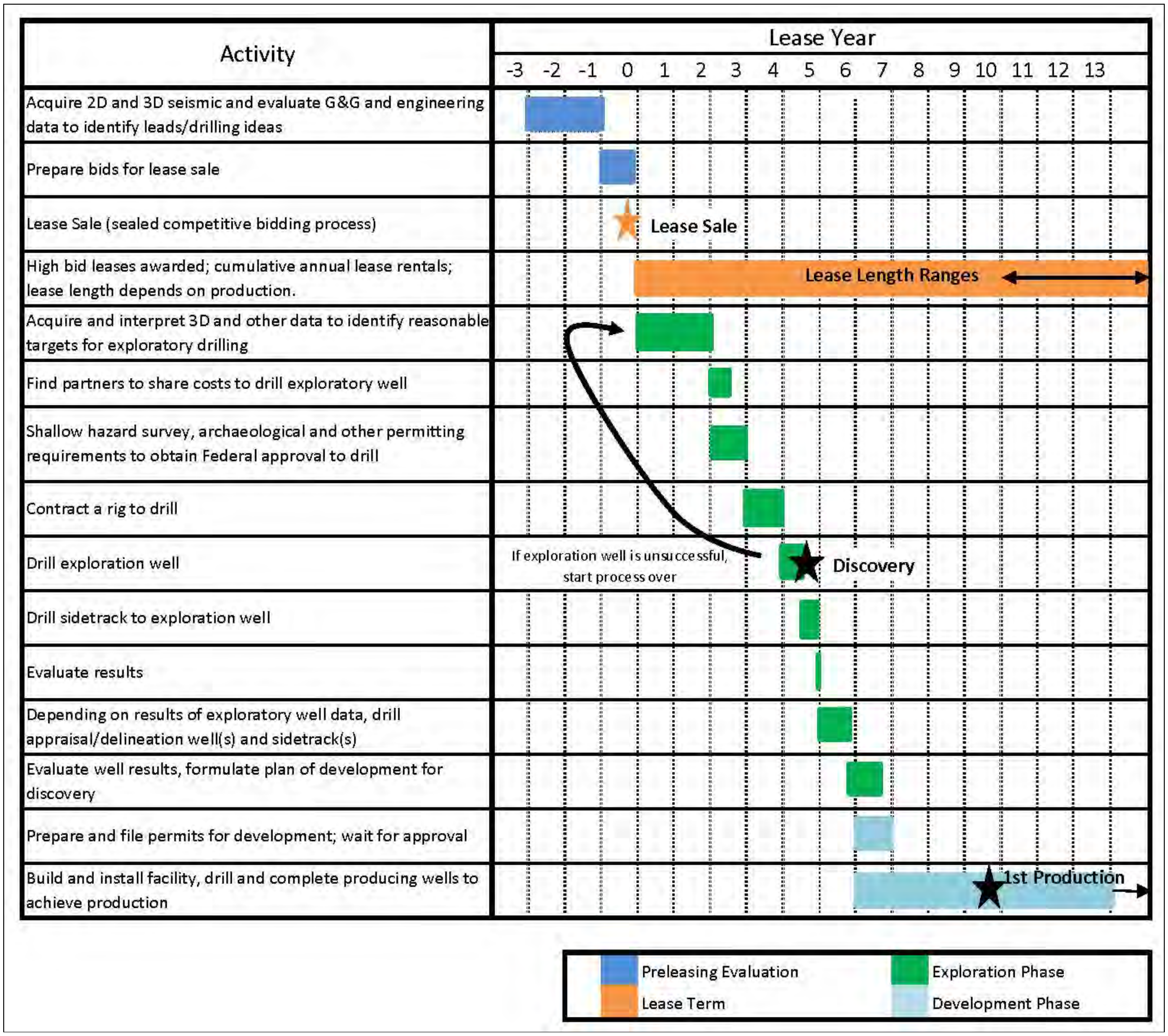

Figure 3-2. Typical Exploration and Production Timeline for Offshore Oil and Gas Drilling.

3.1.2.1 Geological and Geophysical Surveys

Airgun Surveys

Shallow-penetration airgun (HRG airgun) seismic surveys image shallow depths, typically 1,000 m (3,280 ft) or less below the seafloor to produce high-resolution images. Shallow-penetration surveys, also commonly known as shallow hazard surveys, are conducted to investigate the shallow subsurface for geohazards and soil conditions and to identify potential benthic biological communities (or habitats) and archaeological resources. The shallow hazards survey is also used to identify and map geologic features in the vicinity of proposed wells, platforms, anchors and anchor chains, mounds or knolls, acoustic void zones, gas- or oil-charged sediments, or seeps associated with surface faulting that may be indicative of ocean-bottom chemosynthetic communities.

Since 1987, operators have reported shallow waterflow events to BOEM and its predecessors. These events are a phenomenon encountered in water depths exceeding 600 ft (183 m). Reported waterflows are between a few hundred feet to more than 4,000 ft (1,219 m) below the seafloor. Water flowing up and around the well casing and annulus may deposit sand or silt on the seafloor within a few hundred feet of the wellhead. Although in most cases there is no gas content in the waterflow, in these water depths a stream of gas bubbles may form frozen gas hydrates at the sea bottom and on flat surfaces of seafloor drilling equipment. Shallow waterflows can result from buried channels filled with more permeable sediment. Abnormally pressured shallow sands may result from either rapid slumping or rotating faults or from reworked cut-and-fill channels sealed by impermeable mud or clay. In rare cases, hydrates below the mudline could be a source of shallow waterflow by melting down hydrates during oil production. Shallow waterflow events can cause additional expenditure of time and money for the driller to maintain well control and can lead to drilling difficulty up to and including a decision to permanently plug and abandon the well. Unanticipated shallow hazards can lead to downhole pressure kicks that range from minor and controllable to significant and uncontrollable, and up to and including a serious blowout condition.

Deep-penetration airgun seismic surveys are conducted to obtain data on geological formations as deep as 40,000 ft (12,192 m) below the seafloor. Further detailed information on airgun surveys may be found in BOEM's *Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement* (Atlantic G&G Activities Programmatic EIS) (USDOI, BOEM, 2014a). A G&G Programmatic EIS is currently being developed for the GOM (refer to **Chapter 1.7**). Data from these surveys can be used to assess potential hydrocarbon structural and stratigraphic traps and reservoirs, and also help to optimally locate exploration, development, and production wells, thus maximizing extraction and production from a reservoir. BOEM's resource evaluation staff uses deep 2D and 3D seismic data for resource estimation and bid evaluation to ensure that the Government receives a fair market value for lease blocks offered.

The vast majority of the underwater sound generated during an airgun survey is attributable to the airgun or airgun arrays, survey vessel towing the airgun(s), and additional equipment such as electromechanical (HRG non-airgun) tools. An airgun or airgun array releases compressed air into the water, creating a sound energy pulse that can penetrate deep beneath the seafloor.

Airgun arrays are broadband sound sources that project energy over a wide range of frequencies, from less than 10 Hertz (Hz) to more than 2,000 Hz (2 kilohertz [kHz]). Most of the usable energy, however, is concentrated in the frequency range below 200 Hz. The energy level produced by an airgun array depends primarily on three factors:

- the firing pressure in pounds per square inch (psi) of the guns (2,000 psi for most of the surveys currently being conducted);
- the number of airguns in the array (generally between 20 and 80); and
- the total volume in cubic inches of the array (generally between 1,500 and 8,640 cubic inches).

The output of an airgun array is directly related to the firing pressure and to the number of guns and is only proportional to the cube root of the volume. The airguns in the array are arranged to project the maximum amount of seismic energy vertically into the seafloor. Nonetheless, a significant portion of the sound energy from the array is emitted at off-vertical angles and spreads into the surrounding environment. Most of the sound energy is directed downward. The frequency spectrum of the sound spreading near-horizontally can differ markedly from that of the sound directed downward. There also can be substantial differences in the intensity and frequency spectrum of sound spreading in different horizontal directions.

Data acquisition generally takes place day and night and, depending on the size of the survey area, may continue for days, weeks, or months. A typical deep-penetration seismic airgun survey may experience approximately 20-30 percent of non-operational downtime due to a variety of factors, including technical or mechanical problems, standby for weather or other interferences, and performance of mitigating measures (e.g., ramp-up, pre-survey visual observation periods, and shutdowns).

There are several different types/methods of performing airgun surveys dependent upon the data needs. These range from 2D, 3D, and 4D techniques more commonly used in the prelease phase to various vertical seismic profiling (VSP) techniques (e.g., zero-offset, multiple-offset, walk-away, and checkshot surveys), as well as HRG airgun surveys more commonly used during postlease operations.

Checkshot surveys are similar to zero-offset VSP but (1) are less complex and require less time to conduct, (2) produce less information, (3) are cheaper, (4) use a less sophisticated borehole seismic sensor, and (5) acquire shorter data records at fewer depths. During a checkshot survey, a seismic sensor is sequentially placed at a few depths (<20) in a well, and a seismic source (almost always an airgun) is hung from the side of the well platform. Only the first energy arriving at the sensor from the seismic source is permanently recorded. No reflection events are recorded, and no sophisticated data processing like that for VSP surveys are required. The purpose of a checkshot survey is to estimate the velocity of sound in rocks penetrated by the well. Typically, the depths at which the sensors are placed are at, or near, the boundaries of prominent lithologic features. Checkshot surveys can be conducted much quicker than other VSP surveys, but they produce much less information. Because checkshot surveys are much less expensive and do not use the wellbore and the drilling rig as long, they are much more common than other VSP surveys. In most checkshot surveys, the seismic source is hung from the platform in a fixed location within the water column, so a surface vessel is not needed. Because reflection energy does not need to be acquired, the seismic source usually is smaller than those used for other VSP surveys. Detailed descriptions of other VSP survey methods are summarized in BOEM's Atlantic G&G Activities Programmatic EIS (USDOI, BOEM, 2014a).

Both 2D and 3D towed-streamer seismic exploration surveys are conducted off-lease by geophysical contractors either on a proprietary or nonexclusive (multiclient) basis. Proprietary surveys usually cover only a few blocks for an individual client who will then own the data and therefore will have exclusive use of it. In contrast, nonexclusive (multiclient or speculative) survey data are owned by the contractor, are generally collected over large multi-block areas, and are licensed to as many clients as possible to recover costs and produce profits for the contractor.

Newer acquisition technology involves multiple vessels towing airgun arrays with additional vessels towing streamers. These 3D WAZ surveys increase the illumination of many subsurface areas, particularly areas that are overlain with salt, and eliminate unwanted noise attenuation. The 3D coil surveys are a navigational variation of WAZ surveys and are acquired in a spiral fashion that allows for a longer acoustical distance between source and receivers for a better illumination of the acquired data and do not involve vessel turning and repositioning associated with linear acquisition. Detailed descriptions of the different airgun survey methods are summarized in BOEM's Atlantic G&G Activities Programmatic EIS (USDOI, BOEM, 2014a).

Electromechanical/HRG Non-airgun Surveys

Electromechanical (also referred to as HRG non-airgun surveys) surveys use a higher frequency, low-energy sound signal that is emitted and reflected back to the source. The survey equipment is either mounted to the ship or remotely operated vehicle (ROV), conducted using an autonomous underwater vehicle, or towed behind a survey vessel. The sound source and receiver can be located in a single piece of equipment or the sound source is collected by towed hydrophones. When conducted for oil and gas exploration and development, these seafloor- to shallow-focused subbottom penetration surveys are used to identify benthic/biological communities/habitats, archaeological resources, seafloor bathymetry, geological hazards, and seafloor engineering.

There are several different types of HRG non-airgun (electromechanical) equipment used to meet the data needs and different sound levels (frequencies) used for different mapping resolutions. The specific frequency used would depend on the manufacturer, water depth, purpose of the survey, and seabed characteristics in the area of interest. Detailed descriptions of the different electromechanical/HRG non-airgun survey methods are provided in BOEM's Atlantic G&G Activities Programmatic EIS (USDOI, BOEM, 2014a). A G&G Programmatic EIS is currently being developed for the GOM (refer to **Chapter 1.7**).

Gravity and Electromagnetic Surveys

Measurements of the earth's gravity and magnetic fields are useful in helping to determine geologic structures in the subsurface. Such data are useful in frontier exploration areas and as a complement to seismic data in well-explored areas. Gravity and magnetic surveys are conducted from ships, in conjunction with airgun and electromechanical surveys, aircraft, or, very rarely, are conducted using an autonomous underwater vehicle. The types of surveys that help map oil and gas resources by measuring earth's magnetic and gravity fields are summarized in BOEM's Atlantic G&G Activities Programmatic EIS (USDOI, BOEM, 2014a).

Geological Surveys

Geological surveys are conducted to obtain information about surface and subsurface geological and geotechnical characteristics. For oil and gas purposes, this information is used to aid in the following:

- siting, design, construction, and operation of production facilities;
- assessment of sediment, stratigraphy, and geology (i.e., potential hydrocarbon source rock) characteristics; and
- evaluation of subsurface properties, such as the presence of gas hydrates or hazards to drilling and/or physical structures.

There are several different types of survey methods used to obtain geological/geotechnical information, including grab and box sampling, geologic coring, and shallow test drilling. Detailed descriptions of the different geological surveys are summarized in BOEM's Atlantic G&G Activities Programmatic EIS (USDOI, BOEM, 2014a). As noted earlier, a G&G Programmatic EIS is currently being developed for the GOM (refer to **Chapter 1.7**).

G&G Data Acquisition

Geological and geophysical (G&G) surveys conducted as a result of a lease sale typically collect data on surficial or near-surface geology used to identify on-lease potential shallow geologic hazards for engineering and site planning for bottom-founded structures. The G&G regulations and processes are discussed in **Appendix A.1**. The G&G activities for oil and gas exploration are authorized on the basis of whether or not the proposed activities are (1) before leasing takes place (prelease) and authorized by permits or (2) on an existing lease (postlease or ancillary) and authorized by OCS plan approvals, plan revisions, or by a requirement for notification of BOEM before certain on-lease activities are undertaken. BOEM's resource evaluation program oversees G&G data acquisition and permitting activities pursuant to regulations at 30 CFR parts 550 and 551. There are a variety of G&G activities that are conducted for oil and gas exploration and development as on-lease activities:

- various types of deep-penetration seismic airguns used almost exclusively for oil and gas exploration;
- electromagnetic surveys, deep stratigraphic and shallow test drilling, and various remote-sensing methods in support of oil and gas exploration;

- high-resolution geophysical (HRG) surveys (airgun and non-airgun) used to detect and monitor geohazards, archaeological resources, and certain types of benthic communities; and
- geological and geotechnical bottom sampling used to assess the suitability of seafloor sediments for supporting structures (e.g., platforms, pipelines, and cables), as well as to identify environmental resources such as chemosynthetic communities, gas hydrates, buried channels and faults, and archaeological resources.

Due to the cyclic nature in the acquisition of seismic surveys, a prelease seismic survey would be attributable to lease sales held up to several years after the survey. In preparing the G&G activity forecast, BOEM began with a short-term forecast of two-dimensional (2D) and three-dimensional (3D) G&G activities based on historical relationships. Between 1968 and 2014 about 1,860,000 line miles of 2D data were acquired. Between 1993 and 2014 about 250,000 OCS blocks of 3D data were acquired. In constructing the current forecast, BOEM projected the number of narrow azimuth (NAZ) and wide azimuth (WAZ) 3D survey blocks for each planning area. The NAZ and WAZ 3D survey blocks were then added to generate a baseline forecast which was then anchored to the level of exploratory well drilling activities. This process defined a level of exploration effort per block of 3D seismic acquired. This forecast was then compared with historical 2D line miles and 3D blocks actually acquired in the GOM since 1968 (1993 for 3D) to ensure that the long-term projections were within the range of historical values. For 2D line mile projections, the number of permits forecasted was then derived through the average number of miles per permit issued using historical data, exploration well drilling effort from the exploration and development scenarios, and data from currently pending applications. BOEM conservatively assumed that one HRG survey would occur for every block leased (estimated by the number of production structures predicted) and that one HRG survey would occur for every 5 km (3 mi) of pipeline laid (the average length of a pipeline permit). To estimate VSP surveys, BOEM conservatively assumed that a VSP survey would be conducted on 15 percent of all exploration and development wells drilled. The table below reflects a reasonable level of G&G surveying activities that could be expected to occur leading up to and following scheduled lease sales in the Gulf of Mexico single lease sale areas (2017-2066).

Survey Area	2D Surveys (mi)	2D Permits	3D Lease Blocks	3D Permits	Ancillary Permits	HRG Surveys	VSP Surveys
Regionwide	48,000-650,000	31-310	13,400-185,000	25-128	19-214	87-709	17-263
CPA/EPA	47,000-603,000	27-283	18,900-171,300	20-108	16-198	64-576	11-234
WPA	900-4,100	4-9	5,500-25,100	6-21	3-26	30-134	5-29

If any action is proposed in an area of archaeological concern, BOEM or BSEE's Regional Directors may also require the preparation of an archaeological report (which may include a site-specific survey) to accompany the exploration (EP), development operations and coordination document (DOCD), or development and production plan (DPP) under 30 CFR § 250.194(c) and 30 CFR § 550.194(c). Refer to **Chapter 4.1.3** for information on archaeological requirements and impacts to archaeological resources.

> *Alternative A, B, or C**: For each alternative, seismic surveys are projected to follow the same trend as exploration drilling activities, which would peak in 2030-2040 and decline until 2060, with regards to a particular lease sale. Geophysical surveys generally would be the first activities to occur within the Gulf of Mexico. The HRG surveys generally occur before exploratory drilling, but they can also occur before development drilling, platform and pipeline installation, and decommissioning activities. It is important to note that the cycling of G&G data acquisition is not driven by the 50-year life cycle of a single productive lease but instead would tend to respond to new production or potential new production driven by new technology. Consequently, some areas would be resurveyed in 2-year cycles, while other areas, considered nonproductive, may not be surveyed for 20 years or more. The above estimates far exceed the number of blocks available for leasing in the entire Gulf of Mexico OCS. Data collection may be repeated on any one block as technology advances, or multiple surveys may be conducted over the same OCS blocks for different purposes (e.g., prelease exploratory surveys and shallow hazard surveys).
>
> *Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

3.1.2.2 Exploration and Delineation Plans and Drilling

> *The term exploration well generally refers to the first well drilled on a prospective geologic structure to confirm that a resource exists and to validate how much resource can be expected.*

Oil and gas operators use drilling terms that represent stages in the discovery and development of hydrocarbon resources. If a resource is discovered during the drilling of an exploration well in quantities appearing to be economically viable, one or more follow-up delineation wells are drilled. Refer to **Figure 3-2** above for a typical exploration and production timeline of an oil or gas lease. Delineation wells are drilled to specific subsurface targets in order to obtain information about the reservoir that can be used by the operator to identify the lateral and vertical extent of a hydrocarbon accumulation. Following a discovery, an operator often temporarily plugs and abandons the well to allow time for a development plan to be generated and for equipment to be built or procured.

In the GOM, exploration and delineation wells are typically drilled with mobile offshore drilling units (MODUs) (i.e., jack-up rigs, semisubmersible rigs, submersible rigs, platform rigs, or drill ships). Non-MODUs, such as inland barges, are also used. The type of rig chosen to drill a prospect depends primarily on water depth, though the water-depth ranges for each type of drilling rig do overlap to a degree. Other factors such as availability and daily rates also play a large role when an operator decides upon the type of drilling rig to contract. The water-depth ranges for drilling rigs used in this analysis are listed below:

MODU or Drilling Rig Type	Water-Depth Range
Jack-up, submersible, and inland barges	≤100 m (≤328 ft)
Semisubmersible and platform rig	100-3,000 m (328-9,843 ft)
Drillship	≥600 m (≥1,969 ft)

Historically, drilling rig availability has been a limiting factor for activity in the GOM and is assumed to be a limiting factor for activity projected as a result of a proposed lease sale. Drilling activities may also be constrained by the availability of rig crews, shore-based facilities, risers, and other equipment.

The scenario for each alternative assumes that an average exploration well would require 6-10 weeks to drill per well, and more than one well can be drilled at a location. The actual time required for each well depends on a variety of factors, including the depth of the prospect's potential target zone, the complexity of the well design, and the directional offset of the wellbore needed to reach a particular zone. This scenario assumes that the average exploration or delineation well depth would be approximately 4,210-8,080 m (13,800-26,500 ft) below the mudline.

Some delineation wells may be drilled using a sidetrack technique. In sidetracking a well, a portion of the existing wellbore is plugged back to a specific depth, directional drilling equipment is installed, and a new wellbore is drilled to a different geologic location. The lessee may use this technology to better understand their prospect and to plan future wells. Use of this technology may also reduce the time and exploration expenditures needed to help evaluate the prospective horizons on a new prospect.

The cost of an average exploration well can be $40-$150 million or more, without certainty that objectives can be reached. Some recent ultra-deepwater exploration wells (>6,000-ft [1,829-m] water depth) in the GOM have been reported to cost upwards of $200 million. The actual cost for each well depends on a variety of factors, including the depth of the prospect's potential target zone, the complexity of the well design, and the directional offset of the wellbore needed to reach a particular zone.

Figure 3-3 represents a generic well schematic for a relatively shallow exploration well in the deepwater GOM. This well design was abstracted from actual well-casing programs from projects in the Mississippi Canyon and De Soto Canyon Areas and from internal BOEM data. A generic well configuration cannot capture all of the possible influences that impact how a well is designed. These influences include (1) unique geologic conditions at a specific well location, (2) directional drilling requirements, (3) potential sidetrack(s), or (4) company preferences. For exploration wells, contingencies (such as anticipated water-flow zones in the formation) must also be considered in the casing program.

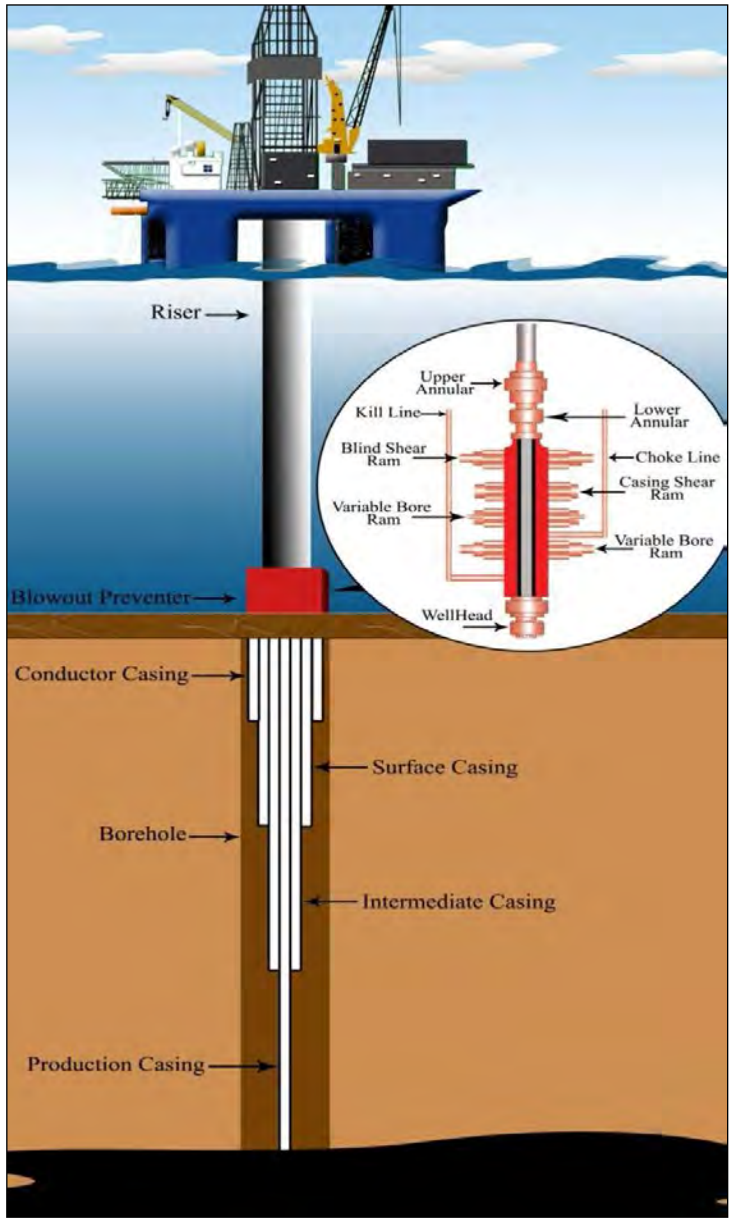

Figure 3-3. General Well Schematic (USDOI, 2010) (not to scale).

For exploration and development, deep water is defined as water ≥1,000 ft (≥305 m) deep and ultra-deepwater is defined as water ≥5,000 ft (≥1,524 m) deep. The drilling (spudding) of a deepwater exploration well begins with setting the conductor casing, one of the many sections or strings of casing (steel tube) installed in the wellbore. The first casing set in the sea bottom (or mudline) can be large, approximately 30-40 in (75-100 cm) in diameter. The larger diameter pipe may be necessary when drilling through salt to reach subsalt objectives because more casing strings may be needed to reach the well's objective. The first string is emplaced by drilling or "jetting" out the unconsolidated sediment with a water jet as the largest casing pipe is set in place. The casing is cemented to the sea bottom and tested. Because the shallow sediments are frequently soft and unconsolidated, the next casing interval (1,000 ft [305 m] or more below mudline) is commonly drilled with treated seawater and without a riser (a steel-jacketed tube that connects the wellhead to the drill rig and within which the drilling mud and cuttings circulate). Because a riser is not used, the formation cuttings are typically discharged from the wellbore directly to the sea bottom unless the location is near sensitive bottom areas (NTL 2009-G40). Muds and cuttings are discussed further in **Chapter 3.1.5.1.1**. After the conductor casing is set, a blowout preventer (BOP) would be installed, commonly at the sea bottom, the riser connected, and circulation for drilling muds and cuttings between the well bit and the surface rig established.

Next, a repetitive procedure would take place until the well reaches its planned total depth: (1) drill to the next casing point; (2) install the casing; (3) cement the casing; (4) test the integrity of the seal; and (5) drill through the cement shoe and downhole until the next casing point is reached and a narrower casing string is then set.

As drilling activities occur in progressively deeper waters, operators may consider using MODUs 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 onboard a rig and later transported to shore for processing. Operators may also consider barge shuttling hydrocarbons from test well(s) 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 BSEE to burn test hydrocarbons. The BSEE would only grant permission to flare or vent associated natural gas during well cleanup and for well-testing procedures for a limited period of time.

The regulation at 30 CFR part 550 subpart B specifies the requirements for the exploration plans (EPs) that operators must submit to BOEM for approval prior to deploying an exploration program. Refer to **Appendix A.2** for a detailed discussion of regulations, processes, and environmental information requirements for lessees and operators related to EPs, operation plans, and DOCDs. Refer to **Chapters 1.3.1 and 3.1.10.3**, which provide a summary of new safety requirements.

Following a lease sale, exploratory drilling activity would likely occur over the course of each lease but could begin within 1 year. The majority of the exploratory drilling for all blocks leased would likely occur early and would generally be complete by the 25th year. Refer to **Figure 3-4** below.

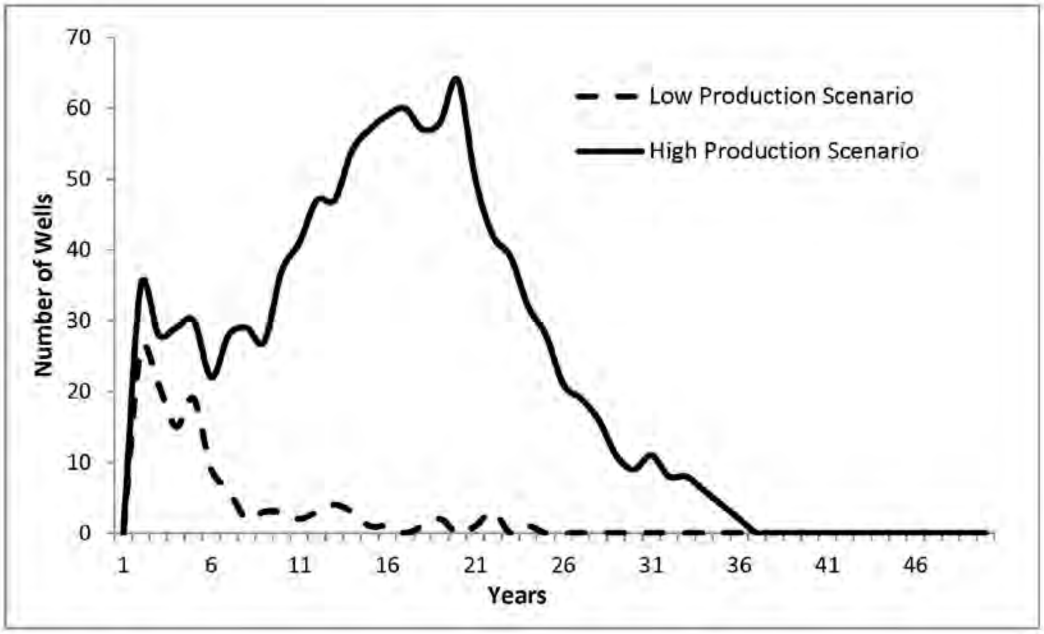

Figure 3-4. Number of Exploration and Delineation Wells Drilled over the Course of a Proposed Action under Alternative A for 50 Years.

Alternative A:* BOEM estimates that 53-984 exploration and delineation wells would be drilled as a result of forecasted activity associated with Alternative A. **Table 3-2** shows the estimated range of exploration and delineation wells by water-depth range. Of these wells, 60-94 percent are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and 40-6 percent are expected in water-depth ranges >200 m (656 ft). The projected number of exploration and delineation wells that would be drilled over the course of a proposed action under Alternative A can be seen in **Figure 3-4** above (including the low production scenario and a high production scenario).

Alternative B:* BOEM estimates that 33-893 exploration and delineation wells would be drilled as a result of forecasted activity associated with Alternative B. **Table 3-2** shows the estimated range of exploration and delineation wells by water-depth range. Approximately 75-85 percent of the projected wells in the CPA and EPA are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and about 25-15 percent are expected in water-depth ranges >200 m (656 ft).

Alternative C:* BOEM estimates that 17-91 exploration and delineation wells would be drilled as a result of forecasted activity associated with Alternative C. **Table 3-2** shows the estimated range of exploration and delineation wells by water-depth range. Approximately 35-78 percent of the projected wells are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and 65-22 percent are expected in water-depth ranges >200 m (656 ft).

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

3.1.3 Offshore Development and Production

3.1.3.1 Development and Production Drilling

A development well is drilled to extract resources from a known hydrocarbon reservoir.

Delineation and production wells are sometimes collectively termed development wells. After a development well is drilled, the operator must decide whether or not to complete the well without delay, to delay completion with the rig on station so that additional tests may be conducted, or to temporarily abandon the well site and move the rig off station to a new location and drill another well. Sometimes an operator may decide to drill a series of development wells, move off location, and then return with a rig to complete all the wells at one time. If an exploration well is clearly a dry hole, the operator would typically permanently abandon the well without delay, but could convert the well into an injection well.

Depending on the information obtained from delineation well drilling, these wells can be completed and prepared to serve as production wells. Production wells are wells that are drilled following the delineation stage of the development program. The production well would be drilled specifically for the purpose of extracting hydrocarbons from the subsurface and therefore positioned within the reservoir in locations where the greatest volume of production can be realized. Wells initially drilled as delineation wells that are later converted to production wells and wells drilled as production wells are sometimes collectively referred to as development wells.

Following the drilling of development wells, the operator of a field may decide to remain on location and immediately begin the next stage of the field development program, i.e., preparing the development wells for production. However, there are a number of reasons that the operator may decide to move off location and delay the work required to prepare the wells for production; for example, additional well tests may be required or the drilling rig may be committed to another location. When a decision to delay the work is chosen, each development well would be temporarily abandoned before the drilling rig can be moved to another location. It is also common for an operator to drill the required number of development wells in stages, leaving some time between the well drilling stages to evaluate the information obtained from the wells and, if necessary, use this information to modify the development program.

Well Completions

The process that includes the suite of activities that are carried out to prepare a development well for production is referred to as the completion process. As described below, there is a wide range of variability in the particular activities that might be used in the completion process, depending on the specific characteristics of the well. Many of the terms used to describe these activities (e.g., fracking and acidization) do not have precise, fixed definitions in all contexts. Accordingly, two very different processes with different potential environmental impacts may both be called by the same name. For these reasons, the description of these activities in this chapter is meant to be a general description of the range of activities that may be involved in well completion.

When the decision is made to perform a well completion, a new stage of activity begins. BOEM estimates that approximately 63-70 percent of wells drilled as development wells become producing wells. There is a wide variety of well completion techniques performed in the Gulf of Mexico, and the type of well completion used to prepare a drill well for production is based on the rock properties of the reservoir as well as the properties of the reservoir fluid. However, for the vast majority of well completions, the typical process includes installing or "running" the production casing, cementing the casing, perforating the casing and surrounding cement, injecting water, brine, or gelled brine as carrier fluid for a "frac pack"/sand proppant pack and gravel pack; treating/acidizing the reservoir formation near the wellbore; installing production screens; running production tubing; and installing a production tree. The term "frac pack" has become an industry-recognized term for the completion process of fracturing and gravel packing and is the most widely used completion technique for sand control in the Gulf of Mexico. The "frac pack" process, which has been used in the Gulf of Mexico for more than 25 years, combines the production improvement from hydraulic fracturing (see below) with the sand control provided by gravel packing. Cement is pumped into the well both to displace drilling fluids that remain in the well and also to fill in the space that exists between the casing and the face of the rock formations in the wellbore. The casing and cement would be perforated adjacent to the reservoir to allow the reservoir fluids to enter the wellbore. A gravel pack is a filtration system that is used to prevent sand from entering the wellbore. Well treatment, such as acidizing, is used to improve the flow of reservoir fluids into the wellbore by cleaning out and/or dissolving debris that accumulates in the wellbore and near-wellbore reservoir formation as a result of the drilling process. For moderate to high permeability reservoirs, today's most technologically advanced well treatment and stimulation processes are designed not only to mitigate flow restrictions caused by a reduction in permeability in the near-wellbore region (also known as formation "damage") but also to serve as another mechanism to help control the flow of sand into the wellbore and to enhance the flow rate of the well. Production tubing is run inside the casing. Production tubing protects the casing from wear and corrosion, and it provides a continuous conduit for the reservoir fluid to flow from the reservoir to the wellhead. The production tree is a wellhead device that is used to control, measure, and monitor the conditions of the reservoir and the well from the surface.

The term hydraulic fracturing covers a broad range of techniques used to stimulate and improve production from a well. Fracture fluid is injected into a wellbore at high pressure to break open the rock to create/ improve the flow path for hydrocarbon to flow in to the well. This completion technique, which is typically used for moderate to high permeability reservoirs, is used to reduce the movement of sand and other fine particulate matter within the reservoir, reduce the concentration of sand and silt in the produced fluids, improve the flow of reservoir fluids into the wellbore, increase production rates, and maximize production efficiency. The fracture pack or "frac-pack" completion process uses pressurized fluids, typically seawater, brine, or gelled brine, to create small fractures in the reservoir rock within a zone near the wellbore where the reservoir's permeability was damaged by the drilling process. The pressurized high-density, gelatin-like fluid also serves as the carrier agent for the mechanical agent or proppant that is mixed with the completion fluids. The mechanical agents, typically sand, manmade ceramics, or small microspheres (tiny glass beads), are injected into the small fractures and remain lodged in the fractures when the process is completed. The proppant serves to hold the fractures open, allowing them to perform as conduits to assist the flow of hydrocarbons from the reservoir formation to the wellbore. Well-treatment chemicals are also commonly used to improve well productivity. For example, acidizing a reservoir to dissolve cementing agents and improve fluid flow is a common well-treatment procedure in the GOM.

In contrast to the large-scale, induced hydraulic fracturing procedures, commonly referred to as “fracking,” used in onshore oil and gas operations for low-permeability “tight gas,” “tight oil,” and “shale gas” reservoirs, the vast majority of hydraulic fracturing treatments carried out on the OCS in the GOM are fracture packs, which are small scale by comparison and most commonly used for high-permeability formations to reduce the concentration of sand and silt in the produced fluids and to maintain high flow rates. Since formation “damage” caused by drilling operations does not extend for large distances away from the reservoir-borehole interface, the fracturing induced by the procedure is also designed to remain in close proximity to the borehole, extending distances of typically 15-30 m (49-98 ft) from the borehole (Ali et al., 2002; Sanchez and Tibbles, 2007) to prevent the production of formation fines and sand.

Additives used in fracture-pack operations are often similar, if not identical, to those used for shale or tight sand development onshore and are used for similar purposes. The concentrations of some of these additives are typically different due to the GOM’s very different geologic characteristics of the producing formation. The most significant difference is that the GOM typically has much higher formation permeability and lower amounts of clay/shale in typical formations (API, 2015). Another factor that can substantially influence additive selection and use in offshore operations is the ability to discharge treated wastewaters that meet applicable regulatory requirements (API, 2015).

Boehm et al. (2001) notes 22 functional categories of additives and 2 categories of proppants used offshore in the GOM for fracturing activities:

—water-based polymers
—defoamers
—friction reducers
—oil gelling additives
—fluid loss additives
—biocides
—breakers
—acid-based gel systems
—emulsifiers
—water-based systems
—clay stabilizers
—cross-linked gel systems
—surfactants
—alcohol/water systems
—non-emulsifiers
—oil-based systems
—pH control additives
—polymer plugs
—crosslinkers
—continuous mix gel concentrates
—foamers
—resin-coated proppants
—gel stabilizers
—intermediate-to-high strength ceramic proppants

Each of these is described in greater detail in the Boehm et al. (2001) study, along with other treatment and completion chemicals. The appendix to the study offers a chemical inventory with example products and Material Safety Data Sheets for those products. In general, discharges of any fluids, including those associated with well completion, are subject to the terms of National Pollution Discharge Elimination System (NPDES) permits issued by the USEPA under the Clean Water Act. These permits place limitations on the toxicity of selected effluents, as well as other requirements for monitoring and reporting. Wastes and discharges generated from OCS oil- and gas-related activities, including produced water and well completion fluids, are addressed in **Chapter 3.1.5**.

During a "frac pack," the pumping equipment, sand (proppant), and additives are carried, mixed, and pumped from a specialized stimulation and treatment vessel. The base fluid that is used for the frac-pack operation would typically be treated seawater, although other brines may be used if conditions dictate (API, 2015). BOEM considers these large special purpose vessels (supporting fracturing operations) as offshore supply/service vessels (OSVs). In **Table 3-2**, the number of OSV trips is estimated by subareas (range of water depths) in the GOM. Potential impacts associated with OSVs are described in various chapters throughout this Multisale EIS; these impacts include operational wastes, noise, and air emissions related to vessel movement throughout the GOM.

What is explained above is a general procedure for "frac-pack" operation, but every fracturing job is case specific. In general, the fracturing process remains the same but chemical formulations, fluid and proppant volumes, pump time, and pressure will vary based on the depth and engineering/geologic parameters for a particular well completion. After a production test determines the desired production rate to avoid damaging the reservoir, the well is ready to go online and produce.

Deepwater Operations Plans and Development Activity

A deepwater operations plan is required for all deepwater development projects in water depths ≥1,000 ft (305 m) and for all projects proposing subsea production technology. A deepwater operations plan is required initially and is usually followed by a DOCD. The DOCD is the chief planning document that lays out an operator's specific intentions for development. Refer to **Appendix A.2** for a detailed discussion on regulations, processes, and environmental information requirements for lessees and operators related to EP's, deepwater operations plans, and DOCDs.

Development activity during a proposed action usually takes place over a 49-year period, beginning with the installation of a production platform on the first lease and ending with the drilling of the last development wells. The majority of development well drilling would likely occur in the first 25 years of each lease. Production of oil and gas could begin by the third year after the lease sale and generally would conclude by the 50th year; refer to **Figure 3-5** below.

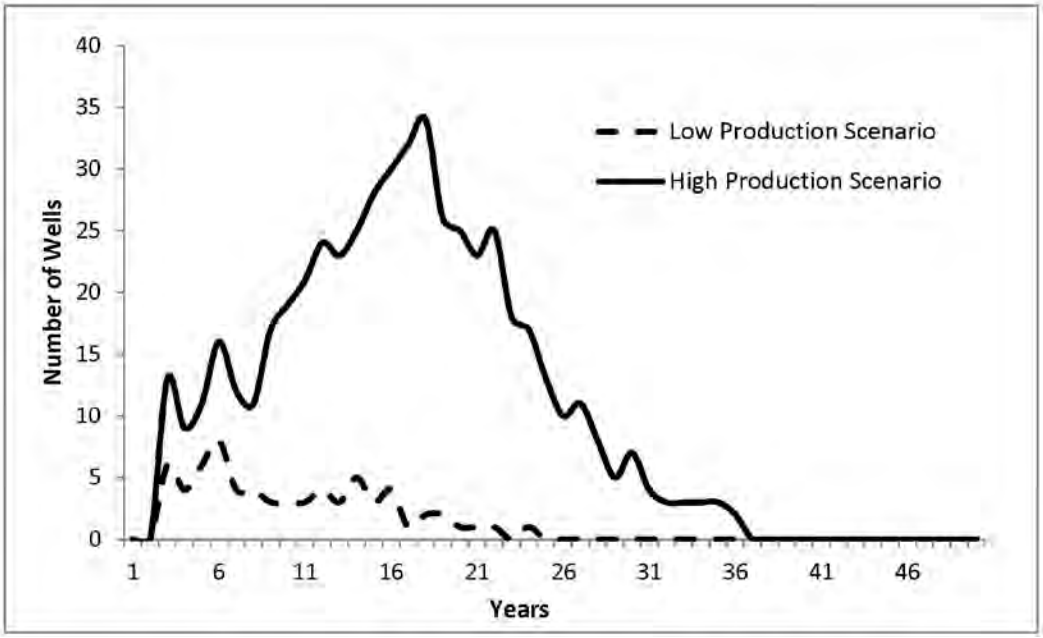

Figure 3-5. Number of Production Wells Drilled over the Course of a Proposed Action under Alternative A for 50 Years.

Alternative A:* It is estimated that 61-767 development and production wells would be drilled as a result of forecasted activity associated with Alternative A. **Table 3-2** shows the estimated range of development wells by water depth. Between 14 and 71 percent of the projected wells are expected to be on the continental shelf (0-200 m [656 ft] water depth) and 86 to 29 percent are expected in water-depth ranges >200 m (656 ft). Trends between the oil and gas development wells are markedly different. Deeper water depths (200-1,600 m; 656-5,249 ft) have a larger portion of projected producing oil wells, while shallow water (0-200 m; 0-656 ft) has a greater percentage of projected producing gas wells. The projected number of production wells that would be drilled over the course of a proposed action under Alternative A can be seen in **Figure 3-5** above (including the low production scenario and a high production scenario).

Alternative B*: BOEM estimates that 46-671 development and production wells would be drilled as a result of Alternative B. **Table 3-2** shows the estimated range of development and production wells by water-depth subarea. The percentage of projected oil wells within the CPA/EPA is more evenly distributed throughout the water-depth ranges. Gas wells for Alternative B follow the same trends as Alternatives A and C. A majority of the gas wells (70-89%) are projected to be drilled on the continental shelf (0-200 m [0-656 ft] water depth).

Alternative C*: BOEM estimates that 22-96 development and production wells would be drilled as a result of Alternative C. **Table 3-2** shows the estimated range of development and production wells by water-depth subarea. Approximately 36-55 percent of the projected wells are expected to be on the continental shelf (0-200 m [656 ft] water depth) and 64-45 percent are expected in deeper water-depth ranges (>200 m; 656 ft). While a majority of oil wells (100-77%) are projected to be drilled in the deeper water depths (200-1,600 m; 656-5,249 ft), a majority of gas wells (80-71%) are projected to be drilled in shallow water (0-200 m; 0-656 ft).

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

3.1.3.2 Offshore Production Systems

After the approval of an EP or DOCD, the operator submits applications for specific activities, including production systems, to BOEM for approval. Refer to **Appendix A.3** for more information on permits and applications related to offshore production systems.

Development wells may be drilled from movable structures, such as jack-up rigs, fixed bottom-supported structures, floating vertically moored structures, floating production facilities, and drillships (either anchored or dynamically positioned drilling vessels) (**Figure 3-6**). The spectrum of these production systems is discussed in **Chapter 3.1.3.2** below.

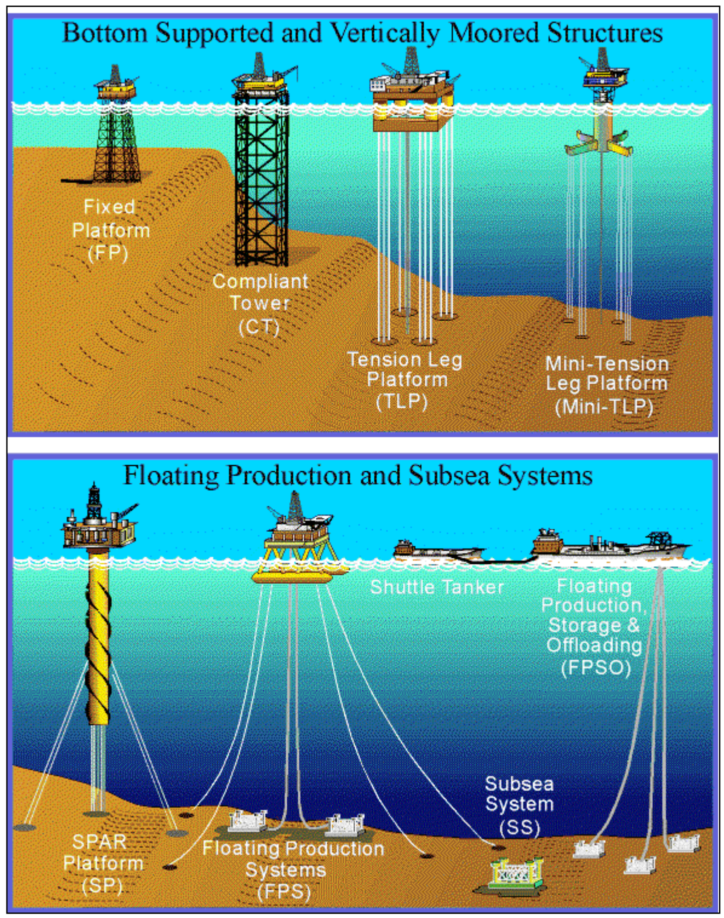

Figure 3-6. Offshore Production Systems.

The type of production structure installed at a site depends mainly on water depth, but the total facility lifecycle, type and quantity of hydrocarbon production expected, number of wells to be drilled, and number of anticipated tie backs from other fields can also influence an operator's procurement decision. 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. Production systems can be fixed, floating, or, increasingly in deep water, subsea. Advances in the composition of drilling fluids and drilling technology are likely to provide operators with the means to reduce rig costs in the deepwater OCS program.

Until recently, there had been a gradual increase of drilling depth (as measured in true vertical depth). Beginning in 1996, the maximum drilling depth increased rapidly, reaching depths below 30,000 ft (9,144 m) in 2002. In 2013, Cobalt International Energy drilled the Ardennes #1 exploration well (Green Canyon Block 896), reaching a true vertical depth of 36,552 ft (11,141 m). The recent dramatic increase in true vertical depth may be attributed to several factors, including enhanced rig capabilities, deeper exploration targets, royalty relief for shallow water, deep gas prospects, and the general trend toward greater water depths.

BOEM has described and characterized production structures in its deepwater reference document (USDOI, MMS, 2000a). These descriptions are summarized below and were used in preparing the scenario for this Multisale EIS. In water depths of up to 400 m (1,312 ft), the scenarios assume that conventional, fixed platforms that are rigidly attached to the seafloor would be the type of structure preferred by operators. In water depths of <200 m (656 ft), 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 (656 and 1,312 ft), all structures are assumed to be manned. It is also assumed that helipads would be located on 66 percent of the structures in water depths <60 m (197 ft), on 94 percent of structures in water depths between 60 and 200 m (656 ft), and on 100 percent of the structures in water depths >200 m (656 ft). At water depths >400 m (1,312 ft), platform designs based on rigid attachment to the seafloor are not expected to be used. The 400-m (1,312-ft) isobath appears to be the current economic limit for this type of structure.

Fixed Platforms

A fixed platform consists of a welded tubular steel jacket, deck, and surface facility. The jacket and deck make up the foundation for the surface facilities. Piles driven into the seafloor secure the jacket. The water depth at the intended location dictates the height of the platform. Once the jacket is secured and the deck is installed, additional modules are added for drilling, production, and crew operations. Large, barge-mounted cranes position and secure the jacket prior to the installation of the topsides modules. While the base dimensions are typically around 200,000 ft^2 (18,581 m^2), the topside modules is typically only 40,000 ft^2 (3,716 m^2). Economic considerations limit development of fixed (rigid) platforms to water depths no greater than 1,500 ft (457 m) (USDOI, MMS, 2000a).

A caisson is a fixed platform that consists of a single vertical column that rises from the seabed and supports a small surface facility above the water. This is termed a free-standing caisson. A braced caisson has the same general structure, but the column is laterally supported by one or more inclined braces. Caissons are not generally designed to be manned.

Compliant Towers

Compliant towers are similar to fixed platforms in that they have a steel tubular jacket that is used to support the surface facilities. Unlike fixed platforms, compliant towers yield to the water and wind movements in a manner similar to floating structures. Like fixed platforms, they are secured to the seafloor with piles. The jacket of a compliant tower has smaller dimensions than those of a fixed platform and may consist of two or more sections. It can also have buoyant sections in the upper jacket with mooring lines from jacket to seafloor (guyed-tower designs) or a combination of the two. The water depth at the intended location dictates platform height. Once the lower jacket is secured to the seafloor, it acts as a base (compliant tower) for the upper jacket and surface facilities. Large barge-mounted cranes position and secure the jacket and install the surface facility modules. These differences allow the use of compliant towers in water depths ranging up to 3,000 ft (914 m). The base dimensions of a compliant tower are typically smaller than a fixed platform and is only around 90,000 ft^2 (8,361 m^2), and the topside modules are typically only 40,000 ft^2 (3,716 m^2). This range is generally considered to be beyond the economic limit for fixed jacket-type platforms (USDOI, MMS, 2000a).

Spar

A spar is a deep-draft floating caisson, which is a hollow cylindrical structure approximately 90-120 ft (27-36 m) in diameter similar to a very large buoy. Its four major systems are hull, moorings, topsides, and risers. The spar relies on a traditional mooring system (i.e., anchor-spread mooring) to maintain its position. About 90 percent of the structure is underwater and supports a conventional production deck (USDOI, MMS, 2000a). A third generation of spar design is the cell spar. The cell spar's hull is composed of several identically sized cylinders surrounding a center cylinder. 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 (2,953 ft) and may be used in water depths of 3,000 m (9,843 ft) or deeper (NaturalGas.org, 2010; USDOI, MMS, 2006; Oynes, 2006).

Tension-Leg Platform

A tension-leg platform (TLP) is a buoyant platform held in place by a mooring system. The TLPs are similar to conventional fixed platforms except that the platform is maintained on location through the use of moorings held in tension by the buoyancy of the hull. The mooring system is a set of tension legs or tendons attached to the platform and connected to a template or foundation on the seafloor. Tendons are typically steel tubes with dimensions of 2-3 ft (0.6-0.9 m) in diameter with up to 3 in (8 cm) of wall thickness, with the length depending on water depth. A typical TLP would be installed with as many as 16 tendons. The template is held in place by piles driven into the seafloor. This method dampens the vertical motions of the platform but allows for horizontal movements. The topside facilities (i.e., processing facilities, pipelines, and surface trees) of the TLP and most of the daily operations are the same as for a conventional platform (USDOI, MMS, 2000a).

Semisubmersibles

Semisubmersible production structures (semisubmersibles) resemble their drilling rig counterparts and are the most common type of offshore drilling rig (NaturalGas.org, 2010). Semisubmersibles are partially submerged with pontoons that provide buoyancy. Their hull contains pontoons below the waterline and vertical columns that connect 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 can be operated in a wide range of water depths. Floating production systems are suited for deepwater production in depths up to 8,000 ft (26,437 m) (NaturalGas.org, 2010; USDOI, MMS, 2006; Oynes, 2006).

Subsea Production Systems

For some development programs, especially those in deep and ultra-deepwater, an operator may choose to use a subsea production system instead of a floating production structure. Although the use of subsea systems has recently increased as development has moved into deeper water, subsea systems are not new to the GOM and they are not used exclusively for deepwater development. Unlike wells from conventional fixed structures, subsea wells do not have surface facilities directly supporting them during their production phases. A subsea production system has various bottom-founded components. Among them are well templates, well heads, "jumper" connections between well heads, flow control manifolds, in-field pipelines and their termination sleds, and umbilicals and their termination assemblies. A subsea production system can range from a single-well template connected to a nearby manifold or pipeline to a riser system at a distant production facility or a series of wells that are tied into the system. 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. A drilling rig would 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 control of the well.

Floating Production, Storage, and Offloading Systems

The category of floating production systems referred to as floating production, storage, and offloading systems (FPSOs) can normally be characterized as ship-shape vessels (tankers) that have been retrofitted (conversions) or purpose built (new built) for this application (USDOI, MMS, 2000a). Floating systems are differentiated as follows:

- FPSO — floating production, storage, and offloading system; offloading of the crude oil to a shuttle tanker; these are typically converted or newly built tankers that produce and store hydrocarbons, which are subsequently transported by other vessels to terminals or deepwater ports.
- FPS — floating production system; universal term to refer to all production facilities that float rather than are structurally supported by the seafloor; included would be TLPs, spars, semisubmersibles, shipshape vessels, etc. The term is

also frequently used to describe the general category of floating production facilities that do not have onsite storage. The term is also used by the American Bureau of Shipping to describe a classification of floating production facilities that do not have storage capability.

- FSO — floating storage and offloading system; like the FPSO, these are typically converted or newly built tankers. They differ from the FPSO by not incorporating the processing equipment for production; the liquids are stored for shipment to another location for processing.

BOEM's predecessor prepared an EIS on the potential use of FPSOs on the Gulf of Mexico OCS (USDOI, MMS, 2001). In accordance with the scenario provided by industry, the FPSO environmental impact statement addresses the proposed use of FPSOs in the deepwater areas of the CPA and WPA only. In January 2002, this Agency announced its decision to accept applications for FPSOs after a rigorous environmental and safety review. Petrobras Americas Inc. developed the first FPSO to come online in the GOM and began production in June 2012 from two prospects. The Cascade Prospect (Walker Ridge Block 206 Unit) is located approximately 250 mi (402 km) south of New Orleans, Louisiana, and about 150 mi (241 km) from the Louisiana coastline in approximately 8,200 ft (2,499 m) of water. The Chinook Prospect (Walker Ridge Block 425 Unit) is located about 16 mi (26 km) south of the Cascade Prospect. A second FPSO is being developed by Shell and is expected to begin production in 2016.

3.1.3.3 Infrastructure Emplacement/Structure Installation and Commissioning Activities

Structures described in **Chapter 3.1.3.2** may be placed over development wells to facilitate production from a prospect. These structures provide the means to access and control wells. They serve as a staging area to process and treat produced hydrocarbons from wells, initiate export of produced hydrocarbons, conduct additional drilling or reservoir stimulation, conduct workover activities, and carry out eventual abandonment procedures. There is a range of offshore infrastructure installed for hydrocarbon production. Among these are pipelines, fixed and floating platforms, caissons, well protectors, casing, wellheads, and conductors.

Subsea wells may also be completed to produce hydrocarbons from on the shelf and in the deepwater portions of the GOM. The subsea completions would require a host structure to control their flow and to process their well stream. Control of the subsea well is accomplished via an umbilical from the host.

Pipelines are the primary means of transporting produced hydrocarbons from offshore oil and gas fields to distribution centers or onshore processing points. Pipelines range from small-diameter (generally 4-12 in; 10-30 cm) gathering lines, sometimes called flowlines, that link individual wells and production facilities to large-diameter (as large as 36 in; 91 cm) lines, sometimes called trunk lines, for transport to shore. Pipelines would typically be installed by lay barges that are either anchored or dynamically positioned while the pipeline is laid. Pipeline sections may be welded together on a conventional lay barge as it moves forward on its route or they may be welded together at a fabrication site onshore and wound onto a large-diameter spool or reel. Once the reel barge is on location, the pipeline is straightened and lowered to the seafloor on its intended route. Both types of lay barge use a stinger to support the pipeline as it enters the water. The stinger helps to prevent undesirable bending or kinking of the pipeline as it is installed. In some cases, pipelines or segments of pipelines are welded together onshore or along a beach front area and then towed offshore to their location for installation. In a typical offshore operation, a lay barge would move one pipe length every 15 minutes, while third-generation barges may achieve rates of a mile per day (Wolbers and Hovinga, 2003). The rate of progress depends on the lay barge type, crew experience, and weather. Additional information on pipeline installation can be found in **Chapter 3.1.4.4** below.

Fixed, jacketed platforms are the most common surface structures of the GOM (refer to **Chapter 3.1.3.2**) and account for about 60 percent of all bottom-founded surface structures on the shallow continental shelf. Fixed platforms are brought on location as a complete unit or in sections on an installation barge towed by powerful tug boats. If the structure is fabricated in sections, it is generally composed of two segments: the jacket and the deck. Accidents have occurred during the vulnerable period when heavy equipment is held only by cranes. In December 1998, the 3,600-ton topside structure for the Petronius compliant tower was lost in 1,750 ft (533 m) of water as it was being lifted into place by the lift barge in Viosca Knoll Block 892.

The platform’s tubular-steel jacket would then be launched from the barge, upended, and lowered into position by a derrick barge with a large crane. The jacket is anchored to the seafloor by piles driven through the legs. The deck section with one or more levels is then lifted atop the jacket and welded to the foundation. The platform may have a helipad installed on its deck section. Platforms may or may not be manned continuously. The different types of floating platforms are discussed in **Chapter 3.1.3.2**.

Caissons are the second most numerous and account for about 30 percent of bottom-founded, surface structures in the GOM. Caissons are typically located primarily on the shallow continental shelf. Simpler in design and fabrication than traditional jacketed platforms, most caissons consist of a steel pipe that generally ranges from 36 to 96 in (91 to 2.44 cm) in diameter. The caisson pipe is driven over existing well(s) to a depth that allows for shoring against varying sea states. Though primarily installed for well protection, some caissons may also be used as foundations for equipment and termination or relay points for pipeline operations.

Well protectors account for about 10 percent of all bottom-founded surface structures in the GOM. Well protectors are used primarily to safeguard producing wells and their production trees from boat damage and from battering by floating debris and storms. Similar to fixed platforms, well protectors consist of small piled jackets with three or four legs generally less than 36 in (91 cm) in diameter, which may or may not support a deck section.

In shallow-water installations, jackets, piles, and topsides are fabricated onshore and transported to the site on a cargo barge, and installation times usually range from 2-4 weeks. For most deepwater systems, installation activities would extend over a period of 2 or 3 months or more, and if a number of wells are subsea, drilling and completion activities may extend over several years. The time required to complete the myriad of operations to start production at a structure is dependent on the complexity of its facilities.

To keep floating structures on station, a mooring system would be designed and installed. Lines to anchors or piling arrays attach the floating components of the structure. With a TLP, tendons stem from a base plate on the sea bottom to the floating portion of the structure. Commissioning activities involve the emplacement, connecting, and testing of the structure's modular components that are assembled on site.

Alternative A:* It is estimated that 16-280 production structures would be installed as a result of a lease sale under Alternative A. **Table 3-2** shows the projected number of structure installations for Alternative A by water-depth range. About 75-96 percent of the production structures installed for a proposed action under Alternative A are projected to be on the continental shelf (0-60 m; 0-197 ft). The estimated number of production structures operating over the life of a proposed action under Alternative A (including the low production scenario and a high production scenario) can be seen in **Figure 3-7** below.

*Alternative B**: It is estimated that 14-247 production structures would be installed as a result of a lease sale under Alternative B. **Table 3-2** shows the projected number of structure installations for Alternative B by water-depth range. About 71-96 percent of all the production structures installed under Alternative B are projected to be on the continental shelf (0-200 m; 0-656 ft).

*Alternative C**: It is estimated that 17-91 production structures would be installed as a result of a lease sale under Alternative C. **Table 3-2** shows the projected number of structure installations for Alternative C by water-depth range. About 55-88 percent of all the production structures installed for Alternative C are projected to be on the continental shelf (0-60 m; 0-197 ft).

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

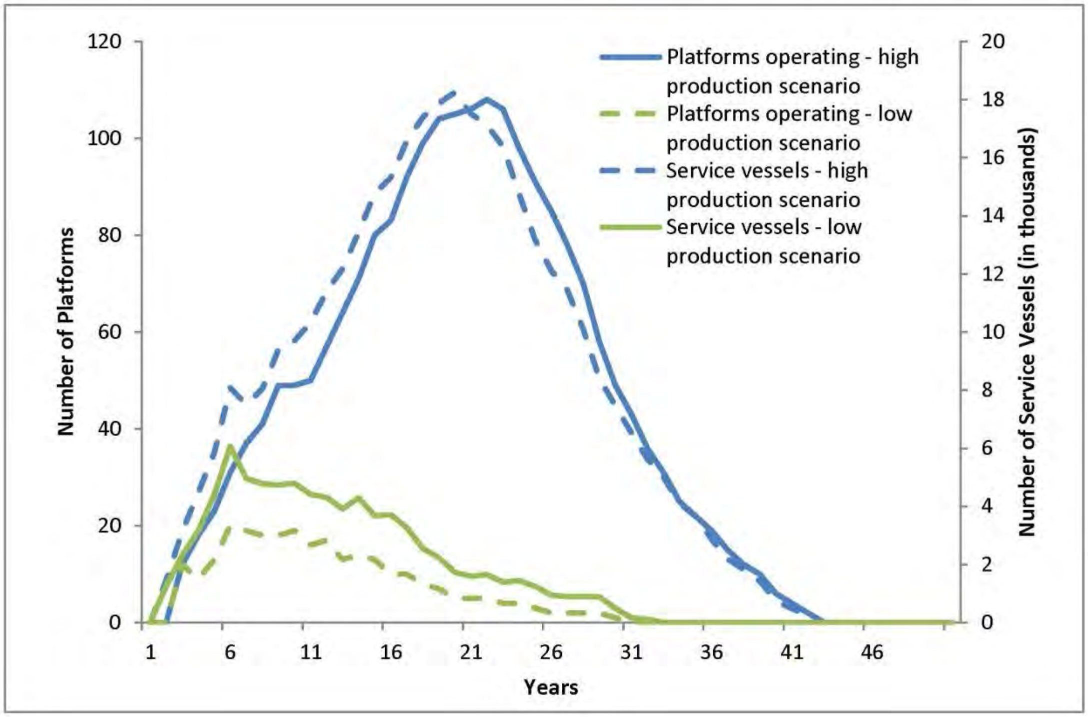

Figure 3-7. Number of Production Structures and Service Vessels Operating over the Course of a Proposed Action under Alternative A for 50 Years.

3.1.3.3.1 Bottom-Area Disturbance

Structures emplaced or anchored on the OCS to facilitate oil and gas exploration and production include drilling rigs or MODUs (i.e., jack-ups, semisubmersibles, and drillships), pipelines, and fixed surface, floating, and subsea production systems; these structures are discussed in **Chapters 3.1.3.2** above. The emplacement or removal of these structures disturbs small areas of the sea bottom beneath or adjacent to the structure. If mooring lines of steel, chain, or synthetic polymer are anchored to the sea bottom, areas around the structure could also be directly affected by their emplacement. This disturbance includes physical compaction or crushing beneath the structure or mooring lines and the resuspension and settlement of sediment caused by the activities of emplacement. Movement of floating types of facilities would also cause the movement of the mooring lines in its array. Small areas of the sea bottom would be affected by this kind of movement. 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 depths ≥400 m (1,312 ft), and archaeological sites.

Wells drilled in shallow water create a splay of drilling muds and cuttings that spread 250 m (820 ft) from the well, and in deepwater (over 300-m [984-ft] water depth) the coverage area would be approximately 500 m (1,640 ft) from the well. Muds and cuttings are discussed further in **Chapter 3.1.5.1.1**. There are numerous studies about splays from various areas of the GOM and other locations around the world (Neff et al., 2000; USEPA, 2000a; International Association of Oil and Gas Producers, 2003). These splays on the seafloor vary from one location to the next and vary by well depth, which controls the total volume of cuttings available for disbursement. Variation in splay size are caused by water depth, well depth, drilling fluid type (cuttings from oil-based or synthetic mud are taken to shore for disposal), and currents. A typical splay is not in a uniform circular shape but rather in the shape of a fan that is influenced by prevailing currents and the fall rate of drill cuttings; however, for this calculation, disturbance is considered a possibility in all directions from a well. The model used here is an oversimplification in order to obtain a conservative estimate of disturbance per offshore production system. Given that a splay from a well generally overlays the footprint of an offshore production system and creates a larger surface area of disturbance, only bottom disturbance from the splay is considered when evaluating overall bottom disturbance.

Subsea production systems located on the ocean floor are connected to surface topsides by a variety of components. These bottom-founded components are an integrated system of flowlines, manifolds, flowline termination sleds, umbilicals, umbilical sleds, blowout preventers, well trees, and production risers. Richardson et al. (2008) indicated that all currently operating subsea systems are tied to an offshore production system. For that reason, any environmental effects resulting from these subsea developments are integral parts of the overall environmental effect of the host offshore production system and the disturbance created by the system.

Emplacement of flowlines and export pipelines that cross a fairway disturb between 0.5 and 1.0 ha (1.2 and 2.5 ac) of seafloor per kilometer of pipeline (Cranswick, 2001). Pipe-laying vessels operating in the deepwater Gulf of Mexico rely on dynamic positioning rather than conventional anchors to maintain their position during operations and do not require trenching, so deepwater pipe-laying is assumed to disturb 0.32 ha (0.79 ac). The variation lies in BSEE's requirement to bury pipelines in water depths <200 ft (61 m) to a depth of 3 ft (1 m). Burial is typically done by water jetting a trench followed by placing the pipeline into it.

Alternative A:* Bottom-area disturbance is calculated as a relationship between the structures projected (i.e., platforms, wells, subsea structures, and pipeline miles installed [**Chapter 3.1.4.1]**) and the associated disturbance of each. Under Alternative A, between 1,226 and 21,158 ha (3,029 and 52,282 ac) of sea bottom is projected to be disturbed. This is <0.01-0.05 percent of the total area of the Gulf of Mexico.

*Alternative B**: Under Alternative B, between 1,056 and 18,648 ha (2,609 and 46,080 ac) of sea bottom is projected to be disturbed in the CPA/EPA. This is <0.01-0.03 percent of the total area of the Gulf of Mexico.

*Alternative C**: Under Alternative C, between 693 and 2,525 ha (1,712 and 6,239 ac) of sea bottom is projected to be disturbed in the WPA. This is <0.001-0.01 percent of the total area of the Gulf of Mexico.

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

3.1.3.3.2 Sediment Displacement

Displaced sediments are those that have been physically moved "in bulk." Displaced sediments cover or bury an area of the seafloor, while resuspended sediments 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.

The chief means for sediment displacement is the overboard discharge of drill cuttings carried to the surface by drilling mud. Cuttings that outfall from surface platforms settle to the sea bottom as a mound or plume if influenced by the prevailing currents. Sediment displacement can also take place when anchored exploration rigs and production structures are subject to high current energy, such as GOM loop currents or hurricane sea states. Mooring lines in contact with the sea bottom can scrape sediment into heaps and mounds as the surface facility moves in response to currents.

Trenching for pipeline burial causes displacement or resuspension of seafloor sediments. Sediment displacement also occurs as a result of the removal of pipelines. It is projected that the number of pipeline removals (or relocations) would increase regionwide as the existing pipeline infrastructure ages. For each kilometer of pipeline removed in water depths <200 ft (61 m), approximately 5,000 m^3 (176,573 ft^3) of sediment would be displaced and resuspended (Cranswick, 2001).

3.1.3.4 Infrastructure Presence

3.1.3.4.1 Anchoring

Most exploration drilling, platform, and pipeline emplacement operations on the OCS require anchors to hold the rig, topside structures, or support vessels in place. Anchors disturb the seafloor and sediments in the area where dropped or emplaced. Anchoring can cause physical compaction beneath the anchor and chains or lines, as well as resuspended sediment. A disturbed area on the sea bottom forms by the swing arc formed by anchor lines scraping across bottom within the range of the anchoring system configuration. Dynamically positioned rigs, production structures, and vessels are held in position by four or more propeller jets and do not cause anchoring impacts. Conventional pipe-laying barges use an array of eight 9,000-kg (19,842-lb) anchors to position the barge and to move it forward along the pipeline route. These anchors are continually moved as the pipe-laying 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. Mooring buoys may be placed near drilling rigs or platforms so that service vessels need not anchor or for when they cannot anchor (in deeper water). The temporarily installed anchors for these buoys would most likely be smaller and lighter than those used for vessel anchoring and, thus, would have less impact on the sea bottom. Moreover, installing one buoy would preclude the need for numerous individual vessel-anchoring occasions. Service-vessel anchoring is assumed not to occur in water depths >150 m (492 ft) and only occasionally in shallower waters (vessels would always tie up to a platform or buoy in water depths >150 m [492 ft]). Barges are assumed to tie up to a production system rather than anchor. Barges and other vessels are also used for both installing and removing structures. Barge vessels use anchors placed away from their location of work.

3.1.3.4.2 Space-Use Requirements

Leasing on the OCS results in operations that temporarily occupy sea bottom and water surface area for dedicated uses. The OCS oil- and gas-related operations include the deployment of seismic vessels, bottom surveys, and the installation of surface or subsurface bottom-founded production structures with anchor cables and safety zones. While in use, these areas would become unavailable to commercial fishermen, sand borrowing, or any other competing use.

The G&G surveys can occur in both shallow and deepwater areas. Usually, fishermen are precluded from a very small area for several days during active G&G surveying. Exploratory drilling rigs spend approximately 40-150 days onsite and are a short-term interference to commercial fishing. A major bottom-founded production platform in water depths less than 450 m (1,476 ft), with a surrounding 100-m (328-ft) navigational safety zone, requires approximately 6 ha (15 ac) of space. A bunkhouse structure needs about 4 ha (9 ac) and a satellite structure needs about 1.5 ha (3.7 ac) of space.

In water depths greater than 450 m (1,476 ft), production platforms would be compliant towers, floating production structures (such as TLPs and spars), and FPSOs. Even though production structures in deeper water are larger and individually would take up more space, there would be fewer of them compared with the great numbers of bottom-founded platforms in shallower water depths. Factoring in various configurations of navigational safety zones, deepwater facilities may require up to a 500-m (1,640-ft) radius safety zone or 78 ha (193 ac) of space (33 CFR § 147.15). Production structures in all water depths have a life expectancy of 20-30 years.

BOEM's data indicate that the total area lost due to the presence of production platforms has historically been and would continue to be less than 1 percent of the total surface area available.

Alternative A:* A maximum of 648 ha (1,598 ac) could be lost to other uses under Alternative A. This number is based on a high of 108 production structures of approximately 6 ha (15 ac) of surface area operating simultaneously during the life of a proposed action. This is approximately 0.001 percent of the surface area of the Gulf of Mexico.

Alternative B:* A maximum of 546 ha (1,347 ac) could be lost to other uses under Alternative B. This number is based on a high of 91 production structures of approximately 6 ha (15 ac) of surface area operating simultaneously during the life of Alternative B. This is approximately 0.0008 percent of the surface area of the Gulf of Mexico.

> *Alternative C*:* A maximum of 120 ha (296 ac) could be lost to other uses under Alternative C. This number is based on a high of 20 production structures of approximately 6 ha (15 ac) of surface area operating simultaneously during the life of Alternative C. This is approximately 0.0002 percent of the surface area of the Gulf of Mexico.
>
> *Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

3.1.3.4.3 Structure Lighting

Light pollution in the GOM comes from OCS oil- and gas-related structures and service vessels and may increase visibility during night hours. The OCS oil- and gas-related structures in the GOM are illuminated from incandescent lights and from the glow of burning or flaring natural gas that cannot be stored or transported to shore. To assist in nighttime operations and aid navigation, manned platforms are generally well illuminated by exterior floodlights. Platforms generally have two varieties of floodlights: high-pressure sodium or mercury vapor. High-pressure sodium lights emit yellow-orange light, whereas mercury vapor lights emit a perceptually blue-white light. Some initiative has been taken to move toward downward facing lighting and green light. Although there are differences between platforms, floodlights located between 20 and 40 m (66 and 132 ft) above the water surface illuminate the structure and the surrounding water to a depth of at least 100-200 m (328-656 ft) and can often be observed several miles away from the platform (Keenan et al., 2007). Unmanned structures usually have minimal aid-to-navigation lights.

In addition to offshore lighting, coastal support infrastructure is also illuminated. Coastal infrastructure lighting may be specifically designed to emit horizontal or vertical light. Horizontal and near-horizontal light emittance increases the visibility of light sources from a distance and significantly increases the illuminated area, but it can also cause the encroachment of light into adjacent unlit areas. Light emitted horizontally or near-horizontally produces more sky glow than that emitted upward, and much more than light emitted downward (Gaston et al., 2012).

3.1.3.5 Workovers and Abandonments

Completed and producing wells may require periodic reentry that is designed to maintain or restore a desired flow rate. These procedures are referred to as a well "workover." Workover operations are also carried out to evaluate or reevaluate a geologic formation or reservoir (including recompletion to another strata) or to permanently abandon a part or all of a 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. Workovers on subsea completions require that a rig be moved on location to provide surface support. Workovers can take from 1 day to several months to complete depending on the complexity of the operations, with a median of 7 days. Current oil-field practices include preemptive procedures or treatments that reduce the number of workovers required for each well. On the basis of historical data, BOEM projects a producing well may expect to have seven workovers or other well activities during its lifetime. Workover fluids are discussed in **Chapter 3.1.5.1.3** below.

There are two types of well abandonment operations—temporary and permanent. An operator may temporarily abandon a well to (1) allow detailed analyses or additional delineation wells while deciding if a discovery is economically viable, (2) save the wellbore for a future sidetrack to a new geologic bottom-hole location, or (3) wait on design or construction of special production equipment or facilities. The operator must meet specific requirements to temporarily abandon a well. Permanent abandonment operations are undertaken when a wellbore is of no further use to the operator (i.e., the well is a dry hole or the well's producible hydrocarbon resources have been depleted). During permanent abandonment operations, equipment is removed from the well, and specific intervals in the well that contain hydrocarbons are plugged with cement. A cement surface plug is also required for the abandoned wells. This serves as the final isolation component between the wellbore and the environment.

3.1.4 Transport

3.1.4.1 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 GOM (**Table 3-3**). A mature pipeline network exists in the GOM to transport oil and gas production from the OCS to shore. There are currently 144 pipeline landfalls (pipelines that have at one time or another carried hydrocarbon product) in the Louisiana Coastal Area (LCA) (Smith, official communication, 2015). Included in this number of pipeline landfalls is a subset of 121 pipeline systems under the U.S. Department of Transportation's (DOT) jurisdiction originating in Federal waters and terminating onshore or in Louisiana State waters (Smith, official communication, 2015; **Table 3-4**). There are 14 OCS oil- and gas-related pipelines that transition into Texas State lands or that make landfall onshore, many of which switch back across this boundary. The BSEE and DOT share responsibility for pipeline regulation on the OCS in the transition between Federal and State waters. For more information on regulation and permitting of pipelines, refer to **Appendix A.3**.

Table 3-3. Oil Transportation Scenario under Alternative A, B, or C.

Activity	Alternative[1]	Offshore Subareas (m)[2]						Totals[3]
		0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Percent Oil Piped[4]	A	72-94%	100%	100%	100%	100%	100-66%	99.8-90.0%
	B	70-94%	100%	100%	100%	100%	100-50%	98.8-84.6%
	C	100%	100%	100%	100%	100%	100%	100%
Percent Oil Barged	A	28-6%	0%	0%	0%	0%	0%	0.2%
	B	30-6%	0%	0%	0%	0%	0%	0.2%
	C	0%	0%	0%	0%	0%	0%	0%

Activity	Alternative[1]	Offshore Subareas (m)[2]						Totals[3]
		0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Percent Tankered[5]	A	0%	0%	0%	0%	0%	0-34%	0-9.8%
	B	0%	0%	0%	0%	0%	0-50%	0-15.2%
	C	0%	0%	0%	0%	0%	0%	0%

[1] Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information. Percentage values indicated here would not change.
[2] Refer to **Figure 3-1**.
[3] Subareas totals may not add up to the planning area total because of rounding.
[4] 100% of gas is assumed to be piped.
[5] Tankering is forecasted to occur only in water depths >1,600 m.

Table 3-4. Existing Coastal Infrastructure Related to OCS Oil- and Gas-Related Activities in the Gulf of Mexico.

Infrastructure	Texas	Louisiana	Mississippi	Alabama	Florida	Total
Pipeline Landfalls[1]	14	122	3	5	0	144
Platform Fabrication Yards[2]	12	37	4	1	0	54
Shipyards[2]	32	64	9	18	14	137
Pipe Coating Facilities[2]	9	6	0	2	2	19
Supply Bases[2]	32	55	2	7	0	96
Ports[2]	11	14	3	1	5	34
Waste Disposal Facilities[2]	16	29	3	3	2	53
Natural Gas Storage Facilities[2]	13	8	0	1	0	22
Helicopter Hubs[2]	118	115	4	4	0	241
Pipeline Shore Facilities[2]	13	40	0	0	0	53
Barge Terminals[2]	110	122	6	6	8	252
Tanker Ports[2]	4	6	0	0	0	10
Gas Processing Plants[2]	39	44	1	13	1	98
Refineries[3]	20	16	3	3	0	42
Petrochemical Plants[2]	126	66	2	9	13	216

[1] Source: Smith, 2015.
[2] Source: Dismukes, 2011.
[3] Source: USDOE, Energy Information Administration, 2015a.

Newer installation methods have allowed the pipeline infrastructure to extend farther into deep water. The gas pipeline supporting the Shell Stones FPSO is expected to be the deepest pipeline in the GOM at 2,900 m (9,500 ft). More than 500 pipelines reach water depths of 400 m (1,312 ft) or more, and over 400 of those pipelines reach water depths of 800 m (2,625 ft) or more. These technical challenges are described in more detail in *Deepwater Gulf of Mexico 2006: America's Expanding Frontier* (USDOI, MMS, 2006).

Pipeline Installation and Maintenance

> *30 CFR § 250.1003*
>
> *Pipelines greater than 8 5/8 inches in diameter and installed in water depths of less than 200 feet shall be buried to a depth of at least 3 feet unless they are located in pipeline congested areas or seismically active areas as determined by the Regional Supervisor.*

Pipelines constructed in water depths <200 ft (61 m) are potential snags for anchors and trawls and must be buried according to BSEE's regulations. These pipelines account for 56 percent of the total pipeline length in Federal waters. The regulations also provide for the burial of any pipeline, regardless of size, if BSEE determines that the pipeline may constitute a hazard to other uses of the OCS; in the Gulf of Mexico, BSEE has determined that all pipelines installed in water depths <60 m (197 ft) must be buried. The purpose of these requirements is to reduce the movement of pipelines by high currents and storms, protect the pipeline from the external damage that could result from anchors and fishing gear, reduce the risk of fishing gear becoming snagged, and minimize interference with the operations of other users of the OCS. For lines >8$^5/_8$ in (22.9 cm) 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 would allow the weight of the line to cause it to sink into the sediments (self-burial). For a pipeline that crosses a fairway or anchorage in Federal waters in depths ≤60 m (197 ft), any length of pipeline must be buried to a minimum depth of 10 ft (3 m) below mudline across a fairway and a minimum depth of 16 ft (5 m) below mudline across an anchorage area. Some operators voluntarily bury these pipelines deeper than the minimum.

The purposes of these requirements are to (1) reduce the movement of pipelines during high sea states by storm currents and waves, (2) protect the pipeline from the external damage that could result from anchors and fishing gear, (3) reduce the risk of fishing gear becoming snagged, and (4) minimize interference with the operations of other users of the OCS.

Where pipeline burial is necessary, a jetting sled would be used. Such sleds are mounted with high-pressure water jets and pulled along the seafloor behind the pipe-laying 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 (1.0 mi/day). The cross section of a typical jetted trench for the flowline bundles would be about 4 m^2 (43 ft^2); for deeper burial when crossing a fairway, the cross section would be about 13 m^2 (140 ft^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 (161 ft^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. Newer installation methods have allowed the pipeline infrastructure to extend to deeper water.

The following information is discussed more thoroughly in this Agency's *Deepwater Gulf of Mexico 2006: America's Expanding Frontier* (USDOI, MMS, 2006). 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 (e.g., 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 substantial 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 BSEE's minimum cathodic protection design criteria for pipeline external corrosion protection is 20 years. For the most part, pipelines have a designed life span greater than 20 years and, if needed, can be retrofitted to increase the life span (**Chapter 3.1.6.1**). Should a pipeline need to be replaced because of integrity issues, a replacement pipeline is installed or alternate routes are used to transport the products, or a combination of the two. Besides replacement because of integrity issues, a pipeline may also be required to be replaced as a result of storm or other damages. The BSEE estimates that the overall pipeline replacement over the past few years is about 1 percent of the total installed.

The greater pressures and colder temperatures in deep water 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 (including "pigging" devices) and chemical techniques (e.g., methanol or ethylene glycol) that can be applied to manage these potential accumulations. 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.

BOEM projects that the majority of new pipelines constructed as a result of a proposed action would connect to the existing pipeline infrastructure. In the rare instance that a new pipeline to shore would need to be constructed, it would likely be because there are no existing pipelines reasonably close and because constructing a pipeline to shore is considered more cost effective, although it is highly unlikely for an operator to choose this contingency (Dismukes, official communication, 2011a). BOEM anticipates that pipelines from most of the new offshore production facilities would tie in to the existing pipeline infrastructure offshore or in State waters, which would result in few new pipeline landfalls. Refer to **Chapter 3.1.4.1** for a further discussion of pipeline landfalls. Production from a regionwide proposed action would contribute to the capacity of existing and future pipelines and pipeline landfalls.

The length of new pipelines was estimated using the amount of production, the number of structures projected as a result of each alternative, and the location of the existing pipelines. The range in length of pipelines projected is because of the uncertainty of the location of new structures, which existing or proposed pipelines would be used, and where they tie in to existing lines. Many factors would affect the actual transport system, including company affiliations, amount of production, product type, and system capacity.

Alternative A:* BOEM projects 355-2,144 km (220-1,332 mi) of new pipelines under Alternative A (**Table 3-2**). About 16-25 percent of the new pipeline length would be in water depths <60 m (197 ft), requiring burial.

Alternative B:* BOEM projects 254-1,641 km (157-1,020 mi) of new pipelines under Alternative B (**Table 3-2**). About 15-24 percent of the new pipeline length would be in water depths <60 m (197 ft), requiring burial.

Alternative C:* BOEM projects 105-505 km (65-314 mi) of new pipelines under Alternative C (**Table 3-2**). About 19-26 percent of the new pipeline length would be in water depths <60 m (197 ft), requiring burial.

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

Pipeline Landfalls

The OCS oil- and gas-related pipelines nearshore and onshore may join pipelines carrying production from State waters or territories for transport to processing facilities or to distribution pipelines located farther inland. Oil and gas companies have a strong financial incentive to reduce costs by utilizing, to the fullest extent possible, the mature pipeline network that already exists in the GOM. Economies of scale are a factor in pipeline transportation; maximizing the amount of product moved through an already existing pipeline decreases the long-term average cost of production. Additional considerations include mitigation costs for any new wetland and environmental impacts and various landowner issues at the landfall point. Because of these strong incentives to move new production into existing systems and to avoid creating new landfalls, the 5-year moving average of new OCS pipeline landfalls has been below two per year since 1986. Over the last 15 years (1999-2014), there has been an average of slightly over one new OCS pipeline landfall every 2 years (0.53 per year). **Table 3-5** lists the OCS pipeline landfalls that have been installed since 1996. While no new pipelines landfalls have been installed in the last 5 years, pipeline landfalls have been approved during that time. To project the likely number of new OCS pipeline landfalls, BOEM examined the historical relationships between new pipeline landfalls and a variety of factors including platforms installed, oil and gas production, and the total number of new pipelines. Based on this examination, BOEM assumes that the majority of new Federal OCS oil and gas pipelines would connect to the existing pipelines in Federal and State waters and that very few would result in new pipeline landfalls.

Table 3-5. OCS Pipeline Landfalls Installed from 1996 to 2014.

Segment Number	Year of Installation*	Product Type	Size (in)	Company	State
10631	1996	Oil	24	Equilon Pipeline Company LLC	LA
12470	1996	Oil	24	Manta Ray Gathering Company LLC	LA
11217	1997	Gas	30	Enbridge Offshore	LA
11496	1997	Oil	12	ExxonMobil Pipeline Company	LA
11952	2000	Oil	18-20	ExxonMobil Pipeline Company	TX
14470	2004	Oil	10	Chevron USA Inc.	LA
13972	2004	Oil	24	Manta Ray Gathering Company LLC	TX
13987	2004	Oil	24	Manta Ray Gathering Company LLC	TX
13534	2005	Oil	30	BP Pipelines (North America)	LA
13534	2005	Oil	30	Mardi Gras Endymion Oil Pipeline Co.	LA
17108	2007	Gas/Condensate	16	Stone Energy Corporation	LA
17691	2009	Gas/Oil	8	Stone Energy Corporation	LA

*Year when the initial hydrostatic test occurred.
Source: Smith, official communication, 2015.

Alternative A, B or C:* Up to one (i.e., 0-1) new pipeline landfall could result under Alternative A, B, or C.

*Alternative D is not expected to affect pipeline landfalls. Refer to **Chapter 2.2.2.4** for more information.

3.1.4.2 Barges

The capacity of oil barges used offshore can range from 5,000 to 80,000 bbl. Barges transporting oil may remain offshore for as long as 1 week while collecting oil; each round trip is assumed to be 5 days.

It is assumed that barging would continue to account for <1 percent of the oil transported for the entire OCS Program and for any single alternative. **Table 3-3** provides the percentages of oil barged to shore by subarea for each alternative. The average amount of oil barged between 2010 and 2014 was 0.2 percent annually.

The barging of oil from offshore facilities located in the GOM has been reduced substantially compared with the 2005 statistics. Barging continues to represent a very small portion of the total volume of oil being transported from the GOM to shore. In 2014, that portion was 0.08 percent of the total volume as compared with 0.13 percent in 2010. The total oil production from the Gulf of Mexico for 2013 was reduced by approximately 10 percent as compared with the oil production for 2010.

The number of active barging systems has been reduced over time from approximately eight systems in 2005 to four systems in 2010 and has remained constant since then. In 2010, there were 17 offshore locations that were approved to barge oil. In 2013, this number was reduced to eight offshore locations that were approved to barge oil. Of these locations, seven barged oil at some point during the years 2013-2014. The remaining location did not report any oil sales for the entire period of 2013-2014.

In 2013, all “active” offshore barging locations were located in the CPA. The locations east of the Mississippi River accounted for roughly 78 percent of the total barged volume. Likewise, the locations located west of the Mississippi River accounted for the remaining 22 percent.

3.1.4.3 Oil Tankers

The FPSOs store crude oil in tanks in the hull of the vessel and periodically offload the crude to shuttle tankers or oceangoing barges for transport to shore. The FPSOs are used to develop marginal oil fields or are used in areas remote from the existing OCS pipeline infrastructure, especially development in the Lower Eocene Wilcox trend (Walker Ridge leasing area) that is far from most existing pipeline networks. The FPSO systems are suitable for the light and intermediate oils of the GOM, as well as heavier oil, such as the heavy oil Brazil plans to produce offshore in deep water. The use of FPSOs and shuttle tankering are only projected in water depths >800 m (2,625 ft). Shuttle tankers are 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. Shuttle tanker design and systems are in compliance with USCG regulations, the Jones Act, and OPA requirements. As such, shuttle tankers are required to be double hulled. In the Gulf, the maximum size of shuttle tankers is limited primarily by the 34- to 47-ft (10- to 14-m) water depths. Because of 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 can maintain their station during FPSO offloading operations using techniques that generally do not require anchoring. Offloading could occur at an average rate of 50,000 bbl per hour. 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. Safety features, such as marine break-away offloading hoses and emergency shut-off valves, would be incorporated in order to minimize the potential for, and size of, an oil spill. In addition, weather and sea-state limitations would be established to further ensure that hook-up and disconnect operations would not lead to accidental oil release. A vapor recovery system between the FPSO and shuttle tanker would be employed to minimize the release of fugitive emissions from cargo tanks during offloading operations.

Tankering related to FPSO systems in the GOM began in 2012 at the Cascade Chinook Project. For additional information on FPSOs, refer to **Chapter 3.1.3.2**. The production transported by shuttle tankers related to this FPSO system accounted for 2.2 percent of the total volume produced in the GOM during 2014. Forecasted tankering operations are presented in **Table 3-3**. During the production ramp up interval (the first 2 years of production operations), 8 offloads were made during the first 6 months followed by 15 offloads over the next year. During the 2nd full year of operation, 46 offloads were made. In the subsequent years of production, two shuttle tankers on a staggered schedule were predicted to perform one offload every week (52 trips a year). A second FPSO (Stones Project) in the GOM area (Walker Ridge) is under construction by Shell Offshore, Inc. and is anticipated to commence production in 2016. This facility is also scheduled to transport the produced liquid hydrocarbons by shuttle tankers.

To develop a scenario for analytical purposes, the following assumptions are made regarding future OCS oil transportation by shuttle tanker:

- advances in pipe-laying technology would keep pace with the expansion of the oil industry into the deeper waters of the Gulf beyond the continental slope;
- all produced gas would be piped;
- tankering would not occur from operations on the continental shelf;
- tankering would only take place from marginal fields or fields in areas remote from the existing OCS pipeline infrastructure; and
- maximum offloading frequency for an FPSO could be once every 3 days during peak production.

Alternative A:* BOEM projects 0-1 FPSO systems could result under Alternative A. The number of shuttle tanker trips to port in a given year is primarily a function of the FPSO production rate, the number of wells drilled, 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, maximum offloading could occur once every 3.3 days. This would equate to a 54.75-MMbbl production with 110 offloading events and shuttle tanker transits to GOM coastal or offshore ports annually per FPSO.

*Alternative B**: BOEM projects 0-1 FPSO systems would result under Alternative B. Because the FPSO projections are expected to occur in the CPA, a similar number of tanker trips would occur from an FPSO under Alternative B as would under Alternative A.

*Alternative C**: BOEM projects no FPSO systems would result under Alternative C because no FPSO activity is expected to occur in the WPA; thus, no tankering is projected to occur under Alternative C.

*Because FPSOs are not expected to occur in the same area as the sensitive topographic features, Alternative D is not expected to affect FPSO system development. Refer to **Chapter 2.2.2.4** for more information.

3.1.4.4 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. Service vessels were evaluated for the following categories: wells (exploration and development drilling); plug and abandonment of wells; platform installation; platform operation; platform decommissioning; subsea installation; subsea removal; and pipeline installation. Other vessel operations, including G&G activity associated with a leasing event, is assumed to be covered in these estimates. Based on the model provided by Kaiser (2010), there were an average of 4.46 supply vessels needed per week during exploration and development drilling in shallow water and 6.4 supply vessels needed per week during exploration and development drilling in deep water. Drilling operations in shallow water takes less time (5.9 weeks) when compared with deepwater drilling (10 weeks). A platform in shallow water (<800 m; 2,624 ft) is estimated to require one vessel trip every 3.1 days over the production life. A platform in deep water (≥800 m; 2,624 ft) is estimated to require one vessel trip every 1.2 days over the production life. All trips are assumed to originate from the designated service base. The duration vessels service an operational platform was considered to be between 11 and 31 years (low to high). Service-vessel operations are most closely tied to actual production activities. Visual representation of this can be seen in **Figure 3-7**.

Alternative A:* Alternative A is estimated to generate 43,000-541,000 service-vessel trips over the 50-year period (**Table 3-2**) or 860-10,820 trips annually. **Table 3-6** indicates that over 875,000 service-vessel trips occurred on Federal navigation channels, ports, and OCS-related waterways in 2012. The number of service-vessel trips projected annually for Alternative A would represent <2 percent of the total annual traffic on these OCS-related waterways.

*Alternative B**: Alternative B is estimated to generate 38,000-452,000 service-vessel trips over the 50-year period (**Table 3-2**) or 760-9,040 trips annually. **Table 3-6** indicates that over 875,000 service-vessel trips occurred on Federal navigation channels, ports, and OCS-related waterways in 2012. The number of service-vessel trips projected annually for Alternative B would represent <2 percent of the total annual traffic on these OCS-related waterways.

*Alternative C**: Alternative C is estimated to generate 30,000-88,500 service-vessel trips over the 50-year period (**Table 3-2**) or 600-1,770 trips annually. **Table 3-6** indicates that over 875,000 service-vessel trips occurred on Federal navigation channels, ports, and OCS-related waterways in 2012. The number of service-vessel trips projected annually for Alternative C would represent <1 percent of the total annual traffic on these OCS-related waterways.

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

3.1.4.5 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. An operation is considered a roundtrip and includes takeoff and landing.

Deepwater operations require helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating costs. Helicopter trips have been declining over the last 15 years. There are several issues that could be contributing to this decline, including competition with increasingly faster boats and the development of new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed. Additionally, oil and gas companies are increasingly subcontracting all helicopter support to independent contractors who may use one fleet to service multiple oil and gas companies. The number of helicopters operating in the GOM is expected to decrease in the future, and helicopters that do operate are expected to be larger and faster.

The scenarios for each alternative and the Cumulative OCS Oil and Gas Program scenarios (**Chapter 3.3.1.7**) below use the current level of activity as a basis for projecting future helicopter operations in relation to the production activity forecasted. 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. The Helicopter Safety Advisory Conference recommended practice states that helicopters should maintain a minimum altitude of 750 ft (229 m) while in transit offshore and a maximum of 500 ft (152 m) while working between platforms and drilling rigs (Helicopter Safety Advisory Conference, 2010). When flying over land, the specified minimum altitude is 1,000 ft (305 m) over unpopulated areas and coastlines, and 2,000 ft (610 m) over populated areas and sensitive areas including national parks, recreational seashores, and wildlife refuges. In addition, guidelines and regulations issued by the NMFS under the authority of the Marine Mammal Protection Act include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft (305 m) within 100 yd (91 m) of marine mammals.

According to the Helicopter Safety Advisory Conference (2015), from 1996 to 2014, helicopter operations (take offs and landings) in support of regionwide OCS operations have averaged, annually, about 1.2 million operations, 2.7 million passengers, and 386,000 flight hours. There has been a decline in helicopter operations from 1,668,401 in 1996 to 741,201 in 2014 (Helicopter Safety Advisory Conference, 2015). Future projections are based on a high equal to the average number of flights over the last 15 years and a low equal to a continuing forecast of the current decline.

Alternative A:* There are 122,000-3,750,000 helicopter trips projected over the 50-year period for Alternative A (**Table 3-2**), or 2,440-75,000 trips annually.

*Alternative B**: There are 105,000-3,415,000 helicopter trips projected over the 50-year period for Alternative B (**Table 3-2**), or 2,100-68,300 trips annually.

*Alternative C**: There are 70,000-440,000 helicopter trips projected over the 50-year period for Alternative C (**Table 3-2**), or 1,400-8,800 trips annually.

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

3.1.4.6 Navigation Channels

BOEM conservatively estimates that there are approximately 4,850 km (3,013 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS traffic regionwide (**Table 3-6**; **Figure 3-8**) and that the average canal is widening at a rate of 0.99 m/yr (3.25 ft/yr) (Thatcher et al., 2011). This would result in a total (OCS and non-OCS oil- and gas-related) annual land loss of approximately 831 ac/yr (336 ha/yr). Total land loss in these areas can be caused by multiple factors, including saltwater intrusion, hurricanes, and vessel traffic (refer to **Chapter 3.3.2.8** below). Assuming that vessel traffic alone was the sole source of erosion, the rate of land loss would be related to the usage of those canals by both OCS Program-related vessels and other vessel traffic. Using the estimated proportion of OCS Program vessel traffic as a measurement of erosion, the numbers above are considered conservative because open waterways were included in the total length of Federal navigation channels, vessel size was not taken into consideration, and there are sources of erosion to navigation canals other than vessel traffic alone.

Table 3-6. Waterway Length, Depth, Traffic, and Number of Trips for 2012.

Waterway	Canal Length (km)	Maintained Depth (ft)	Traffic (1,000 short tons)	Number of Trips	
				Foreign	Domestic
Gulf Intracoastal Waterway (GIWW)					
Apalachee Bay to Panama City, FL	217	12	607	0	329
Panama City to Pensacola Bay, FL	177	12	1,610	0	1,114
Pensacola Bay, FL to Mobile Bay, AL	74	12	3,962	0	3,646
Mobile Bay, AL to New Orleans, LA	215	12, 14	18,209	0	13,585
Mississippi River, LA to Sabine River, TX	428	12, 10	63,911	0	52,435
Sabine River to Galveston, TX	135	12	59,577	0	33,113
Galveston to Corpus Christi, TX	305	11, 11, 10.2	29,314	0	21,178
Corpus Christi, TX to Mexican Border	214	10, 12, 7	1,920	0	1,483
Morgan City - Port Allen Route, LA	103	10	18,832	0	9,463
Florida Harbors, Channels, and Waterways					
Escambia and Conecuh Rivers, FL and AL; Escambia Bay, FL	12	10	1,664	0	1,930
La Grange Bayou, FL	3	9	219	0	70
Panama City Harbor, FL	9	34, 32, 10	2,326	308	674
Pensacola Harbor, FL	21	35, 33, 15, 14	879	471	435
St. Marks River, FL	61	9	72	0	36
Tampa Harbor, FL	141	45, 43, 34, 12, 9	31,650	834	1,459
Port Manatee, FL	5	40	3,397	219	30
Alabama Harbors, Channels, and Waterways					
Mobile Harbor, AL	71	47, 45, 40, 13-39	54,888	1,338	17,965
Theodore Ship Channel, AL	13	40	4,646	212	1,357
Mississippi Harbors, Channels, and Waterways					
Biloxi Harbor, MS	39	12, 10, 12	1,047	0	1,106
Gulfport Harbor, MS	34	30, 32, 8	1,888	200	406
Pascagoula Harbor, MS	18	40, 38, 38, 22, 12	33,785	601	3,110
Bayou Casotte, MS	2	38	33,467	518	2,837
Louisiana Harbors, Channels, and Waterways					
Atchafalaya River (Lower), LA	62	20	983	332	11,050
Barataria Bay Waterway, LA	66	17, 10	288	13	5,146
Bayou Lafourche and Bayou Lafourche-Jump Waterway	80	28, 27, 27, 9	6,092	2,342	16,463
Bayou Little Caillou, LA	56	12	68	0	305
Bayou Teche, LA	171	3,3,4,7	474	0	321
Bayou Teche and Vermilion River, LA	83	8,11,9,8,5	601	17	1,541

Waterway	Canal Length (km)	Maintained Depth (ft)	Traffic (1,000 short tons)	Number of Trips	
				Foreign	Domestic
Bayou Terrebonne, LA	61	10	134	0	692
Calcasieu River and Pass, LA	176	42, 42, 41-42, 36, 12, 7	54,382	1,318	32,207
Freshwater Bayou, LA	34	12	493	57	4,989
Houma Navigation Canal, LA	59	16, 15, 16	473	30	1,812
Mermentau River, LA	131	4, 7, 12, 10, 10, 9, 11, 6, 8, 4, 4, 7	311	0	1,802
Mermentau River, Bayou Nezpique, and Des Cannes, LA	122	9, 14, 10	443	0	649
Mississippi River, Baton Rouge LA to the Mouth of Passes	437	45, 13	456,551	5,635	216,588
Port of New Orleans, LA	83	45, 30, 32, 36, 37, 12	79,342	1,852	26,820
Port of Baton Rouge, LA	144	45, 40, 9, 12	59,993	664	47,602
Port of South Louisiana	86	45	252,069	2,451	67,601
Port of Plaquemines, LA	131	45	58,280	654	74,951
Passes of the Mississippi River, LA	57	13, 45	230,048	5,635	3,707
Mississippi River Gulf Outlet via Venice Vicinity Consolidation	22	16, 14, 14	1,585	13	6,276
Petit Anse, Tigre, and Carlin Bayous	28	6, 9, 5, 7	1,563	0	1,243
Port of Iberia	14	13	~2,200	NA	NA
Port of Morgan City, LA	–	12	1,771	202	12,474
Waterway from Empire, LA to the Gulf of Mexico	17	6,9,14	1,044	0	7,292
Waterway from Intracoastal Waterway to Bayou Dulac, LA	61	14	145	0	1,271
Texas Harbors, Channels and Waterways					
Brazos Island Harbor, TX	47	36.5, 38, 31, 38, 12, 14, 7	5,614	251	1,155
Cedar Bayou, TX	22	11	1,349	0	1,222
Channel to Aransas Pass, TX	11	14	782	20	749
Channel to Port Bolivar, TX	17	12	0	0	56,583
Corpus Christi Ship Channel, TX	64	47, 45, 46, 47, 14, 9	69,001	1,349	102,837
Dickenson Bayou, TX	34	9	47	0	25
Freeport Harbor, TX	14	44, 37, 18, 40	22,085	716	3,207
Galveston Channel, TX	6	41	11,618	2,843	61,016
Houston Ship Channel, TX	112	45, 40, 32-39, 9, 7, 35-37, 7, 40, 12	238,186	6,262	81,048
Matagorda Ship Channel, TX	91	35, 9.8, 10, 12.8, 2	9,333	329	1,847
Sabine-Neches Waterway, TX	160	40, 37, 39, 32, 27, 20, 9, 8	137,218	1,908	31,828

Waterway	Canal Length (km)	Maintained Depth (ft)	Traffic (1,000 short tons)	Number of Trips	
				Foreign	Domestic
Texas City Channel, TX	14	43, 41, 42, 42	57,758	776	6,625

Source: U.S. Dept. of the Army, COE, 2012.

Alternative A:* Assuming that vessel traffic alone was the sole source of erosion, there would be an annual loss of 0.40-5.02 ha (0.99-12.40 ac) for Alternative A. All service vessels associated with EPA blocks are assumed to use CPA navigational canals while inland and constitute less than 1 percent of the total vessel traffic. Service vessels associated with CPA leases are assumed to use CPA navigational canals and constitutes less than 2 percent of the total traffic. Service vessels associated with WPA leases are assumed to use WPA navigational canals and constitute less than 1 percent of the total traffic in the GOM.

*Alternative B**: Assuming that vessel traffic alone was the sole source of erosion, there would be an annual loss of 0.46-5.53 ha (1.15-13.66 ac) for Alternative B.

*Alternative C**: Assuming that vessel traffic alone was the sole source of erosion, there would be an annual loss of 0.18-0.54 ha (0.45-1.34 ac) for Alternative C.

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

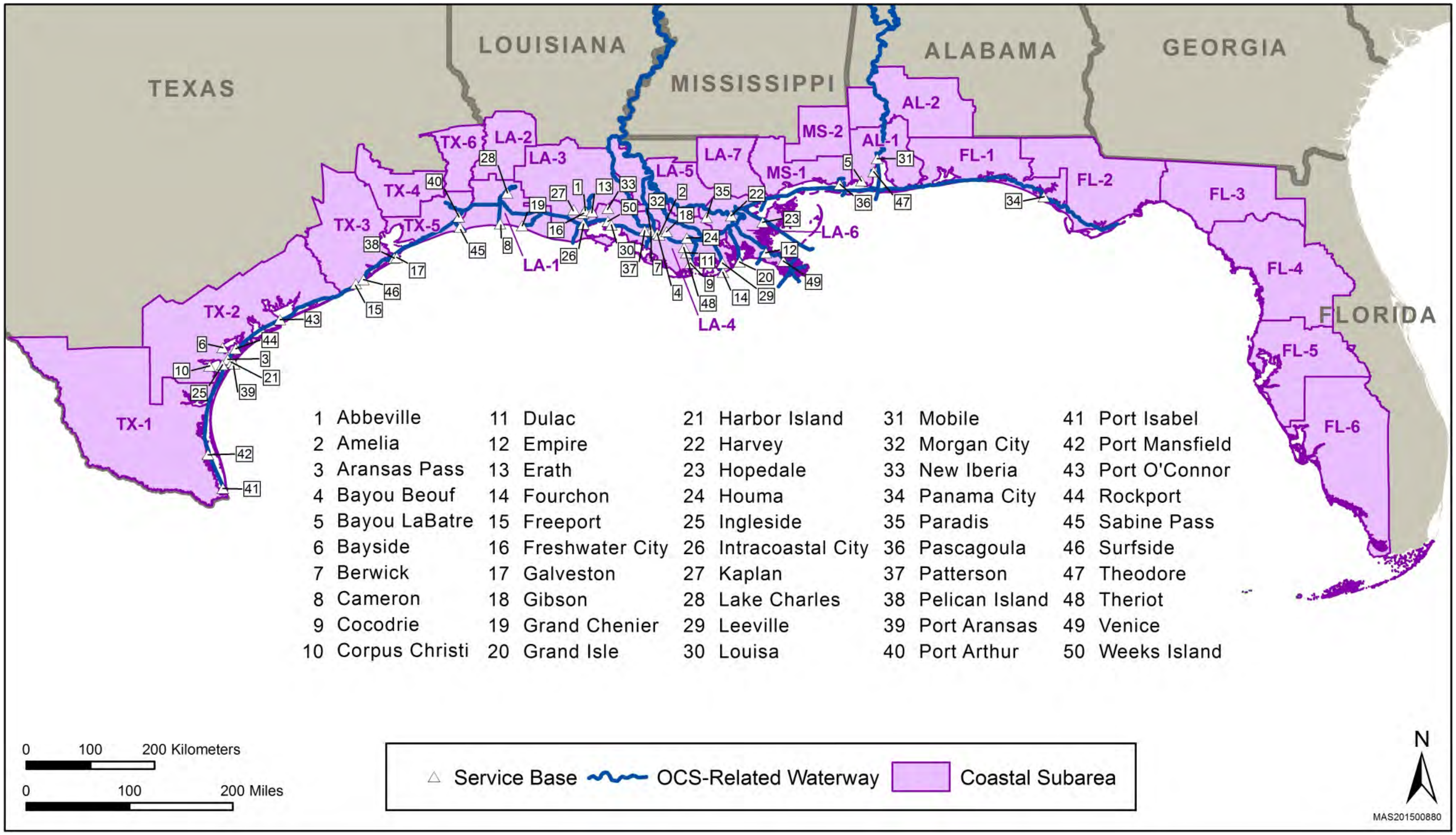

Figure 3-8. Gulfwide OCS Oil- and Gas-Related Service Bases and Major Waterways.

3.1.5 Discharges and Wastes

3.1.5.1 Operational Wastes and Discharges Generated by OCS Oil- and Gas-Related Facilities

The primary operational wastes and discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, various waters (e.g., bilge, ballast, fire, and cooling), deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced water, produced sand, and well-treatment, workover, and completion fluids. Minor additional discharges occur from numerous sources. These discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, several fluids used in subsea production, and uncontaminated freshwater and saltwater.

Regulations

The Clean Water Act (CWA) establishes conditions and permitting for discharges of pollutants into the waters of the United States under the National Pollution Discharge Elimination System (NPDES) and gives the USEPA the authority to implement pollution control programs such as setting wastewater standards for industry and to set water quality standards for all contaminants in surface waters. Accordingly, the USEPA regulates all waste streams generated from OCS oil- and gas-related activities through permits issued by the USEPA Region that has jurisdictional oversight.

The USEPA Region 4 has jurisdiction over the eastern portion of the Gulf of Mexico OCS, including all of the EPA and a portion of the CPA off the coasts of Alabama and Mississippi (**Figure 3-9**). The USEPA Region 6 has jurisdiction over the rest of the CPA and all of the WPA. Each region issues general permits but can require an operator to apply for an individual permit. Each USEPA Region has promulgated general permits for discharges that incorporate the 1993 and 2000 effluent guidelines (USEPA, 1993a and 2000b) for synthetic-based fluid (SBF)-wetted cuttings as a minimum. The permits are valid for 5 years. The current USEPA Region 4 general permit (GEG460000) was issued on March 15, 2010; became effective on April 1, 2010; and expired on March 31, 2015 (USEPA, 2010a). The renewal of the permit is being administratively continued for those operators who are already covered under the permit and request an extension. However, no new general permits will be granted until the permit is renewed. Operators may apply for an individual permit. The current Region 6 permit (GMG290000) was reissued with an effective date of October 1, 2012, expiring at midnight on. September 30, 2017 (USEPA, 2012a).

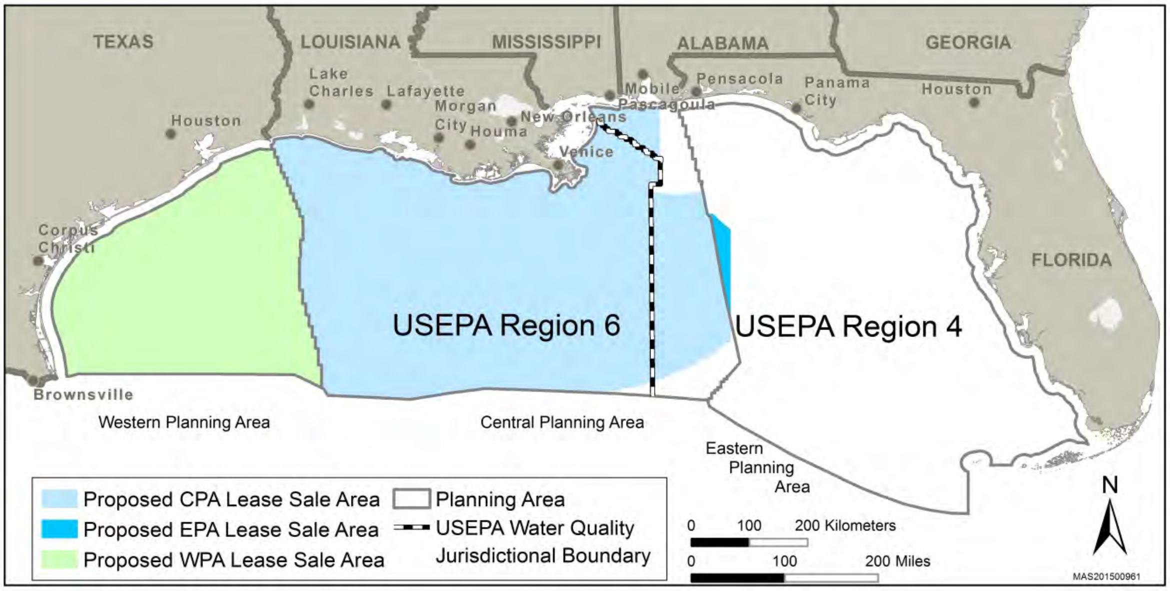

Figure 3-9. Water Quality Jurisdictional Boundaries for USEPA Regions 4 and 6.

Permits issued under Section 402 (NPDES) of the CWA for offshore activities must comply with any applicable water quality standards and/or Federal water quality criteria, as well as Section 403 (Ocean Discharge Criteria) of the CWA. Water quality standards consist of the waterbody's designated uses, water quality criteria to protect those uses and to determine if they are being attained, and antidegradation policies to help protect high-quality waterbodies (refer to **Chapter 4.2**). Discharges from offshore activities near State water boundaries must comply with all applicable State water quality standards.

Section 403 of the CWA requires that NPDES permits for discharges to the territorial seas (baseline to 3 mi [5 km]), contiguous zone, and ocean be issued in compliance with USEPA's regulations for preventing unreasonable degradation of the receiving waters. Prior to permit issuance, ocean discharges must be evaluated against the USEPA's published criteria for determination of unreasonable degradation. Unreasonable degradation is defined in the NPDES regulations (40 CFR § 125.1211e) as the following:

- significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities;
- threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; and
- loss of aesthetic, recreational, scientific, or economic values, which is unreasonable in relation to the benefit derived from the discharge.

Compliance and Enforcement

U.S. Environmental Protection Agency

In order for a facility to be covered by a general NPDES permit, the operator must submit a notice of intent (NOI) to be covered by the general permit. Region 6 developed an “electronic NOI (eNOI)” system so that coverage is immediate (USEPA, 2015a). The USEPA evaluates NOIs on a case-by-case basis and reserves the right to deny coverage if it is determined the facility is ineligible or has falsified information. The NPDES permit sets minimum requirements that every allowable discharge must meet. If a waste does not meet the requirements of the permit, the permit would be considered violated and the USEPA could take an enforcement action. Discharges are monitored and the data are reported to the USEPA through discharge monitoring reports (DMRs). These reports must be turned in quarterly and contain all of the information required by the permit for that discharge. Region 6 now has an electronic Discharge Monitoring Report (DMR) system known as “NetDMR,” which is now required for all facilities covered by their general permit (USEPA, 2015b). Failure to submit any information or monitoring results required by the permit is considered a violation. Data from submitted NetDMRs populate the USEPA’s national Integrated Compliance Information System database. Region 6 reviews the Integrated Compliance Information System’s data to identify facilities violating the permit conditions or reporting requirements. Violations are reviewed and enforcement actions are taken as deemed appropriate, particularly for serious single event violations, an ongoing pattern of noncompliance, or significant noncompliance (noncompliance for two running quarters or more). Depending on the type of violation, severity, length of violation, environmental damage, or illegal activity, the USEPA may request more information, issue a warning letter or order corrective actions, assess a penalty, or refer it to the U.S. Department of Justice or Criminal Investigation Division. The USEPA may use information, pictures, and other documentation from BSEE, BOEM, or the USCG to support its enforcement cases. The public may view violations and enforcement actions in the Enforcement and Compliance History Online database (USEPA, 2015c), which is updated every 30 days from the Integrated Compliance Information System’s database.

Bureau of Safety and Environmental Enforcement

In addition to facilities’ inspections in Federal waters in the Gulf of Mexico (refer to **Chapter 1.3.2**), BSEE performs NPDES inspections on behalf of the USEPA for production platforms and drilling rigs through a 1984 Memorandum of Understanding between the U.S. Department of the Interior, the USEPA, and the U.S. Department of Transportation (USDOI, MMS, 1983) and a 1989 Memorandum of Agreement between MMS (BSEE’s predecessor) and the USEPA Region 6 (USDOI, MMS, 1989). According to the Memorandum of Agreement, BSEE inspects a maximum of 50 OCS facilities per year for compliance with NPDES permit provisions. The Region 6 NPDES inspection responsibility officially transitioned from BSEE’s Districts to BSEE’s Environmental Enforcement Branch, Environmental Inspection and Enforcement Unit on September 18, 2014, in preparation for the 2015 inspection cycle (Sanders, official communication, 2015). The scope of those inspections does not include sampling. Coordination of a potential Memorandum of Agreement between BSEE and USEPA Region 4 concerning NPDES inspection needs is ongoing.

Facility inspections are chosen on a variety of parameters such as pollution history, the USEPA's reporting anomalies and errors, and general frequency for a lack of past inspection visits, among others. An inspection or audit may also be triggered by a major pollution release event triggering a rapid visit turnaround. The BSEE utilizes the U.S. Environmental Protection Agency's ICIS database where DMRs are reported for the permitted features specific to the facility, and deviations and violations are noted. A thorough review of these data is included and evaluated for every inspection. When completed, an inspection report is prepared and sent to the USEPA where the noncompliances observed during the inspection are summarized and formally referred to them for support of potential further enforcement action. If violations or concerns are observed during the inspection, as per any of BSEE regulations from 30 CFR parts 200-699, then BSEE-driven incidents of noncompliance are prepared and sent directly to the offending facility, and the USEPA is copied as a courtesy.

Pollution-related incidents of noncompliance are shown in **Table 3-7**. The BSEE posts some incidents of noncompliance on its website (USDOI, BSEE, 2015a), but as BSEE is working to improve its website postings, additional information can be requested through BSEE's Freedom of Information Act office. Over 700 NPDES inspections were performed between 1999 and 2014 (**Table 3-8**).

Table 3-7. Pollution-Related Incidents of Noncompliance Issued from 1986 to the Present.

INC Number	INC Description	Approximate Number of INCs Issued
E-100	The operator failed to prevent unauthorized discharge of pollutants into offshore waters.	2,035
E-101	The lessee failed to dispose of drill cuttings, sand, and other well solids as approved.	18
E-102	Facility is not equipped with curbs, gutters, drip pans, and drains necessary to collect all contaminants not authorized for discharge.	1,331
E-103	The sump system does not automatically maintain the oil at a level sufficient to prevent discharge of oil into offshore waters.	1,054
E-104	All hydrocarbon handling equipment for testing and production is not designed, installed, and operated to prevent pollution.	43
E-105	All gravity drains are not equipped with a water trap or other means to prevent gas in the sump system from escaping through the drains.	194
E-106	Sump piles are used as processing devices.	48
E-107	The lessee failed to adhere to the prohibition on the addition of petroleum-based substances to the mud system without prior approval of the district manager.	2
E-108	The lessee failed to prevent the disposal of equipment, cables, chains, containers, or other materials into offshore waters.	49

Source: USDOI, BSEE, 2011.

Table 3-8. National Pollutant Discharge Elimination System Inspections from 1999 through 2014.

Calendar Year	Number of Platforms Inspected	Number of Rigs Inspected	Annual Totals
1999	34	16	50
2000	76	15	91
2001	40	12	52
2002	39	18	57
2003	30	10	40
2004	16	7	23
2005	22	11	33
2006	20	12	32
2007	25	4	29
2008	30	20	50
2009	26	23	49
2010	17	12	29
2011	18	21	39
2012	30	24	54
2013	37	32	69
2014	16	14	30
Total	476	251	727

(1) Data as of February 4, 2015.

(2) Inspections performed by the Minerals Management Service; Bureau of Ocean Energy Management, Regulation and Enforcement; and Bureau of Safety and Environmental Enforcement.

Drilling Muds and Cuttings

Drilling fluids (also known as drilling muds) and cuttings represent a large quantity of the discharge generated by drilling operations. 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 its bit, and to seal the well. Drill cuttings are the fragments of rock generated during drilling and carried to the surface with the drilling fluid. Drilling discharges of muds and cuttings are regulated by the USEPA through the NPDES permitting process.

The composition of drilling fluids is complex. Drill cuttings are a different grain size and composition from the existing surface sediments. Drilling fluids used on the OCS are divided into two categories: water based and nonaqueous based. Water-based fluids (WBFs) have a water soluble continuous phase while nonaqueous-based fluids have a continuous phase that is not soluble in water. The base fluid can be freshwater or saltwater in WBFs, mineral or diesel oil-based fluids (OBFs), or synthetic-based fluids (SBFs). Thus, both OBFs and SBFs are nonaqueous-based fluids.

Drilling fluids used on the OCS are divided into two categories: *water based (WBFs) and nonaqueous based (OBFs or SBFs).*

Clays, barite, and other chemicals are added to the base fluid to improve the performance of the drilling fluid (Boehm et al., 2001).

On the OCS, the WBFs have been used for decades in drilling. In the GOM, they are the most commonly used drilling fluids for exploration and production wells. The discharge of WBFs and cuttings associated with WBFs is allowed on the OCS under the general NPDES permits issued by USEPA Regions 4 and 6, as long as the discharge meets the conditions required in the permit. Discharge of WBFs results in increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and the input of trace metal into the environment. Occasionally, formation oil may be discharged with the cuttings, adding hydrocarbons to the discharge. However, as noted in the NPDES permits, no free oil shall be discharged; static sheen tests must be performed once per week when discharging. In shallow environments, WBFs are rapidly dispersed in the water column immediately after discharge and rapidly descend to the seafloor (Neff, 1987). In deep waters, fluids dispersed near the water surface would disperse over a wider area than fluids dispersed in shallow waters.

The early nonaqueous drilling fluids, termed oil-based drilling fluids (OBF), were occasionally used for directional drilling and in drill-bore sections where additional lubricity was needed. Crude, diesel, and mineral oil were used. Diesel OBFs contains light aromatics such as benzene, toluene, and xylene. Mineral oil is advantageous over diesel because it is less toxic. Hydrocarbon concentration and impacts to benthic community diversity and abundance have been observed within 200 m (656 ft) of the drill site with diminishing impacts measured to a distance of 2,000 m (6,562 ft) (Neff, 1987). All OBFs and associated cuttings must be transported to shore for recycling or disposal unless reinjected. Due to the environmental concerns of OBFs, SBFs were created in the 1990s (Bakhtyar and Gagnon, 2012). The OBFs are rarely used because of the many advantages of SBFs. The SBFs are manufactured hydrocarbons. The SBF mud system also contains additives such as emulsifiers, clays, wetting agents, thinners, and barite. Since the SBFs are not petroleum based, they do not contain the aromatic hydrocarbons and polycyclic aromatic hydrocarbons (PAH) that contributed to OBF toxicity and persistence on the seafloor (Bakhtyar and Gagnon, 2012). In fact, SBFs have several additional advantages over OBFs, which include that they are well characterized, have lower toxicity and bioaccumulation potentials, and biodegrade faster. Since 1992, SBFs have been increasingly used, especially in deep water, because they perform better than WBFs and OBFs. The SBFs reduce drilling times and costs incurred from expensive drilling rigs. By 1999, about 75 percent of all wells drilled in waters deeper than 305 m (1,000 ft) were drilled with SBFs in the Gulf of Mexico (CSA, 2004). Although there are many types of SBFs, esters, internal olefins, and linear alpha olefins are most commonly used in the GOM.

A literature review (Neff et al., 2000) discussed knowledge about the fate and effects of SBFs discharges on the seabed. Like OBFs, the SBFs are hydrophobic, meaning they are not soluble in the water column and therefore are not expected to adversely affect water quality. The SBF-wetted cuttings settle close to the discharge point and affect the local sediments. Cuttings piles with a maximum depth of 8-10 in (20-25 cm) were noted in a seabed study of shelf and slope locations where cuttings drilled with SBF were discharged. The SBF discharge can alter sediment grain size and add organic matter, which can result in localized anoxia while SBF degrades (Melton et al., 2004). Different formulations of SBFs use base fluids that degrade at different rates, thus affecting the duration of the impact. Esters and olefins are the most rapidly biodegraded SBFs. Ongoing research is aimed at understanding the relationships between the chemical structure in SBFs and the environmental fates and effects, which would provide the design basis for fluids with better environmental performance. For example, recent testing showed that less branching of alpha and internal olefins positively impacted both sediment toxicity and anaerobic biodegradation (Dorn et al., 2011).

Bioaccumulation tests indicate that SBFs and their degradation products should not bioaccumulate (Neff et al., 2000). In a study to measure degradation rates of SBFs on the seafloor, biodegradation proceeded after a lag period of up to 28 weeks, which was influenced by both the SBF type and prior exposure of the sediments to SBFs (Roberts and Nguyen, 2006). Sediment sulfate depletion due to microbial activity coincided with SBF degradation. Decreased SBF concentrations indicated that recovery in sediments occurred in the year between sample collections. Deposited cuttings and measurable sediment effects indicative of organic enrichment were concentrated within a distance of 250 m (820 ft) in both shelf and slope sites (CSA, 2004).

The discharge of the base SBF drilling fluid is prohibited. The SBFs and cuttings must meet environmental requirements. Both USEPA Regions 4 and 6 permit the discharge of cuttings wetted with SBF as long as the retained SBF amount is below a prescribed percent, meets biodegradation and toxicity requirements, and is not contaminated with the formation oil or PAH.

Typically, the upper portion of the well is drilled with WBF and the remainder is drilled with SBF. The upper sections would be 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 would be greater than the volume generated in the deeper sections.

Barite, a barium sulfate ($BaSO_4$) mineral, is used as a weighting agent to increase the hydrostatic pressure of drilling muds in order to control high-pressure zones encountered during drilling. Because barite is also soft, it does not erode equipment but instead acts essentially as a lubricant (Mills, 2006). Additionally, barite is inert and does not react with other additives in the drilling fluid. Because of barite's useful qualities, barite is a major component of all types of drilling fluid, but its use has somewhat declined due to advances in synthetic-based mud formulations and drilling technology. A study of 81 wells noted that, from 1998 to 2002, the quantity of barite discharged for a shallow well (2,936 m; 9,634 ft average) to a deep well (5,140 m; 16,864 ft average) is 110 tons barite per well and 586 tons barite per well, respectively (Candler and Primeaux, 2003).

Since barite is a natural mineral, it can have natural impurities associated with it. The impurities of concern in barite are trace metals such as mercury (Hg), cadmium (Cd), copper (Cu), zinc (Zn), and lead (Pb) that are often found in other mineral phases that were formed on or in the barite mineral deposit (Crecelius et al., 2007). However, the American Petroleum Institute (API) has set specifications for the barite used in the oil industry, which includes that the amount of water-soluble alkaline earth metals must be below 250 milligrams/kilogram (parts per million [ppm]) (Mills, 2006). More importantly, since 1993, the USEPA has required the concentrations of Hg and Cd to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make up drilling muds (USEPA, 1993a and 2000b). Through Hg and Cd regulation, the USEPA can also control levels of other trace metals in barite. This reduces the addition of Hg to sediments to values similar to the concentration of mercury found in marine sediments throughout the GOM (Neff, 2002). Furthermore, barite is nearly insoluble in seawater, which means that it remains in the solid form where it is not readily available to biota unless the mineral particles themselves are directly digested.

Despite atmospheric mercury deposition being considered the main source of anthropogenic Hg inputs into the marine environment, the availability of Hg in barite was studied to confirm that barite in drilling muds was not a significant or available source of Hg in the marine environment. Crecelius et al. (2007) studied the solubility of barite and the rate at which it dissolves (and thereby releases associated metals such as Hg from the solid phase into the aqueous phase), the amount of metals released from barite, and the rate of dissolution of barite and release of metals after burial under simulated seafloor conditions. The research used three grades of barite: one commercially available barite ore used in drilling fluids, which meets the USEPA's trace metal criteria; and two grades of barite to represent those used in the GOM prior to the 1993 USEPA regulation enacted to reduce the concentrations of Hg and Cd in drilling fluid. During a 1-week exposure of barite in seawater, in the pH range of 7.3 to 8.3, <1 percent of the Hg dissolved from the barite. The studies conducted at varying pH levels to mimic digestive tract conditions showed that very little (<0.1%) of the Hg in barite became available within 48 hours. When barite is added to anoxic sediments, the concentrations of methylmercury (methyl-Hg) and Hg were not elevated as compared with the same anoxic sediment without the addition of barite.

Crecelius et al. (2007) confirmed that trace metal contaminants in barite were in sulfide mineral inclusions dispersed within the barite matrix. In seawater with a pH of 7.3 to 8.3 over the period of 1 week, <1 percent of the Cu and Pb, 3 percent of the Zn, and 15 percent of the Cd dissolved from the inclusions within the barite. Thus, a small amount of these metals are soluble in seawater at this pH range. Since low-metal barite (barite that meets current USEPA standards) releases little of these metals to seawater, low-metal barite is not likely to cause environmental effects to organisms living in the water column. However, in acidic conditions simulating the gut of deposit-feeding benthic animals, a major portion of the Cd, Cu, Pb, and Zn are soluble, and <1 percent of the barium (Ba) are soluble in 48 hours.

In addition to laboratory studies, field studies have also been conducted to examine the role that barite plays in sediment Hg levels. Concentrations of total mercury in uncontaminated estuarine and marine sediments generally are 0.2 micrograms/gram (μg/g) dry weight or lower. Surface sediments collected 20-2,000 m (66-6,562 ft) 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 Gulf of Mexico OCS (Neff, 2002). A comparative study of surface and subsurface sediment samples from six offshore drill locations showed higher levels of total mercury found in the sediments closest to the drilling sites as compared with the sites greater than 3 km (1.9 mi) distant. Higher total mercury concentrations corresponded to higher barium concentrations also present. Higher total mercury levels in nearfield sediments did not translate to higher methyl-Hg concentration in those sediments, with a few exceptions (Trefry et al., 2007). Sediment redox conditions and organic content influence methylmercury formation. For more information on sediment and water quality, refer to **Chapter 4.2**.

3.1.5.1.1 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; well-treatment, completion, and workover compounds added downhole (including flowback water); and compounds used during the oil and water separation process. Formation water (brine) originates in the permeable sedimentary rock strata and is brought up to the surface commingled with the oil and gas. Injection water is water that was injected to enhance oil production and is used in secondary oil recovery. Flowback fluid (or water) is fluid that has been returned uphole after being injected into the formation for stimulation purposes. This includes water and chemicals used for hydraulic fracturing practices, as that would be considered a stimulation practice; fracture pack or "frac packs" are often used in the Gulf of Mexico during the completion process to clean and stimulate the area around the wellbore as well as for sand control (refer to **Chapter 3.1.3.1** for more information on hydraulic fracturing processes used offshore in the Gulf of Mexico).

In addition to the added chemical products, produced water contains chemicals that have dissolved into the water from the geological formation where the water was stored. The amount of dissolved solids can be more concentrated than is found in seawater. Produced water contains inorganic and organic chemicals and radionuclides (226Ra and 228Ra). The composition of the discharge can vary greatly in the amounts of organic and inorganic compounds.

Both USEPA Region 4 and Region 6 general permits allow the discharge of produced water on the OCS provided that they meet discharge criteria. The produced water is treated to separate free oil from the water. Since the oil and water separation process does not completely separate all of the oil, some hydrocarbons remain with the produced water and often the water is treated to prevent the formation of sheen. Produced water may be discharged if the oil and grease concentration does not exceed 42 milligrams per liter (mg/L) daily maximum or 29 mg/L monthly average. The discharge must also be tested for toxicity. Both USEPA Region 4 and Region 6 permits require no discharge within 1,000 m (3,281 ft) of an area of biological concern. Region 4 also requires no discharge within 1,000 m (3,281 ft) of any federally designated dredged material ocean disposal site.

As noted above, completion fluids, including fluids from fracture packs or "frac-packs," not returned to the deck of the platform during the completion job may be co-mingled and discharged with produced water if they meet the conditions of the appropriate NPDES permit. However, if the fluid composition is not compatible with the production system, the operator may decide to separate the returning well fluids from the production fluids and treat the fluids in temporary treatment systems or collect the fluids for onshore disposal depending upon logistics (e.g., treatability of well fluid, volume of fluid, personnel limitations, treatment unit capacity, space on deck, weather, etc.).

The USEPA Region 6 NPDES permit required participation in the Produced Water Hypoxia Study, in which produced water was collected from 50 platforms that discharge into the hypoxic zone and analyzed for oxygen-demanding characteristics (Veil et al., 2005; Rabalais, 2005). The mean biochemical oxygen demand was 957 mg/L, total organic carbon was 564 mg/L, and total Kjeldahl nitrogen was 83 mg/L in produced waters from the platforms located within the hypoxic zone. Samples from platforms that produced mostly gas had higher average biological oxygen demand and total organic carbon concentrations but smaller volumes than platforms that produced mostly oil. About 508,000 bbl/day produced water was generated per day in the hypoxic zone in 2003. The estimated biological oxygen demand loading is 104,000 lb/day. In comparison to loadings from the Mississippi and Atchafalaya Rivers, the total nitrogen loading from produced water is about 0.16 percent and total phosphorus loading is about 0.013 percent of the nutrient loading coming from the rivers. For more information on hypoxia and water quality in the Gulf of Mexico, refer to **Chapters 3.3.2.12 and 4.2**.

Estimates of the volume of produced water generated per well vary because the percent of water is related to well age and hydrocarbon type. Usually, produced-water volumes are small during the initial production phase and increases over time as the formation approaches hydrocarbon depletion. Produced-water volumes range from 2 to 150,000 bbl/day (USEPA, 1993a). 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. However, the vast majority of produced water is discharged per the conditions of the relevant U.S. Environmental Protection Agency NPDES permit. For example, in 2007, 48,673,102 bbl were used for enhanced recovery purposes, 1,298,417 bbl of produced water were reinjected, and 537,352,846 bbl were discharged after treatment (Clark and Veil, 2009). In 2012, of a total produced-water volume of 509,159,846 bbl, 52,043,434 bbl were injected while an estimate of 457,116,412 bbl were discharged (Veil, 2015).

BOEM maintains records of the volume of water produced from each block on the OCS and its disposition—injected on lease, injected off lease, transferred off lease, or discharged overboard. The amount discharged overboard for the years 2000-2014 is summarized by water depth in **Table 3-9**. The total volume for all water depths during this 15-year period ranged from 485.6 to 648.2 MMbbl, with the largest contribution (68-88%) coming from operations on the shelf. The total volume of produced water generally decreased after 2004, reflecting an overall decrease in contributions from operations on the shelf. The contribution of produced water from operations in deep water (>400-m [1,312-ft] water depth) and ultra-deepwater (>1,600-m [5,249-ft] water depth) production has been increasing. From 2000 to 2014, the contribution from these operations (deep and ultra-deepwater together) increased from 6 percent (37.8 MMbbl) to 31 percent (150.0 MMbbl) of the total produced-water volume (calculated from data in **Table 3-9**). The low-temperature and high-pressure conditions found in deeper water can result in flow problems such as hydrate formation in the lines. Additional quantities of chemicals are used to assure production, and even with recovery systems, some of these chemicals will be present in produced water (USDOI, MMS, 2000a). For deepwater operations, new technologies are being developed that may discharge or reinject produced water at the seafloor or at "minimal surface structures" before the production stream is transported by pipeline to the host production facility.

Table 3-9. Annual Volume of Produced Water Discharged by Depth (millions of bbl).

Year	Shelf 0-60 m	Shelf 60-200 m	Slope 200-400 m	Deepwater 400-800 m	Deepwater 800-1,600 m	Ultra-Deepwater 1,601-2,400 m	Ultra-Deepwater >2,400 m	Total
2000	370.6	193.1	35.5	25.6	12.2	0.0	0.0	637.0
2001	364.2	185.2	35.0	32.0	16.6	0.0	0.0	633.0
2002	344.6	180.4	32.5	35.2	21.4	0.0	0.0	614.1
2003	359.4	182.9	31.2	39.0	35.5	0.2	0.0	648.2
2004	346.7	160.5	29.3	36.9	39.2	1.8	0.0	614.4
2005	270.0	113.5	23.1	33.5	43.0	5.8	0.0	488.9
2006	260.3	99.6	20.6	35.1	61.6	12.4	0.0	489.6
2007	307.0	139.3	22.2	40.0	70.6	15.5	0.1	594.7
2008	252.7	118.6	15.9	32.7	60.1	16.1	0.1	496.3
2009	265.2	109.2	19.9	39.2	65.6	25.0	0.1	524.2
2010	278.4	115.7	20.9	40.7	56.8	32.5	0.1	545.1
2011	273.7	117.0	20.7	39.7	67.7	32.2	0.1	551.1
2012	240.7	108.9	20.0	35.0	71.4	32.3	0.1	509.2
2013	248.8	104.2	20.0	33.1	75.9	36.9	0.3	519.2
2014	226.6	91.9	17.1	32.0	72.1	45.0	0.9	485.6

Source: Gonzales, official communication, 2015.

3.1.5.1.2 Well-Treatment, Workover, and Completion Fluids

Wells are drilled using a base fluid and a combination of other chemicals to aid in the drilling process. Fluids (drilling muds) present in the borehole can damage the geologic formation in the producing zone. Completion fluids are used to displace the drilling fluid and protect formation permeability. "Clear" fluids consist of brines made from seawater mixed with calcium chloride, calcium bromide, and/or zinc bromide. These salts can be adjusted to increase or decrease the density of the brine to hold back-pressure on the formation. Additives, such as defoamers and corrosion inhibitors, are used to reduce problems associated with the completion fluids. Recovered completion fluids can be recycled for reuse.

Workover fluids are used to maintain or improve existing well conditions and production rates on wells that have been in production. Workover operations include casing and subsurface equipment repairs, re-perforation, acidizing, and stimulating via hydraulic fracturing. In the Gulf of Mexico, the type of hydraulic fracturing commonly used are fracture-pack or "frac packs" (refer to **Chapter 3.1.3.1** for more information on these processes). During some of the workover operations, the producing formation may be exposed, in which case fluids like the aforementioned completion fluids are used. In other cases, such as acidizing and hydraulic fracturing, including "frac-packs" (also considered stimulation or well treatment), hydrochloric and other acids are used. Both procedures are used to increase the permeability of the formation. The acids dissolve limestone, sandstone, and other deposits. Because of the corrosive nature of acids, particularly when hot, corrosion inhibitors are added. Since the fluids are altered with use, they are not recovered and recycled; however, these products may be mixed with the produced water and disposed of as described in **Chapter 3.1.5.1.2** above.

Production treatment fluids are chemicals applied during the oil and gas extraction process. Production chemicals are used to dehydrate produced oil or treat the associated produced water for reuse or disposal. A wide variety of chemicals are used, including corrosion and scale inhibitors, bactericides, paraffin solvents, demulsifiers, foamers, defoamers, and water treatment chemicals (Boehm et al., 2001). Some of the production chemicals mix with the production stream and are transported to shore with the product. Other chemicals mix with the produced water. Most produced water cannot be discharged without some chemical treatment. Even water that is reinjected downhole must be cleaned to protect equipment. The types and volumes of chemicals that are used changes during the life of the well. In the early stages, defoamers are used. In the later stages, when more water than oil is produced, demulsifiers and water-treatment chemicals are used more extensively.

Boehm et al. (2001) discusses completion, stimulation, and workover chemicals that are used in the Gulf of Mexico. These same chemicals are used for fracturing, including "frac packs," gravel packs, and acidizing processes. The report lists and defines the types of chemicals used as well as providing examples for each category of chemical (Boehm et al. (2001), Table 3). BOEM has included an update to this study in their 2015-2017 Studies Development Plan (http://www.boem.gov/Environmental-Studies-Planning/). After the fluids used for fracturing have performed their desired function, they are disposed of in the same manner as completion fluids or may be combined with the produced water. If the fluids return topside as a part of the completion job, they are considered waste completion fluids and would be disposed of as such. After the completion job is finished, the fluid is removed from the tubing in the well in order to begin producing hydrocarbons; this fluid may be comingled with the produced water and discharged per the requirements for produced water.

Both USEPA Regions 4 and 6 allow the discharge of well-treatment, completion, and workover fluids if they meet the condition of the NPDES permits. Both USEPA Regions 4 and 6 prohibit the discharge of well-treatment, completion, and workover fluid with additives containing priority pollutants (e.g., benzene, toluene, lead, and mercury; the full list of priority pollutants can be found in Appendix A of 40 CFR part 423). Additives containing priority pollutants must be monitored. Some well-treatment, workover, and completion chemicals are discharged with the drilling muds and cuttings or with the produced-water streams. These discharges must meet the general toxicity limits in the NPDES general permit. Discharge and monitoring records must be kept.

3.1.5.1.3 Production Solids and Equipment

As defined by the USEPA in the discharge guidelines (*Federal Register*, 1993), produced sands are slurried particles, which surface from hydraulic fracturing, and the accumulated formation sands and other particles including scale, which is 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 the USEPA (1993). A variety of solid wastes are generated, including construction/demolition debris, garbage, and industrial solid waste. No equipment or solid waste from a facility may be disposed of in marine waters.

3.1.5.1.4 Bilge, Ballast, and Fire Water

Bilge, ballast, and fire water all constitute minor discharges generated by offshore oil and gas production activities, which are allowed to be discharged to the ocean, as long as the USEPA's guidelines are followed. Uncontaminated bilge and ballast water are included in the miscellaneous discharges category of the USEPA Region 4 and Region 6 general permits (USEPA 2010 and 2012). Ballast water is untreated seawater that is taken on board a vessel to maintain stability. Ballast water contained in segregated ballast tanks never comes into contact with either cargo oil or fuel oil. Newly designed and constructed floating storage platforms use permanent ballast tanks, in which the ballast in those tanks rarely becomes contaminated. Bilge water is seawater that becomes contaminated with oil and grease and with solids such as rust when it collects at low points in the facility. With the right equipment on board, dirty bilge and ballast water can be processed in a way that separates most of the oil from the water before it is discharged into the sea (USEPA, 1993a). The discharge of any oil or oily mixtures is prohibited under 33 CFR § 151.10. The USEPA requires monitoring for visual sheen related to miscellaneous discharges, such as bilge and ballast water.

Offshore drilling rigs and the offshore production facilities used to process oil have special fire protection requirements. Fire water is defined in the USEPA Region 4 and Region 6 general permits as excess seawater or freshwater that permits the continuous operation of fire control pumps, as well as water released during training of personnel in fire protection. Fire control system test water is seawater, sometimes treated with a biocide that is used as test water for the fire control system on offshore platforms. This test water is discharged directly to the sea as a separate waste stream (USEPA, 1993a). As well, fire protection can also include a barrier of water that is sometimes used during flaring to provide protection between flaring systems and personnel, equipment, and facilities. The USEPA Region 4 and Region 6 general permits allow for the discharge of fire water that meets their specified limitations. The requirements include regulations and monitoring for treatment chemicals, discharge rate, free oil, and toxicity.

3.1.5.1.5 Cooling Water

Cooling water is defined as water used for contact or noncontact cooling, including water used for equipment cooling, evaporative cooling tower makeup, and dilution of effluent heat content. Seawater is drawn through an intake structure on the drilling rig, ship, or platform to cool power generators and other machinery, and produced oil or water. Drillship cooling water structures have been noted to intake 16-20 million gallons/day while semisubmersibles have been noted to intake 2 to over 10 million gallons/day from a water depth >400 ft (122 m) from the water's surface (USEPA, 2006). However, newer semisubmersible units were noted to have an intake capacity of 35 million gallons per day. Not all intake water is necessarily used as cooling water; some may be use for ballast water, cleaning, firewater, and testing. Organisms may be killed through impingement or entrainment. When fish and other aquatic life become trapped against the screen at the entrance to the cooling water intake structure through the force of the water being drawn through the intake structure, it is termed impingement. When eggs and larvae are sucked into the heat exchanger and eventually discharged from the facility, it is termed entrainment (**Chapter 4.7**; *Federal Register*, 2006a).

The Clean Water Act, Section 316 (b) Phase III, established categorical regulations for offshore oil and gas cooling water intake structures. The NPDES permit began incorporating these regulations in NPDES General Permit GMG290000 for the USEPA Region 6 in 2007 and General Permit GEG460000 for the USEPA Region 4 in 2010 for new facilities that began construction after July 17, 2006, and that take in more than 2 million gallons per day of seawater, of which more than 25 percent is used for cooling (USEPA, 2010 and 2012). The requirements have several tracks depending on whether the facility is a fixed or nonfixed facility and whether it has a sea chest intake or not. Some of the requirements include cooling water intake structure design requirements to meet a velocity of <0.5 ft (0.2 m) per second, construction to minimize impingement and/or entrainment, entrainment monitoring, recordkeeping, and completion of a source water biological study. Alteration to a sea chest intake structure on a mobile facility could render the facility less seaworthy, so it is not required. The requirements include a baseline study that characterizes the biological community in the vicinity of the structure or monitoring. A Joint Industry Biological Baseline Study was completed for USEPA Region 6 in June 2009 (LGL Ecological Research Associates, Inc., 2009), and an industry-wide cooling water intake structure entrainment monitoring study, approved by USEPA Region 6, was completed in 2014 (CSA and LGL Ecological Research Associates, Inc., 2014). For more information on the specifics regarding potential impacts to fisheries, refer to **Chapter 4.7**.

3.1.5.1.6 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's 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 GOM platforms during 1982-1983 determined that deck drainage averaged 50 bbl/day/platform (USEPA, 1993a). The deck drainage is collected, the oil is separated, and the water is discharged to the sea.

3.1.5.1.7 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 (14 mi; 22 km) from the 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 would discharge 35 gallons/person/day of treated sanitary wastes and 50-100 gallons/person/day of domestic wastes (USEPA, 1993a). It is assumed that these discharges are rapidly diluted and dispersed.

3.1.5.1.8 Minor/Miscellaneous Discharges

Minor and miscellaneous discharges include all other discharges not already discussed that may result during oil and gas operations. Minor or miscellaneous wastes may include desalination unit discharge, blowout preventer fluid, boiler blowdown, excess cement slurry, uncontaminated freshwater and saltwater, and miscellaneous discharges at the seafloor, such as subsea wellhead preservation and production control fluid, umbilical steel tube storage fluid, leak tracer fluid, and riser tensioner fluids. These discharges are regulated by the USEPA Region 4 and Region 6 NPDES permits. 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.

3.1.5.2 Operational Wastes and Discharges Generated by Service Vessels

Service vessels are discussed in **Chapter 3.1.4.4**. Discharges from supply/service vessels equal to or greater than 79 ft (24 m) in length are regulated by the U.S. Environmental Protection Agency's NPDES under the Vessel General Permit (VGP). The Final 2013 VGP was issued on March 28, 2013, became effective on December 19, 2013, and expires on December 19, 2018 (USEPA, 2013a). The Final 2013 VGP regulates 26 specific discharge categories, including numeric ballast-water discharge limits for most vessels, and ensures that ballast-water treatment systems are functioning correctly.

Discharges incidental to the normal operation of nonmilitary, nonrecreational vessels less than 79 ft (24 m) (i.e., "small vessels"), operating in a capacity as a means of transportation, are regulated under the Small Vessel General Permit (sVGP). The Final 2014 sVGP was issued on September 10, 2014, became effective on December 19, 2014, and will expire on December 18, 2019 (USEPA, 2014a). The USEPA issued the sVGP in anticipation of the December 18, 2014, expiration date of the then-existing moratorium on permitting small vessels, which specified that neither the USEPA nor the States may require NPDES permits, other than for ballast water, for incidental discharges from these small vessels. However, on December 18, 2014, President Obama signed into law the Howard Coble Coast Guard and Maritime Transportation Act of 2014, which extended that moratorium until December 18, 2017. Ballast-water discharges from small vessels still require NPDES permit coverage under the sVGP.

Operational wastes generated from supply/service vessels that support OCS oil- and gas-related operations include bilge and ballast waters (**Chapter 3.1.5.1.5**), trash and debris (**Chapter 3.1.5.3.4**), and sanitary and domestic wastes (**Chapter 3.1.5.1.8**).

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 (14 mi; 22 km) from land if the oil concentration is less than 100 ppm. Discharges may occur less than 12 nmi (14 mi; 22.5 km) of land 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). Ballast water discharged from ships is one of the pathways for the introduction and spread of aquatic nuisance species. To address this issue, the USCG's ballast-water discharge standard final rule, which was published on March 23, 2012 (*Federal Register*, 2012) and became effective on June 21, 2012, established a standard for the allowable concentration of living organisms in ballast water discharged from ships in U.S. waters.

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-millimeter (mm) (1-in) 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 that complies with 40 CFR part 140 and 33 CFR part 159. Vessels complying with 33 CFR part 159 are not subject to State and local marine sanitation device 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 under the NPDES in the Gulf of Mexico. Gray water should not be processed through the marine sanitation device, which is specifically designed to handle sewage.

3.1.5.3 Onshore Disposal of Waste and Discharge Generated Offshore or Onshore

3.1.5.3.1 Onshore Disposal of Wastes Generated from OCS Oil- and Gas-Related Facilities

Most wastes, other than produced water and water-based drilling muds and cuttings, are regulated by the USEPA and must be transported to shore or reinjected downhole. Additionally, wastes may be disposed of onshore because they do not meet permit requirements or because onshore disposal is economically advantageous. Wastes that are typically transported to shore include produced sand, aqueous fluids such as wash water from drilling and production operations, naturally occurring radioactive materials such as tank bottoms and pipe scale, industrial wastes, municipal wastes, and other exploration and production wastes (Dismukes, 2010). Most OBF muds and some SBF muds are recycled. If the physical and chemical properties of muds degrade, they may be disposed of or treated and reused for purposes other than drilling, instead of being recycled. Different reuses of treated muds include, among others, fill material, daily cover material at landfills, aggregate or filler in concrete, and brick or block manufacturing. The OBF cuttings are disposed of onshore or are injected onsite (USEPA, 1999). Both USEPA Regions 4 and 6 permit the discharge of SBF-wetted cuttings, provided the cuttings meet the criteria with regard to percent SBF retained, PAH content, biodegradability, and sediment toxicity. The SBF is either recycled or transferred to shore for regeneration and reuse or disposal. For information on OBF or SBF, refer to **Chapter 3.1.5.1.1**. Drill cuttings contaminated with hydrocarbons from the reservoir fluid must be disposed of onshore or reinjected.

The USEPA allows treatment, workover, and completion fluids to be commingled with the produced-water stream if the combined produced-water/ treatment, workover, and completion 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 treatment, workover, and completion fluids with the produced-water stream to meet NPDES requirements (USEPA, 1993b). Spent treatment, workover, and completion 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 treatment, workover, and completion wastes are transferred to commercial waste-treatment facilities and disposed of in 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 would generate about 150 bbl of completion fluid.

Operators are prohibited in the GOM 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, 1993b). Refer to **Chapter 3.1.5.1.4** for more information on produced sands. Both Texas and Louisiana have State oversight of exploration and production waste-management facilities (Veil, 1999).

3.1.5.3.2 Onshore Disposal and Storage Facilities Supporting OCS-Generated Operational Wastes

BOEM-funded research by Dismukes et al. (2007) further supports past conclusions that existing solid-waste disposal infrastructure is adequate to support both existing and projected offshore oil and gas drilling and production needs. Recently, there is a trend toward incorporating more innovative methods for waste handling in an attempt to reduce the chance of adverse environmental impacts. Some of these innovative methods include hydrocarbon recovery/recycling programs, slurry fracture injection, treating wastes for reuse as road base or levee fill, and segregating waste streams to reduce treatment time and improve oil recovery (Dismukes, 2011b). Research shows that the volume of OCS-generated waste is closely correlated with the level of offshore drilling and production activity. For each alternative (A, B, C, or D), existing onshore facilities would continue to be used to dispose of wastes generated offshore. However, no new disposal facilities are expected to be licensed as a direct result of Alternative A, B, C, or D. There is no current expectation for new onshore waste disposal facilities to be authorized and constructed during the 2017-2066 period as a direct result of each alternative (A, B, C, or D). If needed, existing facilities may undergo expansion, but no new disposal facilities are expected.

3.1.5.3.3 Discharges from Onshore Support Facilities

The primary onshore facilities that support offshore oil- and gas-related activities include service bases, helicopter hubs at local ports/service bases, construction facilities (i.e., platform fabrication yards, pipeyards, and shipyards), processing facilities (i.e., refineries, gas processing plants, and petrochemical plants), and terminals (i.e., pipeline shore facilities, barge terminals, and tanker port areas). Water discharges from these facilities are from either point sources, such as a pipe outfall, or nonpoint sources, such as rainfall run-off from paved surfaces. The USEPA or the USEPA-authorized State program regulates point-source discharges as part of the NPDES. Facilities are issued general or individual permits that limit discharges specific to the facility type and the waterbody receiving the discharge. Other wastes generated at these facilities are handled by local municipal and solid-waste facilities, which are also regulated by the USEPA or an USEPA-authorized State program.

3.1.5.3.4 Beach Trash and Debris

The discharge of marine debris by the offshore oil and gas industry and supporting activities is subject to a number of laws and treaties. These include the Marine Debris Research, Prevention, and Reduction Act; the Marine Plastic Pollution Research and Control Act; and the MARPOL-Annex V treaty. Regulation and enforcement of these laws is conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and USCG. The BSEE policy regarding marine debris prevention is outlined in NTL 2015-BSEE-G03, "Marine Trash and Debris Awareness and Elimination." This NTL instructs OCS operators to post informational placards that outline the legal consequences and potential ecological harms of discharging marine debris. This NTL also states that OCS workers should complete annual marine debris prevention training; operators are also instructed to develop a certification process for the completion of this training by their workers.

These various laws, regulations, and NTL would likely minimize the discharge of marine debris from OCS operations.

3.1.6 Decommissioning and Removal Operations

During exploration, development, and production operations, the seafloor around activity sites within a proposed lease sale area becomes the repository of temporary and permanent equipment and structures. Regulations and processes related to structure and site clearance are discussed in **Appendix A.13**. The structures are generally grouped into two main categories depending upon their relationship to the platform/facilities (i.e., piles, jackets, caissons, templates, mooring devises, etc.) or the well (i.e., wellheads, casings, casing stubs, etc.).

A varied assortment of severing devices and methodologies has been designed to cut structural targets during the course of decommissioning activities. These devices are generally grouped and classified as either nonexplosive or explosive, and they can be deployed and operated by divers, ROVs, or from the surface. Which severing tool the operators and contractors use takes into consideration the target size and type, water depth, economics, environmental concerns, tool availability, and weather conditions.

Nonexplosive severing tools are used on the OCS for a wide array of structure and well decommissioning targets in all water depths. Based on 10 years of historical data (1994-2003), nonexplosive severing is employed exclusively on about 58 (~37%) removals per year (USDOI, MMS, 2005). Since many decommissionings use both explosive and nonexplosive technologies (prearranged or as a backup method), the number of instances may be much greater. Common nonexplosive severing tools consist of abrasive cutters (e.g., sand cutters and abrasive water jets), mechanical (carbide) cutters, diver cutting (e.g., underwater arc cutters and the oxyacetylene/oxy-hydrogen torches), and diamond wire cutters.

With the exception of minor air and water quality concerns (i.e., exhaust from support equipment and toxicity of abrasive materials), nonexplosive severing tools generally cause little to no environmental impacts; therefore, there are very few regulations regarding their use. However, the use of nonexplosive cutters leads to greater human health and safety concerns, primarily because (1) divers are often required in the methodology (e.g., torch/underwater arc cutting and external tool installation and monitoring), (2) more personnel are required to operate them (increasing their risks of injury in the offshore environment), (3) lower success rates require that additional cutting attempts be made, and (4) the cutters can only sever one target at a time, taking on average 30 minutes to several hours for a complete cut (USDOI, MMS, 2005). The last two items are often hard to quantify and to assign risks to the cutters, but the main principle is that there is a linear relationship between the length of time any offshore operation is staged and on-site (exposure time) and the potential for an accident to occur (Twachtman, Snyder, & Byrd, Inc. and Louisiana State University, Center for Energy Studies, 2004). Therefore, even if there are no direct injuries or incidents involving a diver or severing technicians, the increased “exposure time” needed to successfully sever all necessary targets could result in unrelated accidents involving other barge/vessel personnel.

Explosive severance tools can be deployed on almost all structural and well targets in all water depths. Historically, explosive charges are used in about 98 (~63%) decommissioning operations annually (USDOI, MMS, 2005), often as a back-up cutter when other methodologies prove unsuccessful. Explosives work to sever their targets by using (1) mechanical distortion (ripping), (2) high-velocity jet cutting, and (3) fracturing or “spalling.”

Mechanical distortion is best exhibited with the use of explosives such as standard and configured bulk charges. If the situation calls for minimal distortion and an extremely clean severing, then most contractors rely upon the jet-cutting capabilities of shaped charges. In order to “cut” with these explosives, the specialized charges are designed to use the high-velocity forces released at detonation to transform a metal liner (often copper) into a thin jet that slices through its target. The least used method of severing currently in use on the Gulf of Mexico OCS is fracturing, which uses a specialized charge to focus pressure waves into the target wall and use refraction forces to spall or fracture the steel on the opposing side (NRC, 1996).

In water depths >800 m (2,625 ft), OCS regulations offer the lessees the option to avoid the jetting by requesting alternate removal depths for well abandonments (30 CFR § 250.1716(b)(3)) and facilities (30 CFR § 250.1728(b)(3)). Above mudline cuts would be allowed for depths >800 m (2,625 ft), with reporting requirements on the remnant’s description and height off of the seafloor to BOEM; this is data necessary for subsequent reporting to the U.S. Navy. With the exception of several dynamically positioned vessels, deepwater drilling operations most often use moored semisubmersibles. Coupled with the growing number of TLPs, spars, and MODUs, operators and contractors have to contend with new demands for quick-disconnect and line severing tools that may be necessary during emergencies and decommissioning operations when the anchor cannot be retrieved.

Some of the mooring systems used in deepwater operations have quick-disconnect technology built into their designs. Using several varieties of exploding bolts, electromechanical couplings, and/or hydraulic-actuated connections, these release mechanisms can be controlled from the vessel and triggered on short notice. In situations where the mooring system disconnects were not employed or become disabled, severing contractors have several mechanical and explosive cutting tools at their disposal for shearing cables, lines, and chains from their moorings. Mechanical cutters such as wheel and guillotine saws, hydraulic shears, and diamond wire cutters can be deployed using ROVs, allowing the cuts to be performed as close to the anchors as possible. In much the same way, small explosive shaped-charge devices can be positioned onto the mooring targets by ROVs. These external cutters are generally designed with hydraulic/electric actuators and hinge systems that allow the shaped charge to be “clamped” over the target and then detonated after the ROV is removed to a safe distance. Together, these effective severing methods and the deep-diving capabilities of the ROVs allow for full recovery of the lines/cables/chains, which could present a future hazard to commercial fishing gear and navigation.

After bottom-founded objects are severed and the structures are removed, operators are required to use trawling or sonar searches to verify that the site is clear of any obstructions that may conflict with other uses. Refer to **Appendix A.13** for a more detailed discussion of site-clearance processes.

*Alternative A**: **Table 3-2** shows platform removals by water-depth subarea as a result of Alternative A. Of the 16-280 production structures estimated to be removed as a result of a proposed action under Alternative A, 9-193 production structures (installed landward of the 800-m [2,625-ft] isobath) could likely be removed using explosives. It is anticipated that multiple appurtenances would not be removed from the seafloor if placed in waters exceeding 800 m (2,625 ft). An estimate of the well stubs and other various subsea structures that may be removed using explosives is not possible at this time. For the purposes of impact assessment, the prudent assumption should be that charges used for well severance behave in the same manner and produce parameters of the same magnitude as do charges detonated on the bottom in open water.

Alternative B*: **Table 3-2** shows platform removals by water-depth subarea as a result of Alternative B. Of the 14-247 production structures estimated to be removed as a result of Alternative B, 7-172 production structures (installed landward of the 800-m [2,625-ft] isobath) could likely be removed using explosives. It is anticipated that multiple appurtenances would not be removed from the seafloor if placed in waters exceeding 800 m (2,625 ft).

*Alternative C**: **Table 3-2** shows platform removals by water-depth subarea as a result of Alternative C. Of the 9-33 production structures estimated to be removed as a result of Alternative C, 4-21 production structures (installed landward of the 800-m [2,625-ft] isobath) could likely be removed using explosives. It is anticipated that multiple appurtenances would not be removed from the seafloor if placed in waters exceeding 800 m (2,625 ft).

*Alternative D could reduce activity values of the combined Alternative A, B, or C by up to 4 percent. Refer to **Chapter 2.2.2.4** for more information.

3.1.6.1 Structure Age and Idle Iron

The Bureau of Ocean Energy Management, Regulation and Enforcement issued NTL 2010-G05 to establish guidelines for decommissioning structures within the timeframes established by regulations, conditions of approval, and lease instruments.

Federal regulations require that offshore leases be cleared of all structures within 1 year after production on the lease ceases, but a producing lease can hold infrastructure idle for as long as the lease is producing (30 CFR § 250.112). Refer to **Chapter 3.1.6 and Appendix A.13** for more information on decommissioning. As of 2015, the average age of all removed offshore structures was 19 years. Simpler structures like caissons had an average lifespan of 17 years when decommissioned, and more complex structures like fixed platforms had an average lifespan of 20 years. The average age of all active platforms is 29 years. Although accidents, storm damage, and unforeseen geological problems may cause platforms to be removed early, the discrepancy between the assumed and actual life of platforms is probably explained by the end of economic production from the field rather than by design or engineering factors unique to each platform. Any infrastructure that is decommissioned and no longer "economically viable," severely damaged, or idle on active leases is considered "idle iron" according to NTL 2010-G05, "Decommissioning Guidance for Wells and Platforms."

The BSEE's idle iron policy keeps inactive facilities and structures from littering the Gulf of Mexico by requiring companies to dismantle and responsibly dispose of infrastructure after they plug nonproducing wells. BSEE enforces these lease agreements primarily for two reasons beyond the CFR requirement:

- Environmental Effects – Toppled structures pose a potential environmental hazard due to the topsides and the associated equipment, electronics, wiring, piping, tanks, etc., that are left on the bottom of the Gulf of Mexico. These items pose a financial, safety, and environmental burden, and must be removed from the bottom.
- Safety – Severe weather such as hurricanes have toppled, severely damaged, or destroyed the structures associated with oil and gas production. While any structure could be destroyed during a hurricane, idle facilities pose an unnecessary risk of leaks from wells into the environment and potential damage to the ecosystem, passing ships, and commercial fishermen.

The typical life span of a pipeline has been estimated to be 20-40 years, but with current corrosion management, that lifetime has been substantially increased. One technique for extending the life of a gas pipeline is to coat the inside of the pipe periodically with a corrosion-inhibiting substance. The coating may be applied as either an aerosol pumped in with the production stream or as a liquid "slug" pushed through the pipe with a pig. The slug treatment provides greater protection (Cranswick, 2001). Corrosion can lead to major accidents on platforms. In 2011, a platform owned by Mariner Energy, about 100 mi (161 km) off the Louisiana shore, was using a piece of steel heating equipment that had corroded over its 30-year life, causing it to leak hydrocarbons that ignited the platform (Sebastian, 2011).

Subsea wells, in which the wellhead, Christmas tree, and production-control equipment are all located on the seafloor, were introduced in the 1970's and started to grow especially popular in the 1980's and 1990's. Older generations of subsea wells had a designed life of 15-20 years, and many of those devices are reaching the end of that time span (Holeywell, 2014).

3.1.6.2 Rigs-to-Reefs Policy

Although BSEE supports and encourages the reuse of obsolete oil and gas structures as artificial reefs and is a cooperating agency in implementing the National Artificial Reef Plan, specific requirements must be met for a departure to be granted. More information on these regulations and processes can be found in **Appendix A.15**. Structure-removal permit applications requesting a departure under the Rigs-to-Reefs Policy undergo technical and environmental reviews. The policy document details the minimum engineering and environmental standards that operators/lessees must meet to be granted approval to deploy a structure as an artificial reef. Conditions of approval are applied as necessary to minimize the potential for adverse effects to sensitive habitat and communities in the vicinity of the structure and proposed artificial reef site. Additionally, structures deployed as artificial reefs must not threaten nearby structures or prevent access to oil and gas, marine mineral, or renewable energy resources.

Routine activities include the decommissioning of structures, but redeployment and reefing is considered a State activity. Refer to **Chapter 3.3.2.1.2** for more information on artificial reefs.

3.1.7 Coastal Infrastructure

The following chapters discuss coastal impact-producing factors and provide scenario projections for onshore coastal infrastructure that may potentially result from a proposed lease sale under Alternative A, B, or C in the 2017-2022 Five-Year Program. Under Alternative D, the number of blocks that would become unavailable for lease represents only a small percentage (<4%) of the total number of blocks to be offered under Alternative A, B, or C. Therefore, Alternative D could reduce offshore infrastructure and activities by up to 4 percent when chosen in conjunction with Alternative A, B, or C. However, it is also possible that Alternative D would only shift the location of offshore infrastructure and activities farther from sensitive topographic zones and not lead to a reduction in offshore infrastructure and activities. Refer to **Chapter 2.2.2.4** for more information on Alternative D. This discussion describes the potential need for new facility construction and for expansions at existing facilities. A detailed description of the baseline affected environment for land use and coastal infrastructure in the GOM can be found in **Chapter 4.14.1.1**.

Oil and gas exploration, production, and development activities on the OCS are supported by an expansive onshore infrastructure industry that includes large and small companies providing an array of services from construction facilities, service bases, and waste disposal facilities to crew, supply, and product transportation, as well as processing facilities. It is an extensive and mature system providing support for both offshore and onshore oil and gas activities in the GOM region (**Figure 3-10**). The extensive presence of this coastal infrastructure is not subject to rapid fluctuations and results from long-term industry trends. Existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. Should there be some expansion at current facilities, the land in the analysis area is sufficient to handle such development.

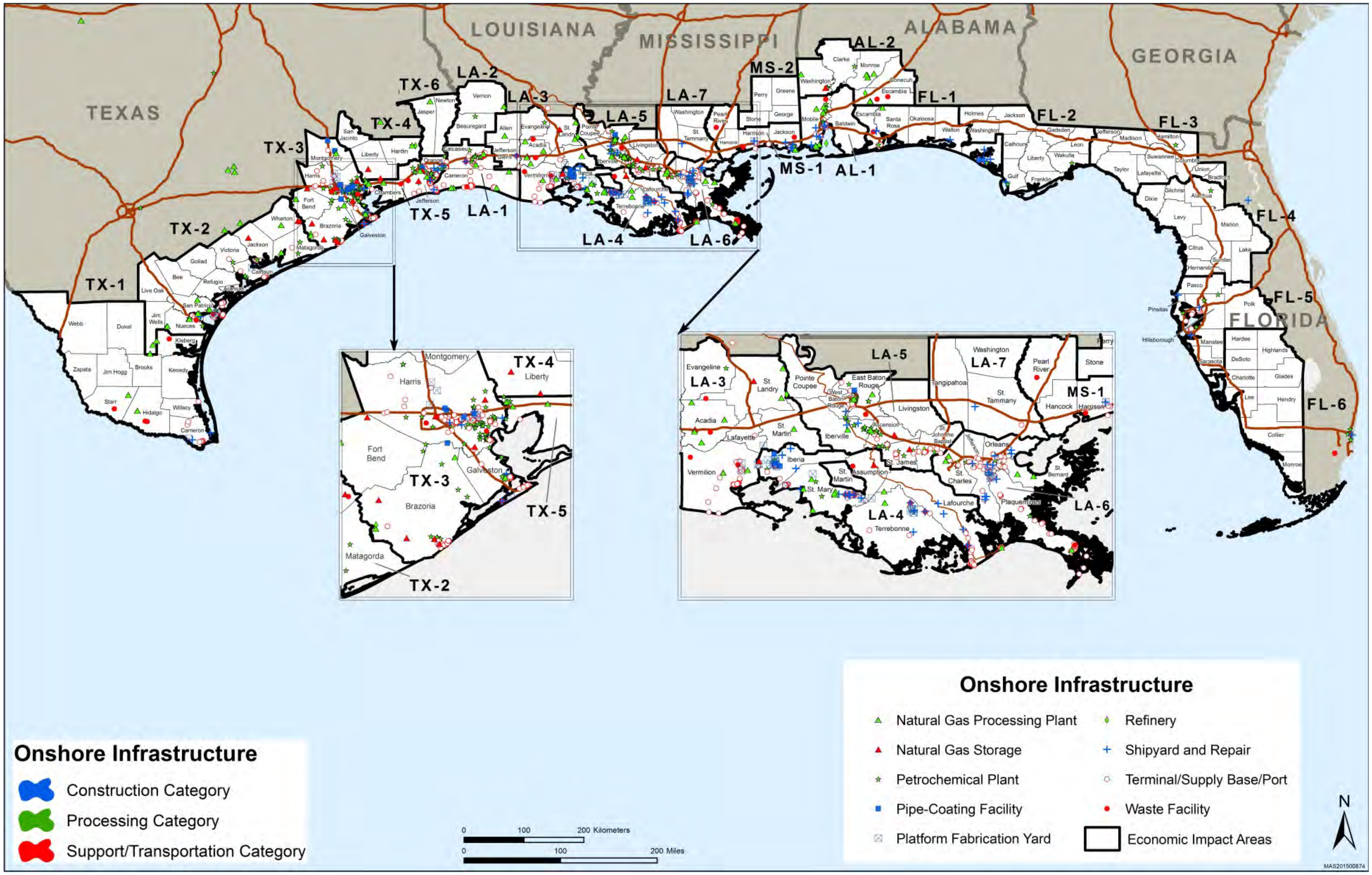

Figure 3-10. Onshore Infrastructure.

Impact-producing factors associated with coastal infrastructure include service bases, gas processing plants, pipeline landfalls, navigation channels, and waste disposal facilities. **Chapter 3.1.5.3** addresses onshore waste disposal. **Chapter 3.1.4.1** discusses pipeline landfalls. While no single proposed lease sale under Alternative A, B, or C is projected to substantially change existing OCS-related service bases or require any additional service bases, it would contribute to the use of existing service bases. Sufficient land exists to construct a new gas processing plant in the unlikely event that one should be needed. However, because the current spare capacity at existing facilities should be sufficient to satisfy new gas production, the need to construct a new facility would possibly materialize only toward the end of the life of a proposed action. Therefore, BOEM projects 0-1 new gas processing plants to result from a proposed lease sale under Alternative A, B, or C. While a proposed action would contribute to the continued need for maintenance dredging of existing navigation channels, a mature network of navigation channels already exists in the analysis area; therefore, no new navigation channel construction would be expected as a direct result of a proposed lease sale under Alternative A, B, or C (Dismukes, official communication, 2015).

BOEM continuously collects new data and monitors changes in infrastructure demands in order to support scenario projections that reflect current and future industry conditions. The scenario projections outlined below reflect the already well-established industrial infrastructure network in the GOM region and fluctuations in OCS oil- and gas-related activity levels. To prevent underestimating potential effects, BOEM makes conservative infrastructure scenario estimates; therefore, a projection of between 0 and 1 is more likely to be 0 than 1.

The following chapters provide the current trends, or outlook scenario projections, for the varied infrastructure categories. The primary sources for all of the information on coastal infrastructure and activities presented here are BOEM's Gulf of Mexico OCS Region's fact books: (1) *OCS-Related Infrastructure in the Gulf of Mexico Fact Book* (The Louis Berger Group, Inc., 2004); (2) *Fact Book: Offshore Oil and Gas Industry Support Sectors* (Dismukes, 2010); and (3) *OCS-Related Infrastructure Fact Book; Volume I: Post-Hurricane Impact Assessment* and *Volume II: Communities in the Gulf of Mexico* (Dismukes, 2011b).

3.1.7.1 Construction Facilities

3.1.7.1.1 Platform Fabrication Yards

Facilities where platforms (and drilling rigs) are fabricated are called platform fabrication yards. Most platforms are fabricated onshore and then towed to an offshore location for installation. When an oil and/or gas discovery occurs, an exploratory drilling rig would be either replaced with, or converted to, a production platform assembled at the site using a barge equipped with heavy lift cranes. Platform fabrication is highly dependent on the structural nature of the oil and gas industry. As oil prices fluctuate, platform fabrication yards adjust accordingly. When oil prices are low, they diversify their operations into other marine-related activities or scale back on the overall scope of their operations. The variety of diversification strategies may include drilling rig maintenance and re-builds, barge or vessel fabrication, dry-docking, or equipment survey.

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 the GOM region for many decades, existing fabrication yards possess a compelling force of economic concentration to prevent the emergence of new fabrication yards. There are 54 platform fabrication yards in the analysis area, with the highest concentration in Louisiana at 37 and followed by Texas at 12 (**Table 3-4**). Given the large size of offshore platforms, fabrication yards necessarily span several hundred acres. The location of platform fabrication yards is tied to the availability of a navigable channel sufficiently large enough to allow the towing of bulky and long structures, such as offshore drilling and production platforms. Thus, platform fabrication yards are located either directly along the Gulf Coast or inland along large navigable channels, such as the Intracoastal Waterway.

Alternative A, B, C, or D: No new facilities are expected to be constructed as a result of Alternative A, B, C, or D. The potential exists for some current yards to close, be bought out, or merge over the 50-year analysis period (2017-2066), resulting in fewer active yards in the analysis area.

3.1.7.1.2 Shipbuilding and Shipyards

There are several kinds of shipyards throughout the Gulf Coast region that build and repair all manner of vessels, many of which are not related to OCS oil- and gas-related activities. These marine vessels are perhaps the most important means of transporting equipment and personnel from onshore bases and ports to offshore drilling and production structures. The shipbuilding and repair industry has struggled over the last few decades. Since the mid-1990’s, there has been some industry stabilization, but the outlook for shipbuilding and shipyards is uncertain. The industry is overly dependent on military contracts and faces numerous economic challenges, such as the lack of international competitiveness, workforce development challenges, availability of capital, and the lack of research and development funding. In the GOM region, there is a direct correlation between OCS oil- and gas-related activities and the demand or opportunities for expanding shipbuilding and offshore support vessels. There are 137 shipyards located within the analysis areas (**Table 3-4**). To a great extent, growth would be based on a successful resolution of several pertinent issues that have affected and continue to affect shipbuilding in the U.S. and particularly in the analysis area: maritime policy; declining military budget; foreign subsidies; USCG regulations; Oil Pollution Act of 1990; financing; and an aging fleet. Generally, as oil and gas drilling and production increase, the demand for an expanded shipbuilding effort also increases. However, despite the drop in oil and gas prices at the end of 2014 and beginning of 2015, Louisiana-based Bollinger Shipyards began construction on four massive dry docks able to service 300-ft (91-m) or larger vessels (Jervis, 2015).

Alternative A, B, C, or D: No new facilities are expected to be constructed as a result of Alternative A, B, C, or D. There is more than an adequate supply of shipyard resources in the GOM region. Some shipyards may close, be bought out, or merge over the 50-year analysis period (2017-2066), resulting in fewer active yards in the analysis area.

3.1.7.1.3 Pipe-Coating Facilities and Yards

Pipe-coating plants generally receive manufactured pipe by rail or water at either their plant or pipeyard depending on their inventory capabilities. At the plant, pipes that transport oil and gas are coated on the interior and exterior to protect from corrosion and abrasion. There are 19 pipe-coating plants in the analysis areas (**Table 3-4**). 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 (12-m) segments. The coated pipe is stored (stacked) at the pipe yard until it is needed offshore.

To meet deepwater demand, pipe-coating companies were expanding capacity or building new plants before the *Deepwater Horizon* explosion, oil spill, and response; afterwards, activity levels dropped temporarily, then rebounded until the oil price drop and economic downturn of late 2014/early 2015, resulting in a decrease in OCS activity levels and less demand for pipe-coating services. As activity levels fluctuate in the GOM, the demands for pipe-coating services fluctuate accordingly.

Alternative A, B, C, or D: No new facilities are expected to be constructed as a result of Alternative A, B, C, or D. Current capacity, supplemented by expansions at already existing facilities, is anticipated to meet OCS Program demand.

3.1.7.2 Support Facilities and Transportation

3.1.7.2.1 Service Bases and Ports

A service base is a community of businesses that load, store, and supply equipment, supplies, and personnel needed at offshore work sites. A service base may also be referred to as a supply base or terminal and may be associated with a port. A proposed lease sale under Alternative A, B, or C is expected to utilize only those ports that currently have facilities used by the oil and gas industry as offshore service bases. Although a service base may primarily serve the adjacent OCS planning area and Economic Impact Areas (EIAs) in which it is located, it may also provide substantial services for the other OCS planning areas and EIAs. **Table 3-10** shows the 50 services bases organized by EIA, and **Figure 3-8** shows the geographic location of the service bases.

Table 3-10. OCS Oil- and Gas-Related Service Bases.

State	EIA	County/Parish		
Texas	TX-1	Port Isabel (Cameron)	Port Mansfield (Willacy)	
	TX-2	Aransas Pass (Nueces) Bayside (Aransas) Corpus Christi (Nueces)	Harbor Island (Nueces) Ingleside (San Patricio) Port Aransas (Nueces)	Port O'Connor (Calhoun) Rockport (Aransas)
	TX-3	Freeport (Brazoria) Galveston (Galveston)	Pelican Island (Galveston)	Surfside (Harris)
	TX-5	Port Arthur (Jefferson) Sabine Pass (Jefferson)		
Louisiana	LA-1	Cameron (Cameron)	Grand Chenier (Cameron)	Lake Charles (Calcasieu)
	LA-3	Amelia (St. Mary) Bayou Boeuf (St Mary)	Berwick (St. Mary)	Cocodrie (Terrebonne)
	LA-4	Amelia (St. Mary) Bayou Boeuf (St. Mary) Berwick (St. Mary) Cocodrie (Terrebonne) Dulac (Terrebonne)	Fourchon (Lafourche) Gibson (Terrebonne) Houma (Terrebonne) Leeville (Lafourche) Louisa (St. Mary)	Morgan City (St. Mary) New Iberia (Iberia) Patterson (St. Mary) Theriot (Terrebonne) Weeks Island (Iberia)
	LA-6	Empire (Plaquemines) Grand Isle (Jefferson)	Harvey (Jefferson) Hopedale (St. Bernard)	Paradis (St. Charles) Venice (Plaquemines)
Mississippi	MS-1	Pascagoula (Jackson)		
Alabama	AL-1	Bayou LaBatre (Mobile)	Mobile (Mobile)	Theodore (Mobile)
Florida	FL-1	Panama City (Bay)		

EIA = Economic Impact Area.

As the industry continues to evolve, so do the requirements of the onshore support network. With advancements in technology, the shore-side supply network would continue to be challenged to meet the needs and requirements. The intermodal nature of oil and gas operations gives ports (which traditionally have water, rail, and highway access) a natural advantage as ideal locations for onshore activities and intermodal transfers (**Figure 3-11**). Therefore, ports would 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.

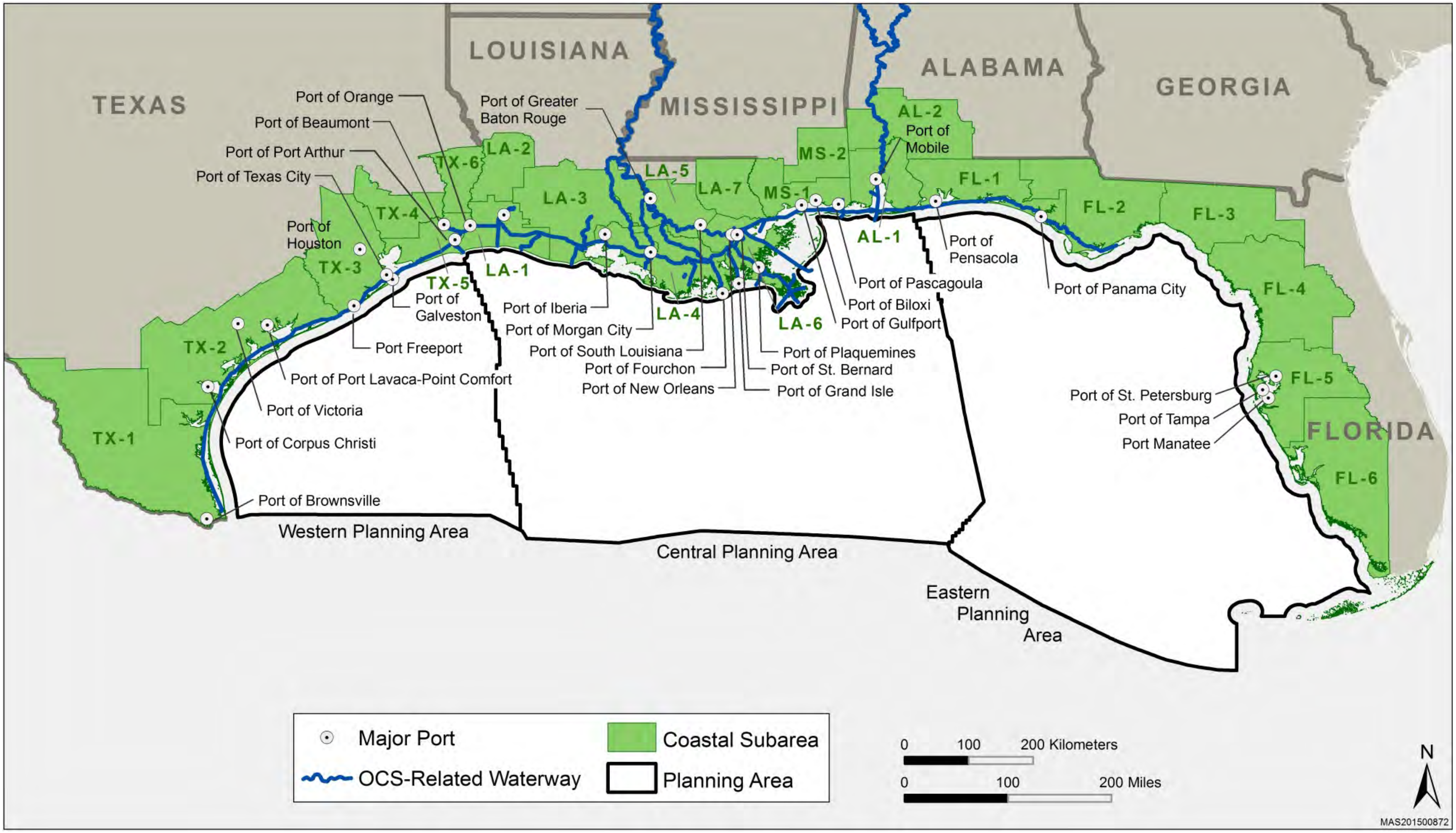

Figure 3-11. OCS-Related Ports and Waterways in the Gulf of Mexico.

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. In early 2015, for example, Louisiana-based Bollinger Shipyards was constructing four massive dry docks able to service 300-plus-foot (91-plus-meter) vessels at Port Fourchon while Schlumberger was expanding its Port Fourchon operations (Jervis, 2015). Some channels in and around the service bases would need to be deepened and expanded in support of deeper draft vessels and other port activities, some of which would be OCS related. Channel depths at most major U.S. ports typically range from 35 to 45 ft (11 to 14 m). The current generation of new large ships that service the offshore industry requires channels from 45 to 53 ft (14 to 16 m).

Alternative A, B, C, or D: Alternative A, B, C, or D would not change identified service bases or require any additional service bases. The OCS oil- and gas-related activities over the course of the 50-year analysis period (2017-2067) would continue to contribute to the ongoing trend of consolidating activities at specific ports, especially with respect to deepwater activities (i.e., Port Fourchon and Galveston).

3.1.7.2.2 Helicopter Hubs

There are 241 identified heliports within the GOM region that support OCS oil- and gas-related activities; 118 are located in Texas, 115 in Louisiana, 0 in Florida, 4 in Mississippi, and 4 in Alabama (**Table 3-4**). Industry consolidation has resulted in a small number of large helicopter service providers. The Gulf of Mexico is served primarily by three large operators, which account for nearly 80 percent of the aircraft available in the GOM. This industry is largely dependent on the level of production, development, and exploration in the GOM. Demand for helicopters increases with an increase in activity levels associated with oil and gas exploration, development, and production; however, as oil and gas companies seek to reduce costs with respect to air transportation services, the demand for these services is reduced. Greater total (and relative) deepwater activities in the GOM are forcing major changes on the transportation industry in the region. Helicopters must have the capability of traversing longer distances with more cargoes than were necessary in the past. Also, new technologies may permit companies to reduce staffing levels on both old and new installations, which could translate into less demand for helicopter services.

Alternative A, B, C, or D: No new helicopter hubs are projected as a result of a proposed lease sale or the OCS Program; however, if activity levels increase, they may expand at current locations. **Chapter 3.1.4.5** provides information on helicopter operation projections.

3.1.7.2.3 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 as destinations for shuttle tankers transporting crude oil from FPSO operations in the GOM: Houston or the Louisiana Offshore Oil Port are most likely candidates, followed by possibly Corpus Christi, Freeport, and Port Arthur/Beaumont, Texas, although it would be most likely for oil to be transported to Port Arthur/Beaumont via pipeline (Dismukes, official communication, 2011a). Tankers that offloaded oil from Petrobras' Cascade Chinook delivered to the following areas: Nederland, Texas; Pascagoula, Mississippi; Mobile, Alabama; Port Arthur, Texas; Garyville, Louisiana; Houston, Texas; Lake Charles, Louisiana; Saint Rose, Louisiana; Galveston Bar, Texas; Texas City, Texas; Corpus Christi, Texas; Baton Rouge, Louisiana; the Louisiana Offshore Oil Port; and Yabucoa, Puerto Rico.

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 could occur once every 3.3 days. This would equate to 54.75 MMbbl of production with 110 offloading events and shuttle-tanker transits to GOM coastal or offshore ports annually per FPSO.

Alternative A, B, C, or D: **Chapter 3.1.4.3** provides BOEM's current tankering projections. Tanker trips associated with Alternative A, B, C, or D would represent a small percentage of annual tanker trips into identified tanker ports. Therefore, no new tanker port facilities are projected to result from Alternative A, B, C, or D.

3.1.7.2.4 Barge Terminals

The OCS oil barged from offshore platforms to onshore barge terminals represents a small portion of the total amount of oil barged in coastal waters. While there is a tremendous amount of barging that occurs in the coastal State waters of the GOM, no estimates exist of the volume of this barging that is directly 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.

Alternative A, B, C, or D: Barging of OCS production is expected to remain stable. No major modifications or new barge terminals are expected to be constructed as a direct result of a proposed lease sale or OCS Program operations. **Chapter 3.1.4.2** provides BOEM's current barging projections.

3.1.7.2.5 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. Some processing may occur offshore at the platform; only onshore facilities are addressed in this discussion. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to the gas processing plant. Therefore, new pipeline shore facilities are projected to only result from oil pipeline landfalls. A pipeline shore facility may support one or several pipelines; therefore, new pipeline shore facilities are projected to only result from larger pipelines (>12 in; 30 cm). Although older facilities may be located in wetlands, current permitting programs prohibit or discourage companies from constructing any new facilities in wetlands. Also, it is more cost effective for companies to tie into the existing offshore pipeline network.

Alternative A, B, C, or D: No new pipeline shore facilities are projected as a result of Alternative A, B, C, or D, which would represent a small percent of the resources handled by existing shore facilities. **Chapter 3.1.4.1** provides BOEM's current pipeline landfall projections.

3.1.7.2.6 Navigation Channels

Coastal oil- and gas-related infrastructure in the GOM region includes a vast and complex system of navigation channels that have been in existence for decades. While a proposed lease sale under Alternative A, B, or C would contribute to the continued need for maintenance dredging of existing navigation channels, a mature network of navigation channels already exists in the analysis area; therefore, no new navigation channel construction would be expected as a direct result of a proposed lease sale under Alternative A, B, or C. Refer to **Chapter 3.1.4.6** for more information on navigation channels.

Alternative A, B, C, or D: No new navigation channels are expected to be constructed as a result of Alternative A, B, C, or D. **Chapter 3.1.4.6** provides BOEM's current scenario analysis for navigation channels.

3.1.7.2.7 Waste Disposal Facilities

A variety of different types of wastes are generated by offshore oil and gas exploration and production activities along the GOM. Some wastes are common to any manufacturing or industrial operation (e.g., garbage, sanitary waste [toilets], and domestic waste [sinks and showers]) while others are unique to the oil and gas industry (e.g., drill fluids and produced water). Most waste must be transported to shore-based facilities for storage and disposal. In the analysis area, there are 16 waste disposal facilities in Texas, 29 in Louisiana, 3 each in Mississippi and Alabama, and 2 in Florida. Refer to **Chapter 3.1.5.3** for more information.

Alternative A, B, C, or D: No new waste disposal facilities are expected to be constructed as a result of Alternative A, B, C, or D. **Chapter 3.1.5.3** provides BOEM's current scenario analysis for waste disposal facilities.

3.1.7.2.8 Natural Gas Storage Facilities

Most of the natural gas storage facilities in the GOM region are salt caverns. The overwhelming majority of all salt cavern storage facilities operating in the U.S. are located along the GOM. Gulf Coast salt caverns account for only 4.2 percent of total U.S. working gas capacity and 15.5 percent of total U.S. deliverability. In the GOM, Texas has 14 salt cavern sites with 78 billion cubic feet per day (Bcf/day) of working gas capacity and Louisiana has 7 sites with 48 Bcf/day of working gas capacity, Mississippi has 3 sites with 32 Bcf/day of working gas capacity, and Alabama has 1 site with 7 Bcf/day of working gas capacity (USDOE, Energy Information Administration, 2007). Not all of these facilities are located within the BOEM-defined EIAs. More specifically, there are 22 underground natural gas storage facilities in the BOEM-defined EIAs. These facilities total 165 Bcf/day of working gas capacity.

Alternative A, B, C, or D: No new natural gas storage facilities are projected as a result of Alternative A, B, C, or D. Any expansions or new facilities would be the result of onshore rather than offshore production.

3.1.7.3 Processing Facilities

The following chapters discuss various processing facilities, i.e., gas processing facilities, refineries, and LNG facilities. These are included as the final endpoint for OCS oil and gas; however, at the time that OCS product reaches these facilities, it has already been joined with non-OCS product from State waters and onshore activities. The percentage of oil and gas product processed by these facilities that actually originated from OCS waters has not been determined and is not likely to ever be possible to discover since it is due to a number of factors unrelated to the delivery of OCS product, such as downstream demand. Therefore, in contrast to most other infrastructure types, scenario projections for processing facilities are inherently limited with no direct correlation to OCS oil- and gas-related activities.

Alternative A, B, C, or D: It is most likely that existing facilities would experience equipment switch-outs, upgrades, or expansions to meet increases in demand. The OCS oil- and gas-related activities that result from Alternative A, B, C, or D would contribute to the likelihood of 0-1 new gas processing facilities.

3.1.7.3.1 Gas Processing Plants

All natural gas is processed in some manner to remove unwanted water vapor, solids, and/or other contaminants that would interfere with pipeline transportation or marketing of the gas. After processing, gas is then moved into a pipeline system for transportation to an area where it is sold. More than half (54%) of the natural gas processing plant capacity in the U.S. is located along the Gulf Coast and is available for supporting Federal offshore production (USDOE, Energy Information Administration, 2011). In the GOM region, the majority of gas processing plants are located in Louisiana (44) and Texas (39), followed by Alabama (13), Mississippi (1), and Florida (1) (**Table 3-4**). While natural gas production on the OCS shelf (shallow water) has been declining, deepwater gas production has been increasing, but not at the same pace. Overall, the combined trends of increasing onshore shale gas development, declining offshore gas production, and increasing efficiency and capacity of existing gas processing facilities have lowered demands for new gas processing facilities along the Gulf Coast. Spare capacity at existing facilities should be sufficient to satisfy new gas production for many years, although there remains a slim chance that a new gas processing facility may be needed by the end of the 50-year life of a proposed lease sale. Expectations for new gas processing facilities being built during the analysis period (2017-2066) are dependent on long-term market trends that are not easily predicable over the next 50 years (Dismukes, official communication, 2015).

> *Alternative A, B, C, or D:* It is most likely that existing facilities would experience equipment switch-outs, upgrades, or expansions to meet increases in demand. The OCS oil- and gas-related activities that result from Alternative A, B, C, or D would contribute to the likelihood of 0-1 new gas processing facilities.

3.1.7.3.2 Refineries

The U.S. Department of Energy's Energy Information Administration updates national energy projections annually, including refinery capacity. Most of the GOM region's refineries are located in Texas and Louisiana (**Table 3-4**). Texas EIAs contain 20 operable refineries, with an operating capacity of over 4.5 MMbbl/day, which is over 25 percent of the total U.S. capacity. Louisiana EIAs contain 16 operable refineries, with an operational capacity of over 3.2 MMbbl/day, which is over 18 percent of the total U.S. capacity (USDOE, Energy Information Administration, 2015c). There has been a trend toward constructing simple refineries instead of complex refineries. In the United States, the last complex refinery started operating in 1977 in Garyville, Louisiana. In the GOM analysis area, a new simple refinery was constructed in 2014 in Galena Park, Texas (USDOE, Energy Information Administration, 2015d).

> *Alternative A, B, C, or D:* No new facilities are expected to be constructed as a direct result of Alternative A, B, C, or D.

3.1.7.3.3 Onshore Liquefied Natural Gas Facilities

The wide variety of pipeline systems and delivery markets makes the GOM attractive for LNG developers. Onshore natural gas production has increased to the extent that LNG facilities along the GOM are seeking and receiving approval to export natural gas to foreign countries. There are six existing LNG import/export terminals in the GOM region—two in Texas, three in Louisiana, and one in Mississippi (USDOE, Federal Energy Regulatory Commission, 2015a). There are 16 proposed LNG export terminals in the GOM region—8 in Texas, 7 in Louisiana, and 1 in Mississippi (USDOE, Federal Energy Regulatory Commission, 2015a). Facilities with export approval that are under construction are located in Sabine and Hackberry, Louisiana; and Freeport and Corpus Christi, Texas. Also approved for export but not yet under construction is Sabine Pass Liquefaction in Sabine Pass, Louisiana (USDOE, Federal Energy Regulatory Commission, 2015a). In 2014, New Orleans-based Harvey Gulf International Marine began construction of an LNG bunkering facility at Port Fourchon, Louisiana. The first of its kind in the United States, the LNG facility will provide LNG fuel to the growing supply of LNG-operated vessels servicing the OCS, as well as over-the-road vehicles fueled by LNG (Schuler, 2014).

Alternative A, B, C, or D: BOEM projects that expansions at existing facilities and construction of new facilities would not occur as a direct result of Alternative A, B, C, or D. Any expansions or new facilities would be the result of onshore rather than offshore production.

3.1.7.3.4 Petrochemical Plants

Petrochemical plants are usually located in areas with close proximity to the raw material supply (petroleum-based) and multiple transportation routes, including rail, road, and water. Texas, New Jersey, Louisiana, North Carolina, and Illinois are the top domestic chemical producing states. However, most of the basic chemical production is concentrated along the Gulf Coast where petroleum and natural gas feedstock are available from refineries. Of the top 10 production complexes in the world, 5 are located in Texas and 1 is located in Louisiana.

Along the Gulf Coast, the petrochemical industry is heavily concentrated in coastal Texas and south Louisiana and in various counties along the Alabama, Mississippi, and Florida coasts. The vast majority of petrochemical plants in the Gulf region are located along coastal Texas (126) and south Louisiana (66). **Table 3-4** provides the numerical distribution for each state in the analysis area, and **Figure 3-10** illustrates the geographical distribution of petrochemical facilities across the 133 Gulf counties and parishes within analysis area.

Alternative A, B, C, or D: No new facilities are expected to be constructed as a direct result of Alternative A, B, C, or D.

3.1.8 Air Emissions

Section 328(a) of the 1990 Clean Air Act Amendments gives the USEPA air quality responsibility for the OCS area in the Gulf of Mexico east of 87.5^{o} W. longitude, and BOEM retains air quality jurisdiction for OCS operations west of the same longitude in the Gulf of Mexico. In addition, Section 328(b) of the Clean Air Act Amendments requires BOEM to assure coordination of air-pollution control regulations between the Gulf of Mexico OCS emissions and emissions in adjacent onshore areas. The Clean Air Act Amendments requires the USEPA to set the NAAQS and to periodically review and update the standards, as necessary, to ensure they provide adequate health and environmental protection. Consequently, there will be a continuing need for emission inventories and modeling whenever the USEPA updates the NAAQS.

The Outer Continental Shelf Lands Act (43 U.S.C. § 1334(a)(8)) tasks the U.S. Department of the Interior to assure that air pollutant emissions from offshore oil and gas exploration, development, and production sources do not significantly affect the air quality of any state. In particular, BOEM is responsible for determining if air pollutant emissions from offshore oil and gas activities in the Gulf of Mexico influence the NAAQS compliance status of Texas, Louisiana, Mississippi, Alabama, and Florida. BOEM's air quality regulations in 30 CFR §§ 550.302, 550.303, and 550.304 were promulgated as mandated by Section 5(a)8 of the OCSLA; however, since the 1990 Clean Air Act Amendments transferred jurisdiction to the USEPA, BOEM's regulations no longer apply to air emission sources in OCS areas where the USEPA has jurisdiction. To assess offshore oil- and gas-related activities and their associated emissions, BOEM conducted a series of studies. BOEM conducted a series of studies. BOEM has published the following study documents: in 1995, the *Gulf of Mexico Air Quality Study* (System Applications International et al., 1995); in 2004, the *Gulfwide Emission Inventory Study for the Regional Haze and Ozone Modeling Effort* (Wilson et al., 2004) and the *Data Quality Control and Emissions Inventories of OCS Oil and Gas Production Activities in the Breton Area of the Gulf of Mexico* (Billings and Wilson, 2004); in 2007, the *Year 2005 Gulfwide Emission Inventory Study* (Wilson et al., 2007); and in 2010, the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010). Due to new and updated NAAQS, drilling in deep water, and offshore sources changing because of new technology, BOEM continues to update the emissions inventories every 3 years to coincide with the USEPA and State agency inventory process. Since the emission inventories also include greenhouse gas emissions, OCS operators can use the data to report their greenhouse gas emissions to the USEPA.

To build on the previously conducted studies, BOEM completed the *Year 2011 Gulfwide Emission Inventory Study* (Wilson et al., 2014) with a goal of having a calendar year 2011 inventory air pollution emissions for all OCS oil and gas production-related sources in the Gulf of Mexico. Pollutants covered in this inventory are the criteria pollutants such as carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter (PM), and sulfur dioxide (SO_2); and volatile organic compounds (VOCs), as well as major greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Ozone (O_3), a criteria pollutant, is formed by photochemical reactions of NO_x and VOC in the atmosphere. Although ozone is not covered in this inventory, ozone precursors (NO_x and VOCs) are covered. Lead (Pb), another criteria pollutant, is not covered in this inventory due to the lack of credible emission factors for this pollutant. Benzene, toluene, ethylbenzene, and xylene (BTEX) is a category of VOCs that occur naturally in crude oil, as well as during the process of making gasoline and other fuels from crude oil. Although BTEX is not individually addressed in this inventory, VOCs are covered.

The *Year 2011 Gulfwide Emission Inventory Study* presents a full description of monthly activity data from platform and non-platform sources, and it additionally updates those procedures used in previous inventories by taking the most recent emission factors from the USEPA and the Emission Inventory Improvement Program to develop a comprehensive criteria pollutant and greenhouse gas emissions inventory. A Year 2014 Gulfwide Emission Inventory Study, which is currently in progress, is built upon previous studies to develop a base year 2014 air pollution emissions inventory for all OCS oil and gas production-related sources in GOM. Furthermore, the study will cover well stimulation vessels and develop hazard air pollutant emission estimates for select oil and natural gas production platform emission sources.

3.1.8.1 Drilling

Refer to **Chapter 3.1.3.1** for the description of drilling operations and activities. Refer to **Chapter 4.1.2** and **Figures 4-9** and **4-10** for emissions in tons per year for criteria pollutants and greenhouse gases from these activities. Emissions associated with drilling from OCS oil- and gas-related activities are attributed to gasoline, diesel, and natural gas fuel usage in engines such as propulsion engines, prime engines, mud pumps, draw works, and emergency power. Pollutants emitted during drilling activities include combustion gases (i.e., CO, NO_x, PM, SO_2, CO_2, CH_4, and N_2O) and VOCs. To understand further how emissions criteria pollutants are estimated, refer to NTL 2008-G04, "Information Requirements for Exploration Plans and Development Operations Coordination Documents."

3.1.8.2 Production

Refer to **Chapter 3.1.3.1** for the description of production operations and activities. Emissions associated with production from OCS oil- and gas-related activities are attributed to boilers, diesel engines, combustion flares, fugitives, glycol dehydrators, natural gas engines, turbines, pneumatic pumps, pressure/level controllers, storage tanks, cold vents, and others. Pollutants emitted during production activities include CO, NO_x, PM, SO_2, VOCs, CO_2, CH_4, and N_2O.

3.1.8.3 Vessel Support Operations and Activities during Offshore Oil and Gas Activities

Refer to **Chapter 3.1.4.4** for the description of vessel support operations and activities during OCS oil- and gas-related activities. Emissions associated with support vessels from OCS oil- and gas-related activities are attributed to the operations of the primary diesel engine used for propulsion and other smaller diesel engines that are used to run generators or small cranes and winches for loading and unloading the vessels. Pollutants emitted during drilling activities include combustion gases (CO, NO_x, PM, SO_2, CO_2, CH_4, and N_2O) and VOCs. For more information on service vessels, refer to **Chapter 3.1.4.4**.

3.1.8.4 Flaring and Venting

The availability of a flare or vent is essential in oil and gas operations, primarily for safety reasons. It ensures that associated natural gas can be safely disposed of in emergency and shutdown situations.

Flaring is the controlled burning of natural gas and is a common practice in oil and gas exploration, production, and processing operations. The burning occurs at the end of a stack or boom. Flares generate heat and noise. Pollutants emitted during flaring include CO, NO_x, PM, SO_2, VOCs, CO_2, CH_4, and N_2O.

Venting is the controlled release of unburned gases into the atmosphere in the course of oil and gas production operations. In venting, the natural gases associated with oil production are released directly into the atmosphere and not burned. Vents produce less noise and are less visible. Pollutants emitted during venting include VOCs, CO_2, and CH_4.

Flaring and venting can have environmental impacts. Flaring may involve the disposal of sweet gas or sour gas. Sweet gas is natural gas that does not contain hydrogen sulfide (H_2S) while sour gas is natural gas that does contain H_2S. Flaring produces predominantly CO_2 emissions, while venting produces predominantly CH_4 emissions. Both carbon dioxide and methane are known as greenhouse gases associated with concerns about global warming. The global warming potential of a kilogram of methane is estimated to be 21 times that of a kilogram of carbon dioxide when effects are considered over 100 years. Therefore, flaring is often considered to be the preferred method to dispose of natural gas in oil and gas operations. Although the global warming potential of methane when compared with carbon dioxide usually suggests that flaring is a more environmentally attractive option than venting, neighbors of onshore oil and gas developments prefer venting because it is less visible and produces less noise. Flaring and venting systems are used to burn off waste gas and surplus gases, and they are also a safety means to protect process equipment, the system's processes, and the environment. Therefore, the activities can be divided into routing flaring and venting, and nonroutine (emergency) flaring and venting. Flares usually operate continuously; however, some are used only for process upsets. Natural gas discharges via venting can be due to routine or emergency releases.

Routine Flaring and Venting

Routine flaring occurs on a regular basis due to the normal operations of a facility. Flares can be used routinely to control emissions from storage tanks, loading operations, glycol dehydration units, vent collection system, and amine units. Natural gas discharges via venting can be due to routine or emergency releases. Vents receive exhaust streams from miscellaneous sources, as well as manifold exhaust streams from other equipment on the same platform such as amine units, glycol dehydrators, loading operations, and storage tanks.

3.1.8.5 Fugitive Emissions

Fugitive emissions are leaks from sealed surfaces associated with process equipment. Leaks can occur from operating conditions (pressure, temperature, etc.), aging, deterioration of sealing devices, and equipment solidity. Specific fugitive source types include cold vents; hydrocarbon loading and unloading operations; and equipment components such as valves, flanges, connectors, pump seals, compressor seals, and open-ended lines. Pollutants emitted from fugitive emissions include VOCs and CH_4.

3.1.8.6 Greenhouse Gases

The gases that keep the solar heat budget in the lower atmosphere are called greenhouse gases. Naturally, the atmospheric layer close to the Earth surface partially captures the long wave radiation from the Sun and keeps the planet habitable. These gases include CO_2, CH_4, N_2O, and a variety of manufactured chemicals. Greenhouse gases can be emitted from natural sources; others are anthropogenic, resulting from human activities.

In response to the FY 2008 Consolidated Appropriations Act, the USEPA issued 40 CFR part 98, which requires reporting of greenhouse gas emissions. Subpart C of the Green House Gas Reporting Rule requires operators to report greenhouse gas emissions from general stationary fuel combustion sources to the USEPA. Subpart W of the Greenhouse Gas Reporting Rule requires petroleum and natural gas facilities that emit 25,000 metric tons or more of CO_2 equivalents (CO_2e) per year to report emissions from equipment leaks and venting. Emissions associated with greenhouse gases from OCS oil- and gas-related activities are attributed to the combustion of fossil fuel, production and transportation of oil and natural gas, and equipment leaks. Pollutants emitted during these activities include CO_2, CH_4, N_2O, and CO_2e.

3.1.8.7 Decommissioning

Refer to **Chapter 3.1.6** for the description of decommissioning operations and activities. Emissions associated with decommissioning from OCS oil- and gas-related activities are attributed to the exhaust of diesel engines from the vessels including mobile offshore work-over rigs and lift vessels involved in the removal of pipelines and field facilities. Pollutants emitted during decommissioning include combustion gases (CO_2, NO_x, CO, PM, SO_2, CH_4 and VOCs).

3.1.9 Noise

Noise associated with OCS oil- and gas-related exploration and development results from seismic surveys, the installation of structures, the operation of fixed structures such as offshore platforms and drilling rigs, the decommissioning and explosive severance of structures, and helicopter and service-vessel traffic.

Acoustic sources can be described by their sound characteristics. For the regulatory process, they are generally divided into two categories: impulsive noise and nonimpulsive noise.

Impulsive Noise

Impulsive noises (e.g., explosives, airguns, and impact pile drivers) are generally considered powerful sounds with relatively short durations, broadband frequency content, and rapid rise times to peak levels.

Airguns produce an intense but highly localized sound energy that propagates throughout the water column, and they represent a noise source of acoustic concern. BOEM completed the Atlantic G&G Activities Programmatic EIS, which includes a detailed description of the seismic surveying technologies, energy output, and operations and which has appendices that provide details on marine mammal, sea turtle, and fish hearing (USDOI, BOEM, 2014a); these descriptions are hereby incorporated by reference.

Deepwater marine seismic surveys (refer to **Chapter 3.1.2.1**) direct low-frequency energy waves (generated by an airgun array) into the ocean floor and record the response of the reflected energy waves' response from the subsurface. The firing times of the guns are staggered by milliseconds in an effort to make the farfield noise pulse as coherent as possible. In short, the intent of the 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). In some airgun surveys (including WAZ), these sources are activated in sequence between source vessels. The noise generated by airguns is intermittent, with pulses generally less than 1 second in duration. Airgun arrays produce noise pulses with very high peak levels. The pulses are a fraction of a second long and repeat every 10-15 seconds (this range is for all airgun arrays). In other words, while airgun arrays are by far the strongest sources of underwater noise associated with OCS oil- and gas-related activities, because of the short duration of the pulses, the total energy is limited (Gordon and Moscrop, 1996). Acoustic calibration for the National Science Foundation's *R/V Marcus Langseth* and its seismic array, conducted work by Tolstoy et al. (2009) in the GOM, suggests that, for deep water (~5,249 ft; 1,600 m), the 180-decibel (dB) radius would occur at less than 0.6 mi (1 km) from the source, while in shallow waters (~164 ft; 50 m), the 180-dB radius would be considerably larger (e.g., ~0.7 mi; 1.1 km).

Nonimpulsive Noise

Nonimpulsive noise generally includes all other noise (e.g., sonars and vibratory pile drivers) and includes continuous anthropogenic noise (e.g., vessel noise).

Ambient noise is an important aspect to the marine habitat and is an efficient way to transmit energy through the ocean; therefore, many marine organisms have evolved to utilize this. It is also the sound field against which animal signals must be detected and is a result of both natural and anthropogenic noise sources. Anthropogenic noise is generally low-frequency (10 to 500 Hz), sea-surface agitation falls within the medium-frequency range (500 Hz to 25 kHz), and high-frequency noise (>25 kHz) can be from thermal noise (Hildebrand, 2009). Anthropogenic noise is generated by many different activities, including shipping, fishing, boating, research, and activities related to oil and gas exploration, development, and production. The activities encompass areas that represent important marine habitat (Hildebrand, 2009). The OCS oil- and gas-related noise generated from these activities can be transmitted through both air and water, and may be long- or short-lived in time, distance, and sound level. The intensity level and frequency of the noise emissions are highly variable, both between and among the various types of sound sources. Noise from proposed OCS oil- and gas-related activities may affect resources near the activities.

It is generally recognized that commercial shipping is a dominant component of the ambient, low- and medium-frequency background noise in modern world oceans (Gordon and Moscrop, 1996) and that OCS oil- and gas-related, service-vessel traffic would contribute to this. Another sound source more specific to OCS operations originates from seismic operations.

Information on drilling noise in the GOM is unavailable to date. From studies mostly in Alaskan waters, drilling operations (these can include pile driving, generators, pumps, etc.) often produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases. Drillships are 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. This sound difference is due to the dynamic positioning systems on the drillships as compared with anchored MODUs. Richardson et al. (1995) stated that sound was measured at three ring-caisson sites in the Arctic. Sound was measured from the 20- to 1,000-Hz band levels at a range of 1.8 km (1.1 mi) at levels of 113-126 dB re: 1μPa (decibels referenced 1 microPascal). The received sound levels varied based on the activity of the support vessels. These estimated levels were higher than drilling activities on an artificial island but lower than on drillships (Richardson et al., 1995).

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 (98 ft) 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 contribute to acoustic pollution around a production facility, as well as the transit area. 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). For example, a Bell 212 helicopter may operate at a 22-Hz tone and have an estimated received level of 149 dB re: 1μPa (Richardson et al., 1995). Differences in the density sound speed of air and water reduce the sound that propagates into the water column from the air and generally restrict it to entry angles that are within about 11 degrees of perpendicular to the water's surface. 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 water than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft (213 m) during transit to and from the working area and an altitude of about 500 ft (152 m) while between platforms.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and rotating machinery; 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 (broad band but with peak energy in low frequency). 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 empty vessels. For example, a 16-m (52-ft) crewboat may have a 90-Hz tone with a source level of 156 dB re: 1μPa, and a small ship may have a broadband source level of 170-180 dB re: 1μPa (Richardson et al., 1995). 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).

Stakeholders (mainly the NMFS, research institutions, and the U.S. Navy) have been in discussions about establishing specific criteria for thresholds on marine animal hearing to cause a temporary threshold shift or permanent threshold shift and determining behavioral effects. Previously, the 180 dB re-1 μPa-m level was an estimate of the threshold of sound energy that may cause hearing damage in cetaceans (U.S. Dept. of the Navy, 2001). In 2012, the Navy updated their acoustic threshold criteria for marine mammals and sea turtles to similar criteria as those published by Southall et al. (2007). Those criteria are discussed in **Chapters 4.9.2 and 4.9.5**. Information on the acoustic environment and marine sound can also be found in Chapter 4.2.2 of the Five-Year Program EIS.

3.1.10 New and Unusual Technology

Technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. BOEM's predecessor prepared a Programmatic EA to evaluate the potential effects of deepwater technologies and operations (USDOI, MMS, 2000b). As a supplement to the EA, BOEM's predecessor prepared a series of reference document that provides a profile of the different types of development and production structures that may be employed in the GOM deep water (USDOI, MMS, 2000a). The Programmatic EA and technical papers were used in the preparation of this Multisale EIS. Additional technologies introduced since the publication of the EA in 2000 include WAZ (**Chapter 3.1.2.1**) and duel-gradient drilling. Duel-gradient drilling uses seawater-density fluid in place of the mud that would normally flow through a well and uses dense mud at the bottom of the well to maintain bottom-hole pressure. This technology allows operators to reach reservoirs 40,000 ft (12,192 m) below the seafloor, a depth that is otherwise affected by water depth.

The operator must identify new or unusual technology, as defined in 30 CFR § 550.200, in exploration and development plans. Some of the technologies proposed for use by the operators are actually extended applications of existing technologies and interface with the environment in essentially the same way as well-known or conventional technologies. These technologies are reviewed by BOEM for alternative compliance or departures that may trigger additional environmental review. Some examples of new technologies that do not affect the environment differently and that are being deployed in the regionwide OCS Program are synthetic mooring lines, subsurface safety devices, and multiplex subsea controls.

Some new technologies differ in how they function or interface with the environment. These include equipment or procedures that have not been installed or used in Gulf of Mexico OCS waters. Having no operational history, they have not been assessed by BOEM through technical and environmental reviews. New technologies may be outside the framework established by BOEM's regulations and, thus, their performance (i.e., safety, environmental protection, efficiency, etc.) has not been studied by BOEM. 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 would be initiated if an operator wishes to deploy it.

BOEM has developed a new and unusual technologies' matrix to help facilitate decisions on the appropriate level of engineering and environmental review needed for a proposed technology. All projects in the GOM using nonconventional production or completion technology require a deepwater operations plan and a review by BSEE. Technologies will be added to the new and unusual technologies' matrix as they emerge, and technologies will be removed as sufficient experience is gained in their implementation. From an environmental perspective, the matrix characterizes new technologies into three components: technologies that may affect the environment; technologies that do not interact with the environment any differently than "conventional" technologies; and technologies for which BOEM does not have sufficient information to determine its potential impacts to the environment. In this latter case, BOEM would seek to gain the necessary information from operators or manufacturers regarding the technologies in order to make an appropriate determination on its potential effects on the environment.

Alternative Compliance and Departures: When an OCS operator proposes the use of technology or procedures not specifically addressed in established BOEM regulations, the operations are evaluated for alternative compliance or departure determination. BOEM, in coordination with BSEE's Technical Assessment Section, conducts a project-specific engineering safety review to ensure that equipment proposed for use is designed to withstand the operational and environmental condition in which it would operate. Any new technologies or equipment that represent an alternative compliance or departure from existing BOEM regulation must be fully described and justified before it would be approved for use. For BOEM to grant alternative compliance or departure approval, the operator must demonstrate an equivalent or improved degree of protection as specified in 30 CFR § 550.141. Comparative analysis with other approved systems, equipment, and procedures is one tool that BOEM uses to assess the adequacy of protection provided by alternative technology or operations. Actual operational experience is necessary with alternative compliance measures before BOEM/BSEE would consider them as proven technology.

In addition to new and unusual technology for drilling, as a result of the *Deepwater Horizon* explosion, oil spill, and response, many technologies or applications were developed in an attempt to stop the spill and cap the well in any future accidents. The NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," applies to operators conducting operations using subsea BOPs or surface BOPs on floating facilities. BOEM would assess whether each lessee has submitted adequate information demonstrating that it has access to and can deploy surface and subsurface containment resources that would be adequate to promptly respond to a blowout or other loss of well control. Containment resources could consist of, but are not limited to, subsea containment and capture equipment including containment domes and capping stacks, subsea utility equipment including hydraulic power, hydrate control, and dispersion injection equipment.

3.2 Impact-Producing Factors and Scenario—Accidental Events

3.2.1 Oil Spills

As a consequence of activities related to the exploration, development, production, and transportation of oil and gas, the potential for accidental releases exists. Input through public scoping meetings, Federal and State agency consultation and coordination, and industry and nongovernmental organizations' comments indicate that stakeholders continue to have concerns about oil spills and the threat they pose to the environment. Although oil-spill occurrence cannot be predicted, an estimate of its likelihood can be quantified using spill rates derived from historical data and projected volumes of oil production and transportation. The following chapters discuss the history of oil spills in the GOM, the processes that affect spilled oil, and a risk analysis for spills that may be reasonably foreseeable as a result of Alternative A, B, C, or D, as well as information on the number and size of spills from non-OCS oil- and gas-related sources. Under Alternative D, the number of blocks that would become unavailable for lease represents only a small percentage (<4%) of the total number of blocks to be offered under Alternative A, B, or C. Therefore, Alternative D could reduce offshore infrastructure by up to 4 percent when chosen in conjunction with Alternative A, B, or C. However, it is also possible that Alternative D would only shift the location of offshore infrastructure and activities farther from sensitive topographic zones and not lead to a reduction in offshore infrastructure and activities. Refer to **Chapter 2.2.2.4** for more information on Alternative D. For an analysis of a low-probability catastrophic spill, which is not reasonably foreseeable as a result of a proposed action or the alternatives, refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

3.2.1.1 Past OCS Spills

3.2.1.1.1 Trends in Reported Spill Volumes and Numbers

A summary of reported spill incidents is available from the USCG in a report entitled *Polluting Incidents In and Around U.S. Waters, A Spill/Release Compendium: 1969-2011* (U.S. Dept. of Homeland Security, CG, 2012). The data include reports of all releases involving oil and hazardous substances from various sources, including barges, tanks, pipelines, and waterfront facilities. A review of the information shows that the majority of spills are ≤1 bbl. Additionally, the overall number and volume of spills in U.S. waters has been on a downward trend since 1973. The number and volume of oil spilled in the Gulf of Mexico from 2001 through 2015 is presented in **Table 3-11**.

Table 3-11. Annual Summary of Number and Total Volume of Oil Spilled into the Gulf of Mexico, 2001-2015[1]

Year	Number of Spills	Volume bbl (gallons)
2001	1,728	3,187 (133,872)
2002	733	2,535 (106,465)
2003	801	1,181 (49,617)
2004	908	760 (31,935)
2005	804	44,141 (1,853,919)
2006	868	2,947 (123,788)
2007	616	1,560 (65,511)
2008	523	355 (14,928)
2009	454	212 (8,898)
2010	455	4,928,389 (206,992,317)[1]
2011	498	483 (20,276)
2012	801	241 (10,136)
2013	848	314 (13,212)
2014	694	902 (37,889)
2015[2]	753	1,164 (48,884)

Year	Number of Spills	Volume bbl (gallons)

Note: The volume reported does not include oil spilled in rivers that enters the Gulf of Mexico. The reported spills include both crude and refined products.

[1] These data include the *Deepwater Horizon* oil spill (4,928,198 bbl). (Note: For purposes of calculating the maximum possible civil penalty under the Clean Water Act, a January 2015 judgement used a quantity of 4.0 million barrels of oil for total discharged and 3.19 million barrels of oil as the actual amount that was released into environment [Barbier and Shushan, 2015]).

[2] Through August 5, 2015.

Source: U.S. Dept. of Homeland Security, CG, 2015a.

Etkin (2009) examined spills in the United States related to both onshore and offshore activities. Between 1998 and 2007 all of the oil spilled from offshore platforms occurred on the OCS in Federal waters. No spills from platforms in State waters were reported. Among these spills, the volume was about equally divided between crude oil and diesel fuel. However, the amount of diesel spilled in 2005 was three times greater than the amount spilled in any other year due to the hurricanes that occurred in the GOM. From 1998 through 2007 an average of 1,273 bbl of oil/year spilled from GOM platforms and 2,613 bbl of oil/year spilled from GOM pipelines. Only about 10 bbl of oil/year spilled from vessels that supply the offshore industry during the same 10-year interval.

The most common causes of spill incidents were hurricane-related, and the relative volumes associated with offshore platform incidents for the decade 1998 through 2007 were as follows:

Causes of Spills	Percentage of Incidents	Percentage of Spill Volume
Hurricanes	47%	85%
Structural Failure (such as corrosion)	26%	4%
Operator Error	18%	8%

The most common causes for pipelines were also hurricane-related, and the relative volumes of pipeline spills during this same 10-year period were as follows:

Causes of Spills	Percentage of Incidents	Percentage of Spill Volume
Hurricanes	58%	43%
Structural Failure	29%	41%
Vessel Damage (such as anchor drag)	5%	15%

It was estimated that, between 1998 and 2007, 1,200 bbl of oil was spilled per billion barrels of oil produced and that offshore platforms and pipelines spilled 3,887 bbl of oil per year.

Previous work by Anderson and LaBelle (1990, 1994, and 2000) provided estimates of oil-spill occurrence rates expressed and normalized in terms of the number of spills per volume of crude oil handled. This work was updated in Anderson et al. (2012) and utilized United States' OCS platform and pipeline spill data from 1964 through 2010. Platform and pipeline spills included both crude oil and condensate, but platform spills may also include refined products such as diesel fuel. The report utilized the spill record from 1964 through 2010 but also examined shorter intervals to identify trends and also to show how the *Deepwater Horizon* explosion, oil spill, and response influenced the spill statistics. The report notes several additional factors that have influenced spill rates, including six highly destructive hurricanes between 2002 and 2008 that destroyed or extensively damaged 305 platforms, 76 drilling rigs, and over 1,200 pipeline segments, and the inclusion of "passive spills" or petroleum missing based on pre-storm platform inventories. Overall, the spill rates of ≥1,000 bbl for OCS platforms declined during the most recent 15-year period analyzed. During this period, two platform spills occurred: Hurricane Rita in 2005 and the *Deepwater Horizon* oil spill in 2010. Prior to the *Deepwater Horizon* oil spill, the last United States' OCS platform spill ≥10,000 bbl occurred in 1970. Spill rates of ≥1,000 bbl for OCS pipelines also declined during the most recent 15-year period with seven spills of ≥1,000 bbl and zero spills ≥10,000 bbl. The last reported OCS pipeline spill ≥10,000 bbl occurred in 1990 (**Table 3-12**).

Table 3-12. Spill Rates for Petroleum Spills ≥1,000 Barrels from OCS Platforms and Pipelines, 1964 through 2010.

Spill Size and Source	Previous Rate, 1964-1999			Updated Rate, 1964-2010			Current Rate, 1996-2010		
	Volume Handled (Bbbl)	Number of Spills	Spill Rate	Volume Handled (Bbbl)	Number of Spills	Spill Rate	Volume Handled (Bbbl)	Number of Spills	Spill Rate
≥1,000 bbl									
Platforms	9.5 of 12.0	3 of 11	0.32	15.8 of 18.1	5 of 13	0.32	8.0	2	0.25
Pipelines	12.0	16	1.33	9.6 of 18.1	9 of 20	0.94	8.0	7	0.88
≥10,000 bbl									
Platforms	12.0	4	0.12	15.8 of 18.1	1 of 5	0.06	8.0	1	0.13
Pipelines	12.0	4	0.33	9.6 of 18.1	–	0.19	8.0	–	0.18

Source: Anderson et al., 2012.

3.2.1.1.2 Coastal Spills

Coastal spills are defined here as spills in State offshore waters and spills in navigation channels, rivers, and bays from barges and pipelines carrying OCS-produced oil. These spills occur at shoreline storage, processing, and transport facilities supporting the OCS oil and gas industry and could be spills of crude oil or spills of fuel oil used in vessels. Many reports of spills cannot be traced back to the source or type of oil and are recorded as unknown. Similarly, for these small spills of unknown oil, the volume is also likely to be an estimate. Records of spills in coastal waters and State offshore waters are maintained by the USCG (USDHS, CG, 2015a). The source may be recorded, for example, as an offshore pipeline, but the database does not identify the source of the oil in the pipeline (OCS versus non-OCS domestic). A pipeline carrying oil from a shore base to a refinery may be carrying oil from both State and OCS production; imported oil might also be commingled in the pipeline. The USCG also records the type of oil spilled and whether it is crude oil, a refined product such diesel fuel or heavy fuel oil, or a type of commodity in transport, such as vegetable oil. The USCG data have some shortcomings that should be noted. For spills of unknown source, the caller may guess as to what type of oil, crude, or fuel was released. The database includes a latitude and longitude GPS (global positioning system) position for each spill, as well as a verbal description of location. The verbal description may not match the position. For example, the verbal description could be Mississippi Sound, but the GPS position is actually on the OCS. For this report, the GPS position was used, not the verbal description of the location.

BOEM pays special attention to spills related to exploration and production that occur on Federal leases in OCS waters, i.e., the submerged lands, subsoil, and seabed lying between the seaward extent of the State's jurisdiction and the seaward extent of Federal jurisdiction. BOEM does not maintain comprehensive data on spills that have occurred in the State's jurisdiction. Although BSEE has occasionally collected information on State pollution incidents, there is no database available that contains only past spills that have occurred in State offshore or coastal waters solely and directly as a result of OCS oil and gas development.

Therefore, coastal spill data from all potential spillage sources were searched using the USCG database for the most recent 12 years, January 2002-April 2014 (USDHS, CG, 2015a) in order to obtain information on spills that have occurred in State offshore or coastal waters, most probably as a result of oil and gas development. In order to search the data, the USCG data were examined using the latitude and longitude provided in the spill report, which resulted in some of the reported locations that fell inland or outside of the GOM being omitted. Some broad assumptions were made in the use of these data. State offshore waters are defined here as the portion of the GOM under State jurisdiction that begins at the coastline and ends at the Federal/State boundary 9 nmi (10.36 mi; 16.67 km) offshore Texas; 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama; and 9 nmi (10.36 mi; 16.67 km) offshore Florida. For the purpose of comparing spill events across GOM coastal waters, spills in rivers, estuaries, and bays, and 0-3 nmi (0-3.45 mi; 0-5.56 km) from shore were counted as coastal spills. The number of GOM coastal spills from five sources associated with State or Federal offshore production and international importation was determined from the data (**Table 3-13**). Louisiana and Texas have extensive oil and gas activity occurring in their territorial seas, as well as in Federal waters on the OCS. The sources that were counted are fixed platforms, MODUs, OSVs, offshore pipelines, and tank ships or barges. Although counts for tank ships and barges are shown as sources, the amount of barged and tankered GOM oil production is limited; therefore, these numbers are conservatively high as they include all of the oil tankered or barged. BOEM shows that 96 percent of OCS oil- and gas-related activity spills are <1 bbl, with an average size of 0.05 bbl, and that 4 percent of OCS oil- and gas-related activity spills are 1-999 bbl, with an average size of 77 bbl (Anderson et al., 2012).

Table 3-13. Historic Spill Source, Location, and Characteristics of a Maximum Spill for Coastal Waters[1] and Offshore Waters[2] (data extracted from USDOT, CG records, 2002-2014[3]).

Source	Number of Spills			Maximum Volume of a Single Incident	
	Total Number of Spill Events	Number of Spills (<1,000 bbl)	Number of Spills (≥1,000 bbl)	Volume (bbl) of Maximum Spill from the Source	Maximum Spill Amount Source/Product/Year
Western Planning Area (WPA)[2]					
Fixed Platform	251	251	0	3	Fixed Platform/Chemical/ 2013
Pipeline	2	2	0	0.08	Offshore Pipeline/Oil/ 2007
MODU	16	16	0	938	MODU/Chemical/2013
OSV	19	19	0	12	OSV/Oil/Unknown
Tank Ship or Barge	11	11	0	43	Tank Barge/Oil/2003
Total	2	2	0	–	–
Central Planning Area (CPA)[2]					
Fixed Platform	3,568	3,567	1	1,137	Fixed Platform/Chemical/ 2003
Pipeline	8	8	0	5	Pipeline/Oil/2005
MODU	248	245	3	4,928,198	MODU/Oil/2010
OSV	183	183	0	350	OSV/Chemical/2002
Tank Ship or Barge	18	17	1	unknown	Tank Ship/Chemical/2010
Total	8	8	5	–	–
Eastern Planning Area (EPA)[2]					
Fixed Platform	6	6	0	5	Fixed Platform/Oil/2007
Pipeline	0	0	0	0	–
MODU	1	1	0	0.12	MODU/Unknown
OSV	0	0	0	0	–
Tank Ship or Barge	0	0	0	0	–
Total	7	0	0	–	–
Coastal Waters: Texas					
Fixed Platform	72	72	0	3	Fixed Platform/Unknown
Pipeline	0	0	0	N/A	N/A-
MODU	9	9	0	0.05	MODU/Unknown
OSV	6	6	0	3	OSV/Oil/2003
Tank Ship or Barge	6	6	0	12	Tank Ship/Oil/2004
Total	93	93	0	–	–

Source	Number of Spills			Maximum Volume of a Single Incident	
	Total Number of Spill Events	Number of Spills (<1,000 bbl)	Number of Spills (≥1,000 bbl)	Volume (bbl) of Maximum Spill from the Source	Maximum Spill Amount Source/Product/Year
Coastal Waters: Louisiana					
Fixed Platform	1,437	1,436	1	1,200	Fixed Platform/Oil/2007
Pipeline	4	4	0	0.7	Pipeline/Oil/2013
MODU	11	11	0	62	MODU/Oil/2002
OSV	32	32	0	12	OSV/Oil/2002
Tank Ship or Barge	9	9	0	10	Deck Barge/Oil/2003
Total	1,493	1,492	1	–	–
Coastal Waters: Mississippi					
Fixed Platform	4	4	0	0.0.024	Fixed Platform/Oil, Misc:Motor/2000
Pipeline	0	0	0	N/A	NA
MODU	0	0	0	N/A	N/A
OSV	0	0	0	N/A	N/A
Tank Ship or Barge	0	0	0	N/A	N/A
Total	4	4	0	–	–
Coastal Waters: Alabama					
Fixed Platform	10	10	0	0.5	Fixed Platform/Oil/2004
Pipeline	0	0	0	N/A	N/A
MODU	1	1	0	0.05	MODU/Unknown
OSV	3	3	0	0.02	OSV/Oil/2008
Tank Ship or Barge	1	1	0	01	Cutter/Dredger Barge/Oil/ 2011
Total	15	15	0	–	–
Coastal Waters: Florida					
Fixed Platform	3	3	0	0.095	Fixed Platform/Unknown
Pipeline	0	0	0	N/A	N/A
MODU	0	0	0	N/A	N/A
OSV	1	1	0	10	OSV/Oil/2009
Tank Ship or Barge	1	1	0	4	Bulk Liquid Cargo (Tank)/Oil/2003
Total	5	5	0	–	–

bbl = barrel; MODU = mobile offshore drilling unit; N/A = not applicable; OSV = offshore support vessel.

Note: The reader should note that the spills are reported to the USCG by responsible parties, other private parties, and government personnel. The USCG does not verify the source or volume of every report.

[1]Coastal Waters – 0-3 nmi (0-3.5 mi; 0-5.6 km) from the coastline and spills in rivers, lakes, bays, and estuaries.

[2]Offshore Waters, WPA, CPA, and EPA – Spills that occurred in water depths 3 nmi (3.5 mi; 5.6 km) from the coastline to the OCS planning area boundary.

[3]The database included represents spill events from January 2002 until April 2014.

3.2.1.2 Offshore Spills

Petroleum spills from OCS oil- and gas- related activities include crude oil, condensate, and refined products such as diesel, hydraulic oil, lube oil and mineral oil. For spills of synthetic oil products, drilling muds, or chemicals, refer to **Chapter 3.2.6**. 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. Oil-spill information comes from a variety of sources. The BSEE requires operators to report any spill ≥1 bbl occurring on the OCS and maintains a database for all reported incidents. Not included in BSEE's data records are spills <1 bbl. Spills of any size and composition are required to be reported to the USCG's National Response Center and are documented in the USCG's Marine Information for Safety and Law Enforcement (2001-present) database and its predecessors. Also not included in BSEE's 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. Spills from vessels are provided for tankers in worldwide waters and tankers and barges in U.S. coastal and offshore waters. The latter is a subset of the spills included in the worldwide tanker spill data. These data identify whether the spill occurred "at sea" or "in port' as they can occur due to mishaps during loading, unloading, and taking on fuel oil, and from groundings, hull failures, and explosions. **Table 3-14 and 3-15** provide information on OCS spills ≥1,000 bbl that have occurred offshore in the GOM for the period from 1964 through 2015. No spill >1,000 bbl has occurred since the *Deepwater Horizon* oil spill.

Table 3-14. Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Platforms, 1964-2015.

Date	Leasing Area[3] and Block Number	Water Depth (ft)	Distance to Shore (mi)	Volume Spilled (bbl)	Operator	Facility or Structure and Cause of Spill
4/08/1964	EI 208	94	48	2,559	Continental Oil	Freighter struck Platform A: fire, platform and freighter damaged
10/03/1964	Hurricane Hilda			11,869[4]	Event Total	5 platforms destroyed during Hurricane Hilda
	EI 208	94	48	5,180	Continental Oil	Platforms A, C, and D destroyed: blowouts (several days)
	SS 149	55	33	5,100	Signal O & G	Platform B destroyed: blowout (17 days)
	SS 199	102	44	1,589	Tenneco Oil	Platform A destroyed: lost storage tank
7/19/1965	SS 29	15	7	1,688[5]	PanAmerican	Well #7 drilling: blowout (8 days), minimal damage
1/28/1969	6B 5165 Santa Barbara Channel, California	190	6	80,000	Union Oil	Well A-21 drilling: blowout (10 days), 50,000 bbl during blowout phase, subsequent seepage of 30,000 bbl (over decades), 4,000 birds killed, considerable oil on beaches, platform destroyed
3/16/1969	SS 72	30	6	2,500	Mobil Oil	Submersible rig *Rimtide* drilling in heavy seas bumped by supply vessel
2/10/1970	MP 41	39	14	65,000[6]	Chevron Oil	Platform C: rig shifted and sheared wellhead, blowout (3-4 days), fire of unknown origin, blowout 12 wells (49 days), lost platform, minor amounts of oil on beaches
12/1/1970	ST 26	60	8	53,000	Shell Oil	Platform B: wireline work, gas explosion, fire, blowout (138 days), lost platform and 2 drilling rigs, 4 fatalities, 36 injuries, minor amounts of oil on beaches
1/09/1973	WD 79	110	17	9,935	Signal O & G	Platform A: oil storage tank structural failure
1/26/1973	PL 23	61	15	7,000	Chevron Oil	Platform CA: storage barge sank in heavy seas
11/23/1979	MP 151	280	10	1,500[7]	Texoma Production	MODU Pacesetter III: diesel tank holed, workboat contact in heavy seas

Date	Leasing Area[3] and Block Number	Water Depth (ft)	Distance to Shore (mi)	Volume Spilled (bbl)	Operator	Facility or Structure and Cause of Spill
11/14/1980	HI 206	60	27	1,456	Texaco Oil	Platform A: storage tank overflow during Hurricane Jeanne evacuation
9/24/2005	Hurricane Rita			5,066[8]	Event Total	1 platform and 2 rigs destroyed by Hurricane Rita
	EI 314	230	78	2,000[5]	Forest Oil	Platform J: destroyed, lost oil on board and in riser
	SM 146	238	78	1,494[9]	Hunt Petroleum	Jack-up Rig Rowan Fort Worth: swept away, never found
	SS 250	182	69	1,572[9]	Remington O & G	Jack-up Rig Rowan Odessa: legs collapsed
04/20/2010	MC 252	4,992	53	4.9 million[10]	BP E & P	*Deepwater Horizon* Rig: gas explosion, blowout (86 days to cap well), fire, drilling rig sank, 11 fatalities, multiple injuries, considerable oil on beaches, wildlife affected, temporary closure of area fisheries

Notes: barrel (bbl) = 42 gallons, billion = 109; MODU = mobile offshore drilling unit

Between 1964 and 2009, over 17.5 billion bbl of oil and 176.1 Mcf of natural gas were produced on the OCS.

[1]Crude oil release unless otherwise noted; no spill contacts to land unless otherwise noted.

[2]Outer Continental Shelf (OCS) – submerged lands, subsoil, and seabed administered by the U.S. Federal Government (http://www.boem.gov/Governing-Statutes/).

[3]Gulf of Mexico leasing area unless otherwise noted (official protraction diagrams, http://www.boem.gov/Official-Protraction-Diagrams/): EI = Eugene Island, HI = High Island, MC = Mississippi Canyon, MP = Main Pass, PL = South Pelto, SS = Ship Shoal, SM = South Marsh Island, ST = South Timbalier, and WD = West Delta.

[4]Hurricane Hilda, 10/3/1964: platform spills ≥1,000 bbl at 3 facilities totaled 11,869 bbl; treated as 1 spill event.

[5]Condensate – a liquid product of natural gas production.

[6]Spill volume estimate between 30,000 and 65,000 bbl, previously reported as 30,000 bbl.

[7]Diesel fuel.

[8]Hurricane Rita, 9/24/2010: platform and 2 rig losses ≥1,000 bbl at 3 locations totaled to 5,066 bbl; treated as 1 spill event. The 5,066-bbl spill was a “passive” spill based on unrecovered pre-storm inventories from the platform and 2 rigs; no spill observed; no response required.

[9]Diesel fuel and other refined petroleum products stored on rig.

[10]The Federal Interagency Solutions Group, 2010. (Note: For purposes of calculating the maximum possible civil penalty under the Clean Water Act, a January 2015 judgement used a quantity of 4.0 million barrels of oil for total discharged and 3.19 million barrels of oil as the actual amount that was released into environment [Barbier and Shushan, 2015]).

Sources: Anderson et al., 2012; U.S. Dept. of Homeland Security, CG, 2015a.

Table 3-15. Petroleum[1] Spills ≥1,000 Barrels from United States OCS[2] Pipelines, 1964-2015.

Date	Leasing Area[3] and Block Number	Water Depth (ft)	Distance to Shore (mi)	Volume Spilled (bbl)	Operator	Pipeline Segment (pipeline authority[4]) Cause/Consequences of Spill
10/15/1967	WD 73	168	22	160,638	Humble Pipeline	12" oil pipeline, Segment #7791 (DOT): anchor kinked, corrosion, leak
3/12/1968	ST 131	160	28	6,000	Gulf Oil	18" oil pipeline, Segment #3573 (DOT): barge anchor damage
2/11/1969	MP 299	210	17	7,532	Chevron Oil	4" gas pipeline, Segment #3469 (DOT): anchor damage
5/12/1973	WD 73	168	22	5,000	Exxon Pipeline	16" gas & oil pipeline, Segment #807 (DOT): internal corrosion, leak
4/17/1974	EI 317	240	75	19,833	Pennzoil	14" oil Bonita pipeline, Segment #1128 (DOI): anchor damage
9/11/1974	MP 73	141	9	3,500	Shell Oil	8" oil pipeline, Segment #36 (DOI): Hurricane Carmen broke tie-in to 12" pipeline, minor contacts to shoreline, brief cleanup response in Chandeleur Area
12/18/1976	EI 297	210	17	4,000	Placid Oil	10" oil pipeline, Segment #1184 (DOI): trawl damage to tie-in to 14" pipeline
12/11/1981	SP 60	190	4	5,100	Atlantic Richfield	8" oil pipeline, Segment #4715 (DOT): workboat anchor damage
2/07/1988	GA A002	75	34	15,576	Amoco Pipeline	14" oil pipeline, Segment #4879 (DOT): damage from illegally anchored vessel
1/24/1990	SS 281	197	60	14,423[5]	Shell Offshore	4" condensate pipeline, Segment #8324 (DOI): anchor damage to subsea tie-in
5/06/1990	EI 314	230	78	4,569	Exxon	8" oil pipeline, Segment #4030 (DOI): trawl damage
8/31/1992	PL 8	30	6	2,000	Texaco	20" oil pipeline, Segment #4006 (DOT): Hurricane Andrew, loose rig Treasure 75, anchor damage, minor contacts to shoreline, brief cleanup response
11/16/1994	SS 281	197	60	4,533[5]	Shell Offshore	4" condensate pipeline, Segment #8324 (DOI): trawl damage to subsea tie-in
1/26/1998	EC 334	264	105	1,211[5]	Pennzoil E & P	16" gas & condensate pipeline, Segment #11007 (DOT): anchor damage to tie-in to 30" pipeline, anchor dragged by vessel in man-overboard response
9/29/1998	SP 38	108	6	8,212	Chevron Pipe Line	10" gas & oil pipeline, Segment #5625 (DOT): Hurricane Georges, mudslide damage, small amount of oil contacted shoreline
7/23/1999	SS 241	133	50	3,200	Seashell Pipeline	12" oil pipeline, Segment #6462 & Segment #6463 (DOT): "Loop Davis" jack-up rig, barge crushed pipeline when sat down on it
1/21/2000	SS 332	435	75	2,240	Equilon Pipeline	24" oil pipeline, Segment #10903 (DOT): anchor damage from MODU under tow

Date	Leasing Area[3] and Block Number	Water Depth (ft)	Distance to Shore (mi)	Volume Spilled (bbl)	Operator	Pipeline Segment (pipeline authority[4]) Cause/Consequences of Spill
9/15/2004	MC 20	479	19	1,720[6]	Taylor Energy	6" oil pipeline, Segment #7296 (DOI): Hurricane Ivan, mudslide damage
9/13/2008	HI A264	150	73	1,316[7]	HI Offshore System	42" gas pipeline, Segment #7364 (DOT): Hurricane Ike, anchor damage parted line
7/25/2009	SS 142	60	30	1,500	Shell Pipe Line	20" oil pipeline, Segment #4006 (DOT): micro-fractures from chronic contacts at pipeline crossing caused failure (separators between pipelines missing)

Notes: barrel (bbl) = 42 gallons, billion = 10^9; MODU = mobile offshore drilling unit.
Between 1964 and 2009, over 17.5 billion bbl of oil and 176.1 Mcf of natural gas were produced on the OCS.

[1]Crude oil release unless otherwise noted; no spill contacts to land unless otherwise noted.

[2]Outer Continental Shelf (OCS) – submerged lands, subsoil, and seabed administered by the U.S. Federal Government (http://www.boem.gov/Governing-Statutes/).

[3]Gulf of Mexico leasing area unless otherwise noted (official protraction diagrams, http://www.boem.gov/Official-Protraction-Diagrams/l): EC = East Cameron, EI = Eugene Island, GA = Galveston, HI = High Island, MC = Mississippi Canyon, MP = Main Pass, PL = South Pelto, SS = Ship Shoal, SP = South Pass, ST = South Timbalier, and WD = West Delta.

[4]Pipeline authority: DOI = Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement; DOT = Department of Transportation, Pipeline and Hazardous Materials Safety Administration.

[5]Condensate – a liquid product of natural gas production.

[6]The 1,720-bbl spill was a "passive" spill based on unrecovered pre-storm inventory trapped in the segment by a mudslide; no spill observed, no response required.

[7]The 1,316-bbl spill was a "passive" spill based on unrecovered pre-storm inventory in the segment parted by storm; no spill observed, no response required.

Sources: Anderson et al., 2012; U.S. Dept. of Homeland Security, CG, 2015a.

3.2.1.3 Characteristics of OCS Oil

Crude oils are a natural mixture of hundreds of different compounds, with liquid hydrocarbons accounting 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 GOM. Extensive laboratory testing has been performed on various oils from the GOM to determine their physical and chemical characteristics. For example, numerous oils collected from the GOM (U.S. waters) are included in Environment Canada's (2013) oil properties database. The database provides details of an oil's chemical composition, including hydrocarbon groups (i.e., saturates, aromatics, resins, and asphaltenes), VOCs (such as benzene, toluene, ethylbenzene, and xylene), sulfur content, biomarkers, and metals. The database also includes API gravities, of which GOM oils are in the range of 15° to 60°. The American Petroleum Institute gravity is a common measure of the relative density of crude oil and is expressed in degrees (°API) with water having a value of 10° API. Crude oils with lower densities and viscosities usually contain higher levels of naphtha with predominantly volatile paraffinic hydrocarbons (**Table 3-16**). Light crude oils are easier to process, while heavy crude oils are more difficult. The sulfur content (sweet vs. sour) of crude oil also determines the amount of processing required. Light sweet crude oil is preferred by refineries because of its low sulfur content (typically less than 0.5%) (API, 2011).

Table 3-16. Properties and Persistence by Oil Component Group.

Properties and Persistence	Light Weight	Medium Weight	Heavy Weight
Hydrocarbon Compounds	Up to 10 carbon atoms	10-22 carbon atoms	>20 carbon atoms
API º	>31.1º	31.1º-22.3º	<22.3º
Evaporation Rate	Rapid (within 1 day) and complete	Up to several days; not complete at ambient temperatures	Negligible
Solubility in Water	High	Low (at most a few mg/L)	Negligible
Acute Toxicity	High due to monoaromatic hydrocarbons (BTEX)	Moderate due to diaromatic hydrocarbons (naphthalenes – 2 ring PAHs)	Low, except due to smothering (i.e., heavier oils may sink)
Chronic Toxicity	None, does not persist due to evaporation	PAH components (e.g., naphthalenes – 2 ring PAHs)	PAH components (e.g., phenanthrene, anthracene – 3 ring PAHs)
Bioaccumulation Potential	None, does not persist due to evaporation	Moderate	Low, may bioaccumulate through sediment sorption
Compositional Majority	Alkanes and cycloalkanes	Alkanes that are readily degraded	Waxes, asphaltenes, and polar compounds (not significantly bioavailable or toxic)
Persistence	Low due to evaporation	Alkanes readily degrade, but the diaromatic hydrocarbons are more persistent	High; very low degradation rates and can persist in sediments as tarballs or asphalt pavements

Notes: API = American Petroleum Institute; BTEX = benzene, toluene, ethylbenzene, and xylene; mg/L = milligram per liter; PAH = polycyclic aromatic hydrocarbons.
Sources: Michel, 1992; Lee et al., 2015.

Data have been collected from approximately 450 deepwater EPs and DOCDs that were submitted to BOEM/BSEE. These data are available through BOEM's Exploration and Development Plans Online Query (USDOI, BOEM, 2014b). Statistics on these API gravities show a similar range of 16° to 58° as those reported in the Environment Canada database. The mean value for all oils examined was 36°.

3.2.1.4 Transport and Fate of Offshore Spills

The physical and chemical properties of oil greatly affect its transport and fate in the environment. Once spilled, oil is subject to a number of physical, chemical, and biological processes that alter its composition and can determine environmental impacts. Horizontal transport of oil is accomplished through spreading, advection, dispersion, and entrainment, whereas vertical transport involves dispersion, entrainment, Langmuir circulation (a series of shallow, slow, counter-rotating vortices at the ocean's surface aligned with the wind developed when wind blows steadily over the sea surface), sinking, overwashing, partitioning, and sedimentation. Following a spill, the composition of the released oil can change substantially due to weathering processes such as evaporation, emulsification, dissolution, and oxidation. The ultimate fate of oil in the environment and its impacts are influenced not only by the magnitude, spatial extent, and duration of the event but also by the response methods that may be employed (**Chapter 3.2.7**). More details on the properties and persistence of different types of oils are provided in **Table 3-16**.

Spreading

It is expected that some portion of spilled oil would rise and/or remain on the sea surface, depending on the depth of the spill and whether a subsurface plume forms. Gulf of Mexico oils, having an average API gravity of 36°, have a tendency to float. Once on the sea surface, oil rapidly spreads out, 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. Oil becomes diluted as it physically mixes with the surrounding water and moves into the water column, and the physical mixing zone of surface oil is generally limited to approximately 33 ft (20 m) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Thompson et al., 1999; Schroeder, 2000). However, under turbulent mixing conditions oil can be transported deeper into the water column. In one extraordinary circumstance, a tropical storm forced a large volume of dispersant/oil mixture as deep as 246 ft (75 m) (Silva et al., 2015).

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 within a few days following a spill, light crude oils can lose up to 75 percent of their initial volume and medium crude oils can lose up to 40 percent (NRC, 2003). Some crude oils mix with water to form an emulsion that is much thicker and stickier than the original oil (USDOC, NOAA, 2010a). Winds and waves continue to stretch and tear the oil patches into smaller pieces, or tarballs. Oil at a "light" API gravity would have few asphaltenes, would not emulsify, and would not form tarballs. Oil at a "heavy" API gravity, or enriched in heavy components after weathering, would more likely emulsify and form tarballs. While some tarballs may be as large as pancakes, most are coin-sized. Tarballs are very persistent in the marine environment and can travel hundreds of miles. It is expected that oil spilled as a result of an accident associated with a regionwide proposed action would be within the range of 30°-35° API. BOEM used the SINTEF Oil Weathering Model to numerically model weathering processes to (1) estimate the likely amount of oil remaining on the ocean surface as a function of time and (2) predict the composition of any remaining oil (USDOI, MMS, 2007b). The results of BOEM's weathering analyses were as follows. By 10 days after a spill event of 1,000 bbl, approximately 32-74 percent of the slick would have dissipated by natural weathering, with between 30 and 32 percent lost to the atmosphere via evaporation and between 2 and 42 percent lost into the water column via natural dispersion. The volume of the slick would be further reduced by spill-response efforts (**Chapter 3.2.7**). However, other fates would likely be appropriate to a catastrophic spill event, especially in deep waters. For example, Ryerson et al. (2011) estimated that the total hydrocarbon mass for the *Deepwater Horizon* oil spill (including gas fraction) was partitioned among the following fates: ~36 percent to the deep subsurface plume; ~21 percent recovered by surface ships; ~10 percent to a surface slick; ~6 percent flared at the surface; and ~4 percent evaporated at the surface, which leaves ~23 percent unaccounted for based on available chemical data.

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. Hypothetical analyses were performed for a simulated pipeline break. Based on several scenarios implemented in the weathering model (e.g., variable season, oil type, and emulsification), BOEM estimated that the spill would dissipate from the water surface in approximately 2-10 days. Similarly, an OCS pipeline spill of 8,212 bbl on September 29, 1998, for which a panel investigation report was available, contained overflight information of the oil spill that showed the spill persisted for 5 days on the surface (USDOI, MMS, 1999).

Subsurface Release

The behavior of a spill depends on many factors, including the characteristics of the oil being spilled as well as oceanographic and meteorological conditions. Previously, an experiment in the North Sea indicated that the majority of oil released during a deepwater blowout would quickly rise to the surface and form a slick (Johansen et al., 2001). In such a case, impacts from a deepwater oil spill would occur at the surface where the oil is likely to be mixed into the water and dispersed by wind and waves. The oil would undergo natural physical, chemical, and biological degradation processes including weathering. However, data and observations from the *Deepwater Horizon* explosion, oil spill, and response challenged the previously prevailing thought that most oil from a deepwater blowout would quickly rise to the surface. Due in part to the application of subsea dispersants, measurable amounts of hydrocarbons (dispersed or otherwise) were detected in the water column as subsurface plumes and on the seafloor in the vicinity of the release (e.g., Diercks et al., 2010; OSAT, 2010). Subsurface plume formation is based on numerous factors, including the level of subsea dispersant injection, the amount of natural dispersion related to blowout properties, and oceanographic conditions such as water column stratification and cross currents. After the *Ixtoc* blowout in 1979, located 50 mi (80 km) offshore in the Bay of Campeche, Mexico, some subsurface oil also was observed dispersed within the water column (Boehm and Fiest, 1982); however, the scientific investigations were limited (Reible, 2010). The water quality of marine waters would be affected by the dissolved components and oil droplets that are small enough that they do not rise to the surface or are mixed down by surface turbulence. In the case of subsurface oil plumes, it is important to remember that these plumes would be affected by subsurface currents and could be diluted over time. Even in the subsurface, oil would undergo natural physical, chemical, and biological degradation processes including weathering.

3.2.1.5 Analysis of Offshore Spills ≥1,000 bbl

3.2.1.5.1 Overview of Spill Risk Analysis

The BOEM conducts an oil spill risk analysis prior to conducting lease sales in OCS areas (refer to **Figure 3-12**). The analysis is conducted in three parts:

(1) The trajectories of oil spills from hypothetical spill locations which are simulated using the OSRA Model (Smith et al., 1982).

(2) The probability of oil spill occurrence, which is based on spill rates derived from historical data (Anderson et al., 2012) and on estimated volumes of oil produced and transported.

(3) The combination of results of the first two to estimate the overall oil spill risk if there is oil development.

In the GOM, the Cumulative OCS Oil and Gas Program scenario comprises all future operations that would occur over a 70-year time period (2017-2086) from proposed, existing, and future leases regionwide. The analysis uses data on past OCS production and spills, along with estimates of future activities, to evaluate the risk of future spills.

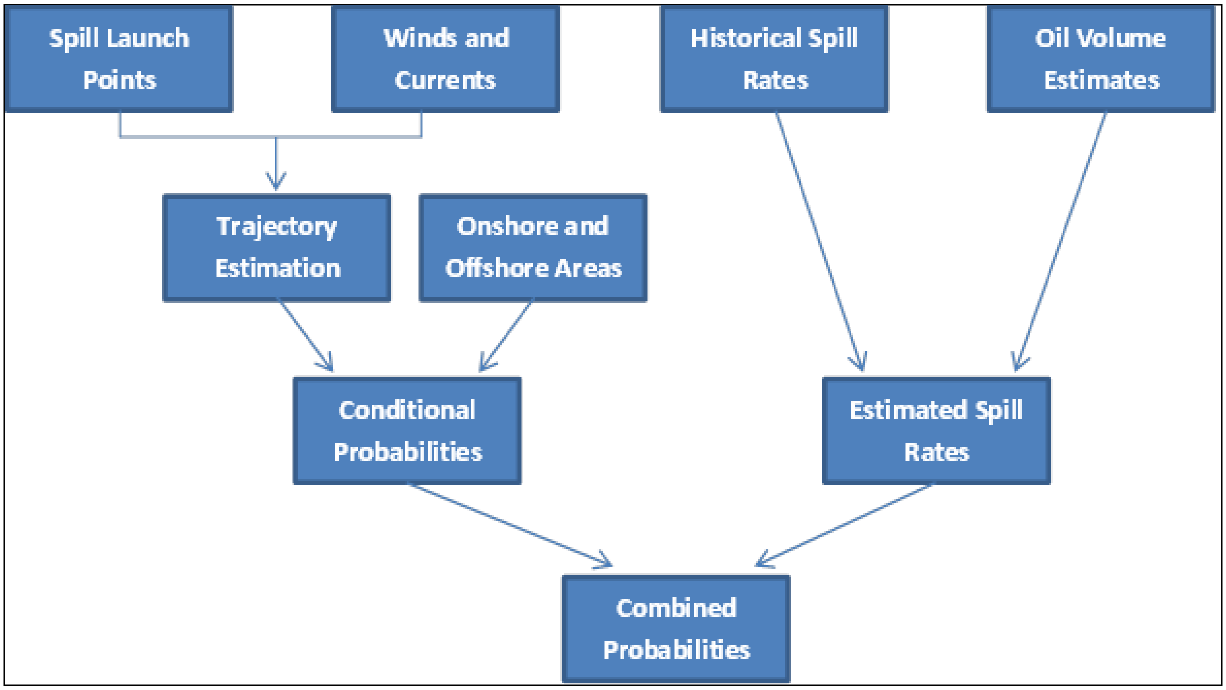

Figure 3-12. The Oil Spill Risk Analysis Model Process.

3.2.1.5.2 Trajectory Modeling for Offshore Spills ≥1,000 bbl

The Oil Spill Risk Analysis (OSRA) model simulates the trajectory of thousands of spills throughout the Gulf of Mexico OCS and calculates the probability of these spills being transported and contacting specified geographic areas and features. Using the OSRA model, BOEM estimates the likely trajectories of hypothetical offshore spills ≥1,000 bbl. Only spills ≥1,000 bbl are addressed because smaller spills may not persist long enough to be simulated by trajectory modeling. For this analysis, the OSRA model was run for Alternatives A, B, and C (**Tables 3-2 and 3-3**) and the Cumulative OCS Oil and Gas Program (2017-2086).

The OSRA model uses hypothetical spill locations called launch points and simulates the trajectory of a spill's movement on the surface of the water using modeled ocean currents and winds. The model can simulate a large number of hypothetical trajectories from each launch point. Spill trajectories are initiated once per day from each launch 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 originate from approximately 6,000 points uniformly distributed 6-7 mi (10-11 km) apart within the Gulf of Mexico OCS. This spacing between launch points is sufficient to provide a resolution that creates a statistically valid characterization of the entire area (Price et al., 2001).

The model tabulates the number of times each trajectory moves across or touches a location (contact) occupied by polygons mapped on the gridded area. These polygons represent specified geographic areas and features. The OSRA model compiles the number of contacts to each feature that results 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 a defined 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 10 and 30 days. All contacts that occurred during these periods were tabulated for Alternatives A, B, and C (**Table 3-17**).

Table 3-17. Probability (percent chance) of a Particular Number of Offshore Spills ≥1,000 Barrels Occurring as a Result of Either Facility or Pipeline Operations Related to Alternative A, B, or C.

	Facility Spills (%)		Pipeline Spills (%)		Total Spills (%)	
Alternative A[1]						
Number of Spills	Low	High	Low	High	Low	High
1	5	21	15	37	19	36
2	<0.5	3	1	18	2	23
3	<0.5	<0.5	<0.5	6	<0.5	10
4	<0.5	<0.5	<0.5	1	<0.5	3
5	<0.5	<0.5	<0.5	<0.5	<0.5	1
Alternative B[2]						
Number of Spills	Low	High	Low	High	Low	High
1	4	19	14	36	17	37
2	<0.5	2	1	16	2	20
3	<0.5	<0.5	<0.5	4	<0.5	7
4	<0.5	<0.5	<0.5	1	<0.5	2
5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Alternative C[3]						
Number of Spills	Low	High	Low	High	Low	High
1	1	4	2	11	3	14
2	<0.5	<0.5	<0.5	1	<0.5	1
3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Note: The columns under each spill category refer to the low and high resource estimates. Refer to **Table 3-1** for more information on resource estimates.

[1]Regionwide proposed lease sale.

[2]Regionwide proposed lease sale excluding blocks in the WPA.

[3]Regionwide proposed lease sale excluding blocks in the CPA/EPA.

3.2.1.5.3 Estimated Number of Offshore Spills ≥1,000 bbl and Probability of Occurrence

The mean number of spills ≥1,000 bbl estimated to occur as a result of each alternative is provided in **Table 3-18**. The range of the mean number of spills reflects the range of oil production volume estimated as a result of each alternative. The mean number of future spills ≥1,000 bbl is calculated by multiplying the spill rate (1.13 spills/BBO) by the volume of oil estimated to be produced as a result of each alternative. 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 (spills/BBO).

Table 3-18. Mean Number and Sizes of Spills Estimated to Occur in OCS Offshore Waters from an Accident Related to Rig/Platform and Pipeline Activities Supporting Each Alternative Over a 50-Year Time Period.

Spill Size Group	Spill Rate (spills/BBO)[1]	Number of Spills Estimated			Estimated Median Spill Size (bbl)[1]
		Alternative A	Alternative B	Alternative C	
0-1.0 bbl	2,020	424-2,258	374-1,959	51-290	<1
1.1-9.9 bbl	57.4	12-64	11-56	2-9	3
10.0-49.9 bbl	17.4	4-20	3-17	1-3	
50.0-499.9 bbl	11.3	2-13	2-11	<1-2	126
500.0-999.9 bbl	1.63	<1-2	<1-2	<1	
Platforms					
≥1,000-9,999 bbl	0.25	<1	<1	<1	5,066
≥10,000 bbl	0.13	<1	<1	<1	–[2]
Pipelines					
≥1,000-9,999 bbl	0.88	<1-1	<1	<1	1,720
≥10,000 bbl	0.18	<1	<1	<1	–[2]

Notes: The number of spills estimated is derived by application of the historical rate of spills (1996-2010) per volume of crude oil handled based on the projected production for each alternative (**Table 3-2**). The actual number of spills that may occur in the future could vary from the estimated number.

[1]The spill rates presented are a sum of rates for United States OCS platforms/rigs and pipelines. The average (vs. the median) spill sizes for a larger number of spill size categories can also be found in the original source (Anderson et al., 2012).

[2]During the last 15 years, the only ≥10,000-bbl spill was the *Deepwater Horizon*. However, this spill is considered to be a low-probability catastrophic event, which is not reasonably foreseeable and is therefore not included.

The probabilities for oil spill occurrence resulting from each alternative (2017-2066) and the Cumulative OCS Oil and Gas Program (2017-2086) for offshore spills ≥1,000 bbl can be found in **Table 3-19** and for spills ≥10,000 bbl in **Table 3-20**. The OSRA model estimates the chance of oil spills occurring during the production and transportation of a specific volume of oil over the lifetime of the scenario being analyzed. The estimation process uses a spill rate constant, based on historical accidental spills ≥1,000 bbl, expressed as a mean number of spills per billion barrels of oil handled. For this analysis, the low estimate and high estimate of projected oil production for a single lease sale for each alternative and for the Cumulative OCS Oil and Gas Program (2017-2086) are used.

For more information on OCS spill-rate methodologies and trends, refer to Anderson et al. (2012). A discussion of how the range of resource estimates was developed is provided in **Chapter 3.1.1** and **Table 3-1**.

Table 3-19. Oil-Spill Occurrence Probability Estimates for Offshore Spills ≥1,000 Barrels Resulting from Each Alternative (2017-2066) and the Cumulative OCS Oil and Gas Program (2017-2086).

	Forecasted Oil Production (Bbbl)[1]	Mean Number of Spills Estimated to Occur				Estimates of Probability (% chance) of One or More Spills			
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Single Lease Sale Alternatives									
Alternative A[2]	0.210	0.05	0.19	0	0.24	5	17	<0.5	21
	1.118	0.28	0.98	0.01	1.27	24	63	<0.5	72
Alternative B[3]	0.185	0.05	0.16	0	0.21	5	15	<0.5	19
	0.970	0.24	0.85	0	1.10	22	57	<0.5	67
Alternative C[4]	0.026	0.01	0.02	0	0.03	1	2	<0.5	3
	0.148	0.04	0.13	0	0.17	4	12	<0.5	15
Cumulative OCS Oil and Gas Program									
Regionwide	15.482	3.87	13.62	0.08	17.57	98	>99.5	7	>99.5
	25.806	6.45	22.71	0.13	29.29	>99.5	>99.5	12	>99.5
CPA/EPA	13.590	3.40	11.96	0.07	15.42	97	>99.5	7	>99.5
	22.381	5.60	19.70	0.11	25.40	>99.5	>99.5	11	>99.5
WPA	1.892	0.47	1.66	0	2.14	38	81	<0.5	88
	3.425	0.86	3.01	0	3.87	58	95	<0.5	98

Notes: Bbbl = billion barrels.
"Platforms" refers to facilities used in exploration, development, or production.
[1]Values represent the low and high resource estimates. Refer to **Table 3-1** for more information on resource estimates.
[2]Regionwide proposed lease sale.
[3]Regionwide proposed lease sale excluding blocks in the WPA.
[4]Regionwide proposed lease sale excluding blocks in the CPA/EPA.

Source: Ji, official communication, 2015.

Table 3-20. Oil-Spill Occurrence Probability Estimates for Offshore Spills ≥10,000 Barrels Resulting from Each Alternative (2017-2066) and the Cumulative OCS Oil and Gas Program (2017-2086).

	Forecasted Oil Production (Bbbl)[1]	Mean Number of Spills Estimated to Occur				Estimates of Probability (% chance) of One or More Spills			
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Single Sale Alternatives									
Alternative A[2]	0.210	0.03	0.04	0	0.07	3	4	<0.5	6
	1.118	0.15	0.20	0	0.35	14	18	<0.5	29
Alternative B[3]	0.185	0.02	0.03	0	0.06	2	3	<0.5	6
	0.970	0.13	0.17	0	0.30	12	13	<0.5	26
Alternative C[4]	0.026	0	0	0	0.01	<0.5	<0.5	<0.5	1
	0.148	0.02	0.03	0	0.05	2	3	<0.5	4
Cumulative OCS Oil and Gas Program									
Regionwide	15.482	2.01	2.79	0.02	4.82	87	94	2	99
	25.806	3.35	4.65	0.04	8.04	97	99	4	>99.5
CPA/EPA	13.590	1.77	2.45	0.02	4.23	83	91	2	99
	22.381	2.91	4.03	0.04	6.97	95	98	4	>99.5

	Forecasted Oil Production (Bbbl)[1]	Mean Number of Spills Estimated to Occur				Estimates of Probability (% chance) of One or More Spills			
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
WPA	1.892	0.25	0.34	0	0.59	22	29	<0.5	44
	3.425	0.45	0.62	0	1.06	36	46	<0.5	65

Notes: Bbbl = billion barrels.
"Platforms" refers to facilities used in exploration, development, or production.
[1]Values represent the low and high resource estimates. Refer to **Table 3-1** for more information on resource estimates.
[2]Regionwide proposed lease sale.
[3]Regionwide proposed lease sale excluding blocks in the WPA.
[4]Regionwide proposed lease sale excluding blocks in the CPA/EPA.

Source: Ji, official communication, 2015.

3.2.1.5.4 Most Likely Source of Offshore Spills ≥1,000 bbl

Table 3-17indicates the probabilities of one or more spills ≥1,000 bbl occurring from OCS facility or pipeline operations related to each alternative. The most likely cause of a spill ≥1,000 bbl is a pipeline break at the seafloor (Anderson et al., 2012). The various circumstances responsible for pipeline breaks included during the 1996-2010 analysis period were damage by an anchor, mudslide damage during a hurricane, a jack-up rig barge crushing the pipeline when it sat down on it, and microfractures from chronic contacts at a pipeline crossing where separators between the pipelines were missing.

3.2.1.5.5 Most Likely Size of an Offshore Spill ≥1,000 bbl

The estimated size of an offshore spill utilizes the median spill size from the trend analysis found in Anderson et al. (2012) for accidents occurring from drilling rig, platform, or pipeline activities. Extreme events such as the *Deepwater Horizon* oil spill skew the average and, as such, does not provide a useful statistical measure. The median size of spills ≥1,000 bbl that occurred during 1996-2010 is 2,240 bbl. This size was calculated based on the nine spills (both platforms/rigs and pipelines) that occurred during this timeframe and included the *Deepwater Horizon* oil spill. For information on the mean number and size of spills estimated to occur for each alternative, refer to **Table 3-18**.

3.2.1.5.6 Length of Coastline Affected by Offshore Spills ≥1,000 bbl

The BOEM has previously estimated the length of shoreline that could be contacted if a spill ≥1,000 bbl occurred as a result of an accident associated with each alternative (USDOI, MMS, 2007b). 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 (98 ft) 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 spill of 4,600 bbl was estimated to be 30-50 km (19-31 mi) 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.

3.2.1.5.7 Risk Analysis by Resource

The BOEM analyzes risk to resources from oil spills and oil slicks that could occur as a result of each alternative. The results are based on BOEM's estimates of likely spill locations, sources, sizes, frequency of occurrence, the physical fate of different types of oil slicks, and the probable transport that are described in more detail in the preceding spill scenarios. For offshore spills, combined probabilities were calculated using the OSRA model, which includes both the likelihood of a spill from each alternative occurring and the likelihood of the oil slick reaching areas where known resources exist.

The environmental, social and economic resources utilizing the OSRA modeling results were selected by BOEM analysts. Details on the individual resource categories, as well as a detailed analysis of the impacts to each resource from oil spills, are provided under each resource category in **Chapter 4**.

3.2.1.5.8 Likelihood of an Offshore Spill ≥1,000 bbl Occurring and Contacting Coastal and Offshore Areas

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 each alternative. This provides a risk factor that represents the probability of a spill occurring as a result of each alternative and contacting a specified geographic area or feature. These are 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 areas of sensitive environmental, social and economic resources. The combined probabilities for an offshore spill ≥1,000 bbl occurring and contacting coastal and offshore areas for each for each alternative can be found in the figures in **Appendix E**.

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, BOEM also generated combined probabilities for smaller areas within the GOM. A cluster analysis was used to analyze the contact probabilities generated for each of the 6,000 launch points. For this analysis, similar trajectories and contact to 10-mi (16-km) shoreline segments were tabulated to identify offshore cluster areas. The estimated oil production from each alternative 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 specific areas 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 each alternative 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.

3.2.1.6 Analysis of Offshore Spills <1,000 bbl

3.2.1.6.1 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 50 years as a result of each alternative is provided in **Table 3-18**. The number of spills is estimated by multiplying the oil-spill rate for each of the different spill size groups by the projected oil production as a result of each alternative (**Tables 3-2 and 3-3**). As spill size increases, the occurrence rate decreases and so the number of spills estimated to occur decreases.

3.2.1.6.2 Most Likely Source and Type of Offshore Spills <1,000 bbl

Most spills <1,000 bbl on the OCS would likely occur from a mishap on a production facility, most likely related to a failure related to the storage of oil. From 1995 to 2009, there were 14,191 spills <1,000 bbl on platforms, rigs, or vessels and 1,139 spills from pipelines (Anderson et al., 2012). Spills on platforms and rigs could be crude or refined (diesel, hydraulic) oil. Reported pipeline spills are likely to be crude oil, and vessel spills are likely to be refined oil. For spills <1,000 bbl, a total of 19,050 bbl were released to OCS waters from platforms, rigs, or vessels, and 8,002 bbl were released from pipelines.

3.2.1.6.3 Most Likely Size of Offshore Spills <1,000 bbl

Table 3-11 provides the most likely volume of oil estimated to be spilled for each of the spill-size groups. As stated previously, the estimated size of an offshore spill utilizes the median spill size from the trend analysis in Anderson et al. (2012) for all spill-size classes During the 50-year analysis period, 96 percent of all spills estimated to occur as a result of each alternative would be small spills <1 bbl (Anderson et al., 2012).

3.2.1.6.4 Likelihood of an Offshore Spill <1,000 bbl Occurring and Contacting Coastal and Offshore Areas

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 3-10 nmi (3.5-11.5 mi; 5.6-18.5 km) 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 [5-19 km] 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 and <1,000 bbl are infrequent. Should such a spill occur, the volume that would make landfall would be expected to be extremely small (a few barrels).

3.2.1.7 Analysis of Coastal Spills

Coastal spills occur in coastal waters, which are defined here as State offshore waters and spills in navigation channels, rivers, and bays from barges and pipelines carrying OCS-produced oil. These spills occur at shoreline storage, processing, and transport facilities supporting the OCS oil and gas industry. BOEM projects that most (>90%) oil produced as a result of a proposed action under Alternative A would be brought ashore via pipelines to oil pipeline shore bases, stored at these facilities, and eventually transferred via pipeline or barge to GOM 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.

3.2.1.7.1 Estimated Number and Most Likely Sizes of Coastal Spills

According to the USCG database for the most recent 12 years, January 2002-April 2014, (USDHS, USCG, 2015a) (**Table 3-13**), in the waters 0-3 nmi (0-3.45 mi; 5.56 km) off the Texas coast, there were a total of 93 spills reported from 2002 to 2014 or about 15 spills <1,000 bbl/yr. In the waters 0-3 nmi (0-3.45 mi; 5.56 km) off the Louisiana coast, there were a total of more than 1,493 spills reported from 2002-2014, or about 124 spills <1,000 bbl/yr. In the waters 0-3 mi (0-5 km) off the Mississippi coast, there were a total of 4 spills reported from all sources, or about 0.3 spills <1,000 bbl/yr. In the waters 0-3 nmi (0-3.45 mi; 5.56 km) off the Alabama coast, there were a total 15 spills reported from all sources from 1996 to 2009, or about 1.3 spills <1,000 bbl/yr. In the waters 0-3 nmi (0-3.45 mi; 5.56 km) off the Florida coast, there were a total 5 spills reported from all sources from 2002-2014, or about 0.4 spills <1,000 bbl/yr. When limited to just oil- and gas-related spill sources such as platforms, pipelines, MODU's, and support vessels, the number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of energy-related commercial and recreational activities remain the same. The coastal waters of Louisiana, Texas, Mississippi, Alabama, and Florida have had a total of 124, 15, 0.3, 1.3, and 0.4 spills <1,000 bbl/yr, respectively. Assuming future trends would reflect past historical records, it is also predicted that Louisiana will be the state most likely to have a spill ≥1,000 bbl occur in water 0-3 mi (0-5 km) offshore.

3.2.1.7.2 Likelihood of Coastal Spill Contact

Estimates of future coastal spills are based on historical spills reported to the USCG. Based upon historical data, offshore Louisiana is the most likely location for the occurrence of a coastal spill. A spill that occurs in Federal waters could also be transported to State waters.

3.2.2 Losses of Well Control

All losses of well control are required to be reported to BSEE. In 2006, BOEM and BSEE's predecessor (the Minerals Management Service), revised the regulations for loss of well control incident reporting, which were further clarified in NTL 2010-N05, "Increased Safety Measures for Energy Development on the OCS." Operators are required to document any loss of well control event, even if temporary, and the cause of the event by mail or email to the addressee indicated in the NTL. The operator does not have to include kicks that were controlled but should include the release of fluids through a flow diverter (a conduit used to direct fluid flowing from a well away from the drilling rig). The current definition for loss of well control is as follows:

- uncontrolled flow of formation or other fluids (the flow may be to an exposed formation [an underground blowout] or at the surface [a surface blowout]);
- uncontrolled flow through a diverter; and/or
- uncontrolled flow resulting from a failure of surface equipment or procedures.

Not all loss of well control events would result in a blowout as defined above, but it is most commonly thought of as a release to the human environment. A loss of well control can occur during any phase of development, i.e., exploratory drilling, development drilling, well completion, production, or workover operations. A loss of well control can occur when improperly balanced well pressure results in sudden, uncontrolled releases of fluids from a wellhead or wellbore (PCCI Marine and Environmental Engineering, 1999; Neal Adams Firefighters, Inc., 1991). Of the 47 loss of well control events reported in the GOM from 2007 to 2014, 25 (53%) resulted in loss of fluids at the surface or underground (USDOI, BSEE, 2015b).

The BSEE reports that they have had 288 unique loss of well control incidents captured in their database from 1956 to 2010 (Herbst, 2014), with an additional 22 incidents documented from 2010 through August 2015. A synopsis conducted by BSEE of the 288 well incidents that occurred from 1956 through 2010 shows the following:

- 69 of the 288 incidents had duration greater than or equal to 5 days (24%);
- 55 of the 69 incidents occurred in water depths <300 ft (91 m) (80%);
- 42 of the 69 incidents occurred within 50 mi (80 km) of shore (61%);
- a total of 31 fatalities occurred in 5 of the 69 incidents;
- a total of 84 injuries occurred in 7 of the 69 incidents; and
- 8 of the 69 incidents were oil blowouts (12%).

In contrast, the *Deepwater Horizon* oil spill continued uncontained for 87 days, between April 20 and July 15, 2010. The *Deepwater Horizon* blowout in Mississippi Canyon Block 252 resulted in the release of 4.9 MMbbl of oil and large quantities of gas (McNutt et al., 2011). For purposes of calculating the maximum possible civil penalty under the CWA, a January 2015 judgement used a quantity of 4.0 million barrels of oil for total discharged and 3.19 million barrels of oil as the actual amount that was released into environment (Barbier and Shushan 2015). As shown by the *Deepwater Horizon* explosion and oil spill, the loss of well control in deep water presents obstacles and challenges that differ from a loss of well control in shallow waters. Although many of the same techniques used for wild well control efforts in shallow water were used to attempt to control the *Macondo* well, these well control efforts were hindered by water depth, which required reliance solely upon the use of ROVs for all well intervention efforts. This is a concern in deep water because the inability to quickly regain control of a well increases the size of a spill.

There are several options that can be attempted to control a well blowout. Common kill techniques include (1) bridging, (2) capping/shut-in, (3) capping/diverting, (4) surface stinger, (5) vertical intervention, (6) offset kill, and (7) relief wells (Neal Adams Firefighters, Inc. 1991). Although much has been learned about well control as a result of the *Deepwater Horizon* explosion, oil spill, and response, if a deepwater subsea blowout occurs in the future, it is still likely that an operator would be required to immediately begin to drill one or more relief wells to gain control of the well. This may be required whether or not this is the first choice for well control because a relief well is typically considered the ultimate final solution for regaining well control in such circumstances. Although it can take months, the actual amount of time required to drill the relief well depends upon the following: (1) the depth of the formation below the mudline; (2) the complexity of the intervention; (3) the location of a suitable rig; (4) the type of operation that must be terminated in order to release the rig (e.g., may need to complete a casing program before releasing the rig); and (5) any problems mobilizing personnel and equipment to the location.

The major difference between a blowout during the drilling phase versus the completion or workover phases is the tendency for a drilling well to "bridge off." Bridging is a phenomenon that occurs when severe pressure differentials are imposed at the well/reservoir interface and the formation around the wellbore collapses and seals the well. Deepwater reservoirs are susceptible to collapse under "high draw down" conditions. However, a completed well may not have the same tendency to passively bridge off as would a drilling well involving an uncased hole. Bridging would have a beneficial effect for spill control by slowing or stopping the flow of oil from the well (PCCI Marine and Environmental Engineering, 1999). There is a difference of opinion among blowout specialists regarding the likelihood of deepwater wells bridging naturally in a short period of time. Completed wells, or those in production, have more severe consequences in the event of a blowout due to the hole being fully cased down to the producing formation, which lowers the probability of bridging (PCCI Marine and Environmental Engineering, 1999). Therefore, the potential for a well to bridge is greatly influenced by the phase of a well. Refer to **Chapter 3.2.7** for a discussion of planned well-source containment options that were designed to address an ongoing loss of well control event.

Blowout Preventers

A blowout preventer (BOP) is a device with a complex of choke lines and hydraulic rams mounted atop a wellhead designed to close the wellbore with a sharp horizontal motion that can cut through or pinch shut well casing and sever tool strings. The BOPs were invented in the early 1920's and have been instrumental in ending dangerous, costly, and environmentally damaging oil gushers on land and in water. The BOPs have been required for OCS oil and gas operations from the time offshore drilling began in the late 1940's.

The BOPs are actuated as a last resort upon imminent threat to the integrity of the well or the surface rig. For cased wells, in a normal situation, the hydraulic ram may be closed if oil or gas from an underground zone enters the wellbore and destabilizes it. By closing a BOP, usually by redundant surface-operated and hydraulic actuators, the drilling crew can prevent explosive pressure release and allow control of the well to be regained by balancing the pressure exerted by a column of drilling mud with formation fluids or gases from below.

Because BOPs are important for the safety of the drilling crew, as well as the rig and the wellbore itself, BOPs are regularly inspected, tested, and refurbished. The post-*Deepwater Horizon* explosion, oil spill, and response regulations and inspection program required for BOPs is discussed in **Appendix A.5**. Among the changes are new provisions for BOP testing. In addition, the Technology Assessment Program, a research element within BOEM's regulatory program, supports research associated with operational safety and pollution prevention. Since the *Deepwater Horizon* explosion, oil spill, and response, several well control-related studies have been funded through this program and the details of this research can be found on BSEE's website at http://www.bsee.gov/Technology-and-Research/Technology-Assessment-Programs/index/.

3.2.3 Accidental Air Emissions

Accidental events associated with offshore oil and gas activities can result in the emission of air pollutants. These OCS oil- and gas-related accidental events could include the release of oil, condensate, or natural gas; chemicals used offshore; pollutants from the burning of these products; fire; or H_2S release. The air pollutants could include NAAQS criteria pollutants, volatile and semi-volatile organic compounds, hydrogen sulfide, and methane. Emissions sources related to accidents from OCS operations can include well blowouts, oil spills, pipeline breaks, tanker accidents, and tanker explosions.

If a fire was associated with an accidental event, it could produce a broad array of pollutants including VOCs, NAAQS primary pollutants, and greenhouse gases. Although temporary in nature, response activities could impact air quality. These response activities could include *in-situ* burning, the use of flares to burn gas and oil, and the use of dispersants applied from aircraft. *In-situ* burning could impact air quality due to the possible release of toxic gases, and dispersants could impact air quality by possibly releasing toxic aromatics into the atmosphere. Atmospheric pollutants emitted from the *Deepwater Horizon* oil spill included plumes of organic aerosol particles and VOCs. In these plumes, the highly volatile species evaporated on time scales of <10 hours, while intermediate volatility evaporated between 10 and 1,000 hours. After the highly volatile species surfaced, they spread to a larger area due to surface currents and contributed to a wide spectrum of vapors (Bahreini et al., 2012). Additionally, in the presence of evaporating hydrocarbons from the oil spill, NO_x emissions from the recovery and cleanup activities produced ozone (Middlebrook et al., 2012).

The presence of H_2S within formation fluids occurs sporadically in the Gulf of Mexico OCS and may be released during an accident. Accidents involving the release of H_2S could result in irritation, injury, and lethality from leaks; exposure to sulfur oxides produced by flaring; equipment and pipeline corrosion; and outgassing and volatilization from spilled oil. Regulations and NTLs include safeguards and protective measures, which are in place to protect workers from H_2S releases.

3.2.3.1 Hydrogen Sulfide and Sulfurous Petroleum

Sulfur may be present in oil as elemental sulfur, within gas as H_2S, or within organic molecules, all three of which vary in concentration independently. Safety and infrastructure concerns include the following: irritation, injury, and even lethality to workers who are exposed to H_2S from leaks; exposure to sulfur oxides produced by flaring; equipment and pipeline corrosion; and outgassing and volatilization from spilled oil.

Sour oil and gas occur sporadically throughout the Gulf of Mexico OCS, primarily off the Louisiana, Mississippi, and Alabama coasts. Sour hydrocarbon tends to originate in carbonate source or reservoir rocks that may not have abundant clay minerals that serve as a binder for elemental sulfur. If not bound in clay minerals, it remains free and can become a part of any hydrocarbon produced or sourced from that rock.

Deep gas reservoirs on the GOM continental shelf are likely to have high corrosive content, including H_2S. There is some evidence that petroleum from deepwater areas may be sulfurous, but exploration wells have not identified deepwater areas that are extraordinarily high in H_2S concentration.

BOEM reviews all exploration and development plans in the Gulf of Mexico OCS for the possible presence of H_2S in the area(s) identified for exploration and development activities. Activities determined to be associated with a presence of H_2S are subjected to further review and requirements. Federal regulations at 30 CFR § 250.490(c) 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.

According to BSEE's regulations at 30 CFR § 250.490(f), all operators on the OCS involved in production of sour gas or oil (i.e., >20 ppm) are also required to file an H_2S Contingency Plan. This plan lays out procedures to ensure the safety of the workers on the production facility. In addition, all operators are required under 30 CFR § 250.107 to adhere to the National Association of Corrosion Engineers' (NACE) *Standard Material Requirements—Methods for Sulfide Stress Cracking and Stress Corrosion Cracking Resistance in Sour Oilfield Environments* (NACE MR0175-2003) (NACE, 2003) as best available and safest technology. The NACE standards that relate to an H_2S partial pressure of 0.05 pounds per square inch absolute primarily address stress cracking and stress corrosion resistance, while BSEE's definition of "H_2S present" addresses human safety and protecting the environment for H_2S concentrations equal to or exceeding 20 ppm. The BSEE is concerned if either threshold is crossed (NTL 2009-G31). These engineering standards preserve the integrity of infrastructure through specifying equipment to be constructed of materials with metallurgical properties that resist or prevent sulfide stress cracking and stress corrosion cracking in the presence of sour gas. The BSEE issued a final rule (30 CFR § 250.490; *Federal Register*, 1997) governing requirements for preventing H_2S releases, detecting and monitoring H_2S and sulfur dioxide, protecting personnel, providing warning systems and signage, and establishing requirements for H_2S flaring and venting. The NTL 2009-G31 establishes Standard Material Requirements, Materials for Sulfide Stress Cracking and Stress Corrosion Cracking Resistance in Sour Oilfield Environments (NACE Standard MR0175-2003) as best available and safest technology, provides further guidance on classifying an area for the presence of H_2S, includes guidance on H_2S detection, updates regulatory citations, and includes a guidance document statement. Hydrogen sulfide contingency plans are discussed in **Appendix A.8**.

3.2.4 Pipeline Failures

Significant sources of damages to OCS pipeline infrastructure can be caused by corrosion (**Chapters 3.1.4.1 and 3.1.6.1**), physical pipeline stress due to location, mass sediment movements and mudslides that can exhume or push the pipelines into another location, and accidents due to weather or impacts from anchor drops or boat collisions.

Long unsupported pipelines subjected to strong bottom currents will experience vortex-induced vibrations, which significantly increase pipeline fatigue. Two potential causes for pipeline failure are regional-scale hydrodynamic forces and vortex-induced vibrations. Hydrodynamic forces are of most concern to pipelines with multiple unsupported spans. In conjunction with strong episodic events, these pipelines may experience lateral instability and movement. Although the effects of hydrodynamic forces warrant attention, vortex-induced vibrations are perhaps of greatest concern.

Following the 2004, 2005, and 2008 hurricane seasons, BOEM commissioned studies to examine the failure mechanisms of offshore pipelines (Atkins et al., 2007; Energo Engineering, 2010; Atkins et al., 2006). Numerous pipelines were damaged after the 2004-2008 hurricanes passing through the CPA and WPA. Much of the reported damage was riser or platform-associated damage, which typically occurs when a platform is toppled or otherwise damaged. While many pipelines were damaged, few resulted in a spill >50 bbl. The total pipeline damage reports and number of spills are listed by hurricane below.

Hurricane	Total Pipeline Damage Reports	Number of Spills >50 bbl
Ivan	168	8
Katrina	299	5
Rita	243	5
Gustav and Ike	314	6

The largest spills are typically due to pipeline movements, mudslides, anchor drops, and collisions of one type or another. Most pipeline damage occurs in shallow water (<200 ft; 61 m) because of the potential for increasing impacts of the storm on the seabed in shallow water, the relative density of pipelines, or the age and design standards of the pipeline or the platforms to which the pipelines are connected. The future impact of hurricanes on damage to pipelines is uncertain. As oil production shifts from shallow to deeper water, there may be a consolidation of pipeline utilization.

The uncertain location of pipelines is an ongoing safety and environmental hazard. On October 23, 1996, in Tiger Pass, a channel through the Mississippi River Delta into the Gulf of Mexico near Venice, Louisiana, the crew of the Bean Horizon Corporation dredge *Dave Blackburn* dropped a stern spud (a large steel shaft that is dropped into the river bottom to serve as an anchor and a pivot during dredging operations) into the bottom of the channel in preparation for continued dredging operations. The spud struck and ruptured a 12-in (30-cm) diameter, submerged natural gas steel pipeline. Within seconds of reaching the surface, the natural gas ignited, destroying the dredge and the tug (USDOT, National Transportation Safety Board, 1998). Lack of awareness of the precise location of the pipeline was a major contributing factor to this accident (USDOT, National Transportation Safety Board, 1998). On December 5, 2003, this Agency received an incident report that a cutterhead dredge barge ruptured a 20-in (51-cm) diameter condensate pipeline in Eugene Island Block 39. Lack of awareness of the precise location of the pipeline was the major contributing factor to this accident as well. An OCS-related spill ≥1,000 bbl would likely be from a pipeline accident; the median spill size is estimated to be 2,200 bbl for rig/platform and pipeline activities supporting each alternative (**Table 3-14**). For Alternative A, B, or C, up to one spill of this size is estimated to occur.

3.2.5 Vessel and Helicopter Collisions

BOEM's data show that, from 2007 to 2014, there were 137 OCS oil- and gas-related collisions (USDOI, BSEE, 2015c). 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. Fires resulted from hydrocarbon releases in several of the collision incidents. 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 leasing area, spilling approximately 1,500 bbl. In 2014, an approximated 3,571 bbl of bunker fuel spilled into the Houston Ship Channel after a collision between a barge and a ship. Diesel fuel is the product most frequently spilled, while oil, natural gas, corrosion inhibitor, hydraulic fluid, and lube oil have also been released as the result of a vessel collision. Human error accounts for approximately half of all reported vessel collisions from 2006 to 2010. 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. To prevent any further incidents in regard to collisions with submerged or destroyed platforms following

Hurricanes Katrina and Rita, in December 2005, the Bureau of Ocean Energy Management, Regulation and Enforcement published a safety alert that provided the location of all facilities that were destroyed during the storms. In addition, the USCG 8th District's Local Notice to Mariners (monthly editions and weekly supplements) informs GOM 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 GOM. 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 (tankers, freight ships, passenger ships, and military vessels) pass within 35 mi (56 km) 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 oil- and gas-related vessels could collide with marine mammals, sea turtles, and other marine animals during transit. To limit or prevent such collisions, the NMFS provides all boat operators with whale-watching 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, sea turtles, or other marine animals probably varies as a function of spatial and temporal distribution patterns of the living resources, as 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.

The average number of helicopter accidents per year in the GOM since 1984 has been 7.9 per year, with the last 10 years averaging 4.7 per year and with only two in 2014. The 2014 GOM oil industry helicopter accident rate per 100,000 flight hours was 0.68, with a total of two accidents compared with a 31-year annual average accident rate of 1.74. The fatal accident rate per

100,000 flight hours during 2014 was 0.34 compared with a 31-year average of 0.44 (Heliport Safety Advisory Conference, 2015).

Since 1999, there have been 23 accidents of which only 5 were fatal; this resulted in 13 fatalities and 15 injuries. The leading causes, not all inclusive, of the accidents since 1999 were engine related, loss of control or improper procedures, helideck obstacle strikes, controlled flight into terrain, and other technical failures (Helicopter Safety Advisory Conference, 2015).

3.2.6 Chemical and Drilling-Fluid Spills

Chemicals and synthetic-based drilling fluids are used in offshore oil and gas drilling and production activities, and may be spilled to the environment due to equipment failure, weather (i.e., wind, waves, and lightning), accidental collision, and human error.

Chemicals are stored and used to condition drill muds during production and in well completions, stimulation, and workover procedures. The relative quantity of their use is reflected in the largest volumes spilled. Well completion, workover, and treatment fluids, including calcium chloride brine and zinc bromide, are the largest quantity used and are typically the largest accidental releases. Zinc bromide is of particular concern because it is persistent (nondegradable) and is comparatively toxic. A study of chemical spills from OCS oil- and gas-related activities determined that only two chemicals could potentially impact the marine environment—zinc bromide and ammonium chloride (Boehm et al., 2001). Other common chemicals spilled include methanol and ethylene glycol, which are used in deepwater operations where gas hydrates tend to form due to cold temperatures. These alcohol-based chemicals are nonpersistent (degradable) and exhibit comparatively low toxicity.

The SBF has typically been used since the mid-1990s for the deeper well sections because SBF has superior performance properties. The synthetic oil used in SBF is relatively nontoxic to the marine environment and has the potential to biodegrade. However, SBF is considered more toxic than water-based fluid, and spills of SBF are categorized separately from water-based fluid releases. Accidental riser disconnections result in the release of large quantities of drilling fluid.

Refer to **Table 3-21** for information on spill statistics for chemicals and SBFs for 2007-2012 (USDOI, BSEE, 2015d). The BSEE reports spills in categories of 10-49 bbl (small spills) and >50 bbl (large spills). **Table 3-21** shows the total annual spill volumes in barrels of product lost for SBFs and chemicals in both spill size categories. The number of spill incidents per year are listed with the average spill volume in barrels for a given year.

Table 3-21. Number and Volume of Chemical and Synthetic-Based Fluid Spills for 10-49 Barrels and >50 Barrels in the Gulf of Mexico from 2007 through 2014.

Year	Product Lost (bbl)		Number of Spills		Average Spill Volume (bbl)	
	SBF	Chemical	SBF	Chemical	SBF	Chemical
A. Spills 10-49 bbl						
2007	110	17	6	1	18	17
2008	73	102	2	6	37	17
2009	38	24	1	2	38	12
2010	54	51	3	3	18	17
2011	73	0	2	0	37	0
2012	88	12	4	1	22	12
2013	51	20	2	1	26	20
2014	0	0	0	0	0	0
Average Value	61	28	3	2	24	12
B. Spills Greater Than 50 bbl						
Year	Product Lost (bbl)		Number of Spills		Average Spill Volume (bbl)	
	SBF	Chemical	SBF	Chemical	SBF	Chemical
2007	1,518	550	2	1	759	550
2008	1,849	3,229	2	16	925	202
2009	602	500	4	3	151	167
2010	131	123	2	1	66	123
2011	252	0	2	0	126	0
2012	158	1,595	3	5	53	319
2013	0	0	0	0	0	0
2014	323	66	3	1	108	66
Average Value	604	758	2	3	273	178

SBF = synthetic-based fluid.

During the period of 2007 to 2014, small SBF spills occurred at an average annual volume of 61 bbl, while large spills occurred at an annual average volume of 601 bbl. During the same period, small chemical spills occurred at an average annual volume of 28 bbl, while large chemical spills occurred at an average annual volume of 758 bbl. Small SBF spills averaged 24 bbl per spill, while large SBF spills averaged 178 bbl per spill. A spike in the volume of large chemical spills in 2008 is attributed to Hurricane Ike, which occurred on September 13, 2008.

3.2.7 Spill Response

3.2.7.1 BSEE Spill-Response Requirements and Initiatives

3.2.7.1.1 Spill-Response Requirements

As a result of the Oil Pollution Act of 1990 and the reorganization of the Bureau of Ocean Energy Management, Regulation and Enforcement into BOEM and BSEE, BSEE was tasked with a number of oil-spill response duties and planning requirements. Within BSEE, the Oil Spill Preparedness Division addresses all aspects of offshore oil-spill planning, preparedness, and response. Additional information about the Oil Spill Preparedness Division can be found on BSEE's website at http://www.bsee.gov/About-BSEE/Divisions/OSPD/index/.

The BSEE implements the following regulations according to 30 CFR parts 250 and 254:

- requires immediate notification for spills >1 bbl—all spills require notification to USCG, and BSEE receives notification from the USCG of all spills ≥1 bbl;
- conducts investigations to determine the cause of a spill;
- assesses civil and criminal penalties, if needed;
- oversees spill source control and abatement operations by industry;
- sets requirements and reviews and approves OSRPs for offshore facilities (More information on oil-spill response plan regulations and processes can be found in **Appendix A.5**.);
- conducts unannounced drills to ensure compliance with OSRPs;
- requires operators to ensure that their spill-response operating and management teams receive appropriate spill-response training;
- conducts inspections of oil-spill response equipment;
- requires industry to show financial responsibility to respond to possible spills; and
- provides research leadership to improve the capabilities for detecting and responding to an oil spill in the marine environment.

BOEM receives and reviews the worst-case discharge information submitted for EPs, DPPs, and DOCDs on the OCS. BOEM also has regulatory requirements addressing site-specific OSRPs and spill-response information. As required by BOEM at 30 CFR §§ 550.219 and 550.250, operators are required to provide BOEM with an OSRP that is prepared in accordance with 30 CFR part 254 subpart B with their proposed exploration, development, or production plan for the facilities that they will use to conduct their activities; or to alternatively reference their approved regional OSRP by providing the following information:

- a discussion of the approved regional OSRP;
- the location of the primary oil-spill equipment base and staging area;
- the name of the oil-spill equipment removal organization(s) for both equipment and personnel;
- the calculated volume of the worst-case discharge in accordance with 30 CFR § 254.26(a) and a comparison of the worst-case discharge in the approved regional OSRP with the worst-case discharge calculated for the proposed activities; and
- a description of the worst-case discharge response scenario to include the trajectory information, potentially impacted resources, and a detailed discussion of the spill response proposed to the worst-case discharge in accordance with 30 CFR §§ 254(b)-(e).

All OSRPs are reviewed and approved by BSEE, whether submitted with a BOEM-associated plan or directly to BSEE in accordance with 30 CFR part 254. Hence, BOEM relies heavily upon BSEE's expertise to ensure that the OSRP complies with all pertinent laws and regulations, and demonstrates the ability of an operator to respond to a worst-case discharge. BOEM's regulations require that an operator must have an approved OSRP prior to BOEM's approval of an operator-submitted exploration, development, or production plan.

The operator is also required to carry out the training, equipment testing, and periodic drills described in the OSRP. In addition, since 1989, BSEE has conducted government-initiated unannounced exercises. In any given year, BSEE will hold both table-top, unannounced exercises and a limited number of response equipment deployment unannounced exercises. Equipment deployment exercises are held when BSEE elects to conduct an exercise of an operator's procurement, loading, and deployment of certain pieces of oil-spill response equipment that are cited within an operator's OSRP. The BSEE equipment deployment exercises are designed most often to take place in open water in waterways adjacent to where the equipment is stored in order to test the equipment that is proposed to be utilized offshore during the response, but the exercise may be moved to an alternate location if BSEE's exercise parameters require it. In addition, BSEE can also require that the nearshore and onshore equipment be deployed if a BSEE-developed drill scenario requires it. Drills testing the nearshore and onshore equipment would typically take place in an onshore or nearshore environment within the vicinity of a staging or storage area.

Any dispersant application included as part of the drill scenario always simulates the actual application of dispersant during BSEE's drills. No actual dispersants are ever utilized during the drills. Likewise, the oil spill itself is only simulated during any of BSEE's unannounced drills. Typical BSEE unannounced deployment exercises last only a few hours and rarely take longer than a day. Multi-day scenarios only occur when a more complicated drill scenario is developed by BSEE to test an operator's ability to adequately respond. Several NTLs and guidance documents have been issued by BOEM and BSEE that clarify oil-spill requirements since the occurrence of the *Deepwater*

Horizon explosion, oil spill, and response. More information on these NTLs and guidance documents can be found in **Appendix A.5**.

3.2.7.1.2 Spill-Response Initiatives

For more than 25 years, BSEE and its predecessors have maintained a comprehensive long-term research program to improve oil-spill response knowledge and technologies. The major focus of the program is to improve the methods and technologies used for oil-spill detection, containment, treatment, recovery, and cleanup. The BSEE Oil Spill Response Research program is a cooperative effort bringing together funding and expertise from research partners in State and Federal government agencies, industry, academia, and the international community. The funded projects cover numerous spill-response-related issues such as chemical treating agents; *in-situ* burning of oil; research conducted at BSEE's Oil Spill Response Test Facility (Ohmsett) located in Leonardo, New Jersey; behavior of oil; decisionmaking support tools; mechanical containment; and remote sensing.

The BSEE's recently awarded research contracts that highlight the varied types of research projects can be found on BSEE's website at http://www.bsee.gov/Technology-and-Research/Oil-Spill-Response-Research/index/.

3.2.7.2 Offshore Response, Containment, and Cleanup Technology

In the event of a spill, particularly a loss of well control, there is no single method of containment and removal that would be 100 percent effective. Spill cleanup is a complex and evolving technology. There are many situations and environmental conditions that necessitate different approaches. New technologies constantly evolve, but they provide only incremental benefits. Each new tool then becomes part of the spill-response tool kit. Each spill-response technique/tool has its specific uses and benefits (Fingas, 1995). Offshore removal and spill-containment efforts to respond to an ongoing spill offshore would likely require multiple technologies, including source containment, mechanical spill containment and cleanup, *in-situ* burning of the slick, and the use of chemical dispersants. Even with the deployment of all of these spill-response technologies, it is likely that, with the operating limitations of today's spill-response technology, not all of the oil can be contained and removed offshore.

Because no single spill-response method is 100 percent effective, it is likely that larger spills under the right conditions would require the simultaneous use of all available cleanup methods (i.e., source containment, mechanical spill containment and cleanup, dispersant application, and *in-situ* burning). Accordingly, the response to the *Deepwater Horizon* explosion, oil spill, and response employed all of these options simultaneously. The cleanup technique chosen for a spill response would vary depending upon the unique aspects of each situation. The selected mix of countermeasures would 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 majority of the proposed lease sale area could range from medium weight oil to condensate. The variety of standard cleanup protocols that were used for removing *Deepwater Horizon* oil from beaches, shorelines, and offshore water are identified in **Table 3-22**.

Table 3-22. Primary Cleanup Options Used during the *Deepwater Horizon* Response.

	Fresh Oil	Sheens	Mousse	Tarballs	Burn Residue
On-Water Response	Disperse, skim, burn	Light sheens very difficult to recover, heavier sheens picked up with sorbent boom or sorbent pads	Skim	Snare boom	Manual removal
On-Land Response	Sorbent pads, manual recovery, flushing with water, possible use of chemical shoreline cleaning agents	Light sheens very difficult to recover, heavier sheens picked up with sorbent boom or sorbent pads	Sorbent pads, manual recovery	Snare boom, manual removal, beach cleaning machinery	Manual removal

Source: USDOC, NOAA, 2010a.

Most oil-spill response strategies and equipment are based upon the simple principle that oil floats. However, as evident during the *Deepwater Horizon* explosion, oil spill, and response, this is not always true. Sometimes it floats and sometimes it suspends within the water column or sinks to the seafloor (refer to **Chapter 3.2.1.4**). Oil suspended in the water column and moving with the currents is difficult to track and recover using standard visual survey methods (Coastal Response Research Center, 2007).

Source Containment

The NTL 2010-N10 states that offshore operators address containment system expectations to be able to rapidly contain a spill as a result of a loss of well control from a subsea well. This resulted in the development of rapid response containment systems that are available through either the Marine Well Containment Company (MWCC) or Helix Well Ops in the Gulf of Mexico. In addition, industry has a multitude of vendors available within the GOM region that can provide the services and supplies necessary for debris removal capability, dispersant injection capability, and top-hat deployment capability. Many of these vendors are already cited for use by MWCC and Helix Well Ops. The BSEE does not allow an operator to begin drilling operations until adequate subsea containment and collection equipment, as well as subsea dispersant capability, is determined by BSEE to be available to the operator and is sufficient for use in response to a potential incident from the proposed well(s).

Marine Well Containment Company

The Marine Well Containment Company's (MWCC's) Containment System includes two modular capture vessels (MCVs); enhanced subsea umbilical, risers, and flowlines (SURF) equipment; three capping stacks; and additional ancillary equipment. The capping stack is uniquely designed to shut off the flow of fluid from the well or by providing a conduit to safely flow well fluids to the two MCVs. The processing equipment on the MCVs can separate sand and process liquids and gases flowed from a damaged subsea well. The MWCC Containment System is built for use in the deepwater Gulf of Mexico, defined as water depths from 500 to 10,000 ft (1,524-3,048 m), in temperatures up to 350 °F (177 °C), and under pressure up to 15,000 psi. The MWCC's suite of containment equipment enables the company to mobilize and deploy the most appropriate well containment technology based upon the unique well control incident and equipment requirements. The system has the capacity to contain up to 100,000 bbl of liquid per day (4.2 million gallons/day) and handle up to 200 million standard cubic feet of gas per day. It is envisioned that this system could be fully operational within days to weeks after a spill event occurs (Marine Spill Response Corporation, 2015a).

The Marine Well Containment Company's SURF equipment, which is used to flow fluid from the capping stack to the MCVs as well as to provide dispersant and hydrate mitigation injection, is staged in Theodore, Alabama. The MWCC houses, stores, and tests the processing equipment for the two MCVs as well as its capping stacks in Ingleside, Texas. The companies that originated this system have formed a nonprofit organization, the Marine Well Containment Company, to operate and maintain the system (Marine Spill Response Corporation, 2015a). The MWCC would provide fully trained crews to operate the system, ensure the equipment is operational and ready for rapid response, and conduct research on new containment technologies (Marine Spill Response Corporation, 2015a).

In the summer of 2012, a full-scale deployment of MWCC's critical well-control equipment to exercise the oil and gas industry's response to a potential subsea blowout in the deep water of the Gulf of Mexico was conducted by BSEE. The MWCC's 15,000-psi capping stack system, a 30-ft (9-m) tall, 100-ton piece of equipment similar to the one that stopped the flow of oil from the *Macondo* well following the *Deepwater Horizon* explosion in 2010, was successfully tested during this deployment drill. During this exercise, the capping stack was deployed from its storage location in Ingleside, Texas, to an area in the Gulf of Mexico nearly 200 mi (322 km) from shore. Once on site, the system was lowered to a simulated wellhead (a pre-set parking pile) on the ocean floor in nearly 7,000 ft (2,134 m) of water, connected to the wellhead, and then pressurized to 10,000 psi.

Helix Well Ops

Another option for source control and containment in the Gulf of Mexico is through Helix Well Ops. Helix Well Ops contracted the equipment that it found useful in the *Deepwater Horizon* explosion, oil spill, and response and offered it to oil and gas producers for use beginning January 1, 2011. This system focused on the utilization of the *Helix Producer I* and the *Q4000* vessels. Each of these vessels played a role in the *Deepwater Horizon* explosion, oil spill, and response explosion, oil spill, and was continually working in the Gulf of Mexico. Helix Well Ops' system, which is referred to as the Helix Fast Response System today, has the ability to fully operate in up to 10,000 ft (3,048 m) of water and has intervention equipment to cap and contain a well with the mechanical integrity to be shut-in. The Helix Fast Response System also has the ability to capture and process 57,000 bbl of oil per day, 72,000 bbl of liquid per day, and 120 million standard cubic feet per day at 10,000 psi (Helix Well Containment Group, 2015).

In April-May 2013, a full-scale deployment of Helix Well Ops' critical well-control equipment to exercise the oil and gas industry's response to a potential subsea blowout in the deep water of the Gulf of Mexico was conducted by BSEE. Helix Well Ops' capping stack system is a 20-ft (6-m) tall, 146,000-pound piece of equipment similar to the one that stopped the flow of oil from the *Macondo* well following the *Deepwater Horizon* explosion in 2010. It was successfully tested during this unannounced deployment drill. The capping stack was deployed from its storage location and once onsite, the system was lowered to a simulated wellhead (a pre-set parking pile) on the ocean floor in nearly 5,000 ft (1,524 m) of water, connected to the wellhead, and then pressurized to 8,400 psi.

3.2.7.2.1 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. Booms are used to enclose oil and prevent it from spreading; to protect harbors, bays, and biologically sensitive areas; to divert oil to areas where it can be recovered or treated; and to concentrate oil and maintain an even thickness so that skimmers can be used; or other cleanup techniques, such as *in-situ* burning, can be applied. Sorbent booms are specialized containment and recovery devices made of porous sorbent material such as woven or fabric polypropylene, which absorbs oil while it is being contained. Sorbent booms are used when the oil slick is relatively thin for final polishing of an oil spill, to remove small traces of oil or sheen, or as a backup to other booms. Skimmers are mechanical devices designed to remove oil from the water surface. Skimmers are classified according to their basic operating principles: oleophilic surface skimmers; weir skimmers; suction skimmers or vacuum devices; elevating skimmers; and submersion skimmers (Fingas, 2013).

It is expected that the oil-spill response equipment needed to respond to an offshore spill in the proposed sale area could be called out from one or more of the following oil-spill equipment base locations: New Iberia, Belle Chasse, Baton Rouge, Sulphur, Morgan City, Port Fourchon, Harvey, Houma, Galliano, New Iberia, Leeville, Fort Jackson, Venice, Grand Isle, or Lake Charles, Louisiana; Corpus Christi, Port Arthur, Aransas Pass, Ingleside, Galveston, or Houston, Texas; Pascagoula or Kiln, Mississippi; Mobile or Bayou La Batre, Alabama; and/or Panama City, Pensacola, Tampa, and/or Miami, Florida (Clean Gulf Associates, 2015; Marine Spill Response Corporation, 2015b; National Response Corporation, 2015). Response times for any of this equipment would vary, depending 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 anticipated that equipment would be procured from the closest available oil-spill equipment bases.

As indicated in **Chapter 3.2.7.1 and Appendix A.5**, BSEE oversees a research program to improve the capabilities for detecting and responding to an oil spill in the marine environment. One of BSEE's recently completed research projects suggested an alternative to improve the present regulatory requirements at 30 CFR § 254.44 for determining the effective daily recovery capacity of spill-response skimming equipment. This suggested alternative would consider the encounter rate of a skimming system with spilled oil instead of the presently used de-rated pump capacity of a skimmer. This project was undertaken because the *Deepwater Horizon* oil-spill response highlighted that the existing regulation may not be an effective or accurate planning standard and predictor of oil-spill response equipment recovery capacity. The project was completed in 2012 and the National Academy of Sciences completed a peer review in 2013. The BSEE is currently utilizing the results of this study during their review and approval of operator-submitted OSRPs (USDOI, BSEE, 2015b). The USCG has indicated that the guidance generated by this research is applicable for offshore use but that a separate standard would still need to be developed for nearshore response capability determinations.

If an oil spill occurs during a storm, spill response from shore may be delayed to after 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).

In rough seas, a large spill of low viscosity oil, such as a light or medium crude oil, can be scattered over many square kilometers within just a few hours. Oil recovery systems typically have swath widths of only a few meters and move at slow speeds while recovering oil. Therefore, even if this equipment can become operational within a few hours, it would not be feasible for them to encounter more than a fraction of a widely spread slick (International Tanker Owners Pollution Federation Limited, 2010). For this reason, it is assumed that a maximum of 10-30 percent of an oil spill in an offshore environment can be mechanically removed from the water prior to the spill making landfall (U.S. Congress, Office of Technology Assessment, 1990). Some newer oil skimming equipment procured internationally displayed faster recovery speed during the response to the *Deepwater Horizon* oil spill, and some changes were also made in the logistics of how skimmers and booms were positioned offshore during this response that increased the equipment's swath width. However, for the *Deepwater Horizon* response, it was estimated that only 3 percent of the total oil spilled was picked up by mechanical equipment offshore (Lubchenco et al., 2010).

A common difficulty when deploying booms and skimmers to recover oil is coordinating vessel activities to work the thickest areas of oil (International Tanker Owners Pollution Federation Limited, 2010). It is a rule of thumb that 90 percent of the oil is in 10 percent of the area. The 10 percent of the oil that makes up 90 percent of a slick is typically sheen. For this reason, containment and recovery operations on water require extensive logistical support to direct the response effort. Additionally, the limitations that poor weather and rough seas impose on spill-response operations offshore are seldom fully appreciated. Handling wet, oily, slippery equipment on vessels that are pitching and rolling is difficult and can raise safety considerations. Winds, wave action, and currents can drastically reduce the ability of a boom to contain and a skimmer to recover oil. It is important to select equipment for a response that is suitable for the type of oil and the prevailing weather and sea conditions for a region. Efforts should generally be made to target the heaviest oil concentrations and areas where collection and removal of the oil would reduce the likelihood of oil reaching sensitive resources and shorelines. As oil weathers and increases in viscosity, cleanup techniques and equipment should be reevaluated and modified (International Tanker Owners Pollution Federation Limited, 2010).

Practical limitations of strength, water drag, and weight mean that generally only relatively short lengths of boom (tens to a few hundred meters) can be deployed and maintained in a working configuration. Towing booms at sea (e.g., in U or J configurations, which increase a skimmer's swath width) is a difficult task requiring specialized vessels and trained personnel (International Tanker Owners Pollution Federation Limited, 2010). Additional boom limitations are discussed in **Chapter 3.2.7.3**. Because skimmers float on the water surface, they experience many of the operational difficulties that apply to booms, particularly those posed by wind, waves, and currents (International Tanker Owners Pollution Federation Limited, 2010). The effectiveness of any skimmer depends upon a number of factors, in addition to the ambient weather and sea conditions, including the type of oil, the thickness of the oil, the presence of debris in the oil or in the water, the extent of weathering and emulsification of the oil, and the location of the spill (Fingas, 2013). Even moderate wave motion can greatly reduce the effectiveness of most skimmer designs (International Tanker Owners Pollution Federation Limited, 2010). In high sea-state conditions, many skimmers, especially weir and suction skimmers, take up more water than oil (Fingas, 2013). Because of the various constraints placed upon skimmers in the field, their design capacities are rarely realized. Experience from numerous spills has consistently shown that skimmer recovery rates reported under test conditions cannot be sustained during a spill response (International Tanker Owners Pollution Federation Limited, 2010). The availability of sufficient oil-storage facilities is necessary to ensure continuous oil-spill recovery. This storage needs to be easy to handle and easy to empty once full so that it can be used repeatedly with the least interruption in recovery activity (International Tanker Owners Pollution Federation Limited, 2010).

There are no proven methods for the containment of submerged oil, and methods for recovery of submerged oils have limited effectiveness. Efforts to mechanically contain and/or recover suspended oil have focused on different types of nets, either the ad hoc use of fishing nets or specially designed trawl nets. There has been some research conducted on the design of trawl nets for the recovery of emulsified fuels. However, the overall effectiveness for large spills is expected to be very low. The suspended oil can occur as liquid droplets or semisolid masses in sizes ranging from millimeters to meters in diameter (Coastal Response Research Center, 2007). At spills where oil has been suspended in the water column, responders have devised low technology methods for tracking the presence and spread of oil over space and time. For suspended oil, these methods include stationary systems such as snare sentinels, which can consist of any combination of the following: a single length of white absorbent pom-poms (snare) on a rope attached to a float and an anchor; one or more crab traps on the bottom that are stuffed with snare; and minnow or other type of traps that are stuffed with snare and deployed at various water depths. The configuration would depend upon the water depth where the oil is located within the water column.

At present, it is not possible to determine the particle size, number of particles, or percent oil cover in the water column based upon the visual observations of oil on these systems (Coastal Response Research Center, 2007).

Spills involving submerged oil trigger the need for real-time data on current profiles (surface to bottom), wave energy, suspended sediment concentrations, detailed bathymetry, seafloor sediment characteristics, and sediment transport patterns and rates. These data are needed to validate or calibrate models (both computer and conceptual), direct sampling efforts, and predict the behavior and fate of the submerged oil. This information might be obtained through the use of acoustic Doppler current profilers, dye tracer studies, rapid seafloor mapping systems, and underwater camera or video systems that can record episodic events (Coastal Response Research Center, 2007). During the *Deepwater Horizon* response, fluorimeters were used successfully to detect the presence of submerged oil.

3.2.7.2.2 Spill Treating Agents

Treating oil with specially prepared chemicals is another option for responding to oil spills. An assortment of chemical spill treating agents is available to assist in cleaning up oil. However, approval must be obtained in accordance with the provisions of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) before these chemical agents can be used.

The USEPA has recently issued a proposed rule to amend the requirements in Subpart J of the NCP that governs the use of dispersants, other chemical and biological agents, and other spill mitigating substances when responding to oil discharges into waters of the United States. The proposed rule addresses the efficacy, toxicity, environmental monitoring of dispersants, and other chemical and biological agents, as well as public, State, local and Federal officials' concerns regarding their use (*Federal Register*, 2015b). The USEPA also updated the NCP product schedule in 2014. The 2014 NCP Product Schedule lists the following types of products that are authorized for use on oil discharges:

- dispersants;
- surface washing agents;
- surface collecting agents;
- bioremediation agents; and
- miscellaneous oil-spill control agents.

In February 2014, the USEPA also published an NCP Product Schedule Notebook that presents manufacturers' summary information that describes (1) the conditions under which each of the products is recommended for use, (2) handling and worker precautions, (3) storage information, (4) recommended application procedures, (5) physical properties, (6) toxicity information, and (7) effectiveness information (USEPA, 2014b).

Dispersants

When dispersants are applied to spilled crude oil, the surface tension of the oil is reduced, allowing wind and wave action to break the oil into tiny droplets that are dispersed into the upper portion of the water column. Oil that is chemically dispersed at the surface move into the top 20 ft (6 m) of the water column where it mixes with surrounding waters and begins to biodegrade (U.S. Congress, Office of Technology Assessment, 1990). Dispersant use, in combination with natural processes, breaks up oil into smaller components that allows them to dissipate into the water and degrade more rapidly (Nalco, 2010). Dispersant use must be in accordance with a Regional Response Team's (RRT) Preapproved Dispersant Use Manual and with any conditions outlined within a RRT's site-specific, dispersant approval given after a spill event. Consequently, dispersant use must be in accordance with the restrictions for specific water depths, distances from shore, and monitoring requirements. At this time, neither the Region IV nor the Region VI RRT dispersant use manuals, which cover the GOM region, give preapproval for the application of dispersant use subsea. However, the USEPA is presently revisiting these RRT preapprovals in light of the dispersant issues, such as subsea application, that arose during the *Deepwater Horizon* response. The USEPA issued a letter dated December 2, 2010, that provided interim guidance on the use of dispersants for major spills that are continuous and uncontrollable for periods greater than 7 days and for expedited approval of subsurface applications. This letter outlined the following exceptions to the current preapprovals until they are updated:

- dispersants may not be applied to major spills that are continuous in nature and uncontrollable for a period greater than 7 days;
- additional dispersant monitoring protocols and sampling plans may be developed that meet the unique needs of the incident; and
- subsurface dispersants may be approved on an incident-specific basis as requested by the USCG On-Scene Coordinator.

In addition, this letter indicated that more robust documentation may be required. This documentation would include daily reports that contain the products used, specific time and locations of application, equipment used for each application, spotter aircraft reports, photographs, vessel data, and analytical data.

Additionally, in light of the dispersant issues that arose during the *Deepwater Horizon* response, the State of Florida's Department of Environmental Protection submitted a letter dated May 5, 2011, to the USEPA Region IV RRT in which the State of Florida withdrew all State waters (9 nmi [10.36 mi; 16.67 km] off the coast of Florida in the Gulf of Mexico) from the Green Zone (or approved area) for dispersant preapproval as outlined within the *Use of Dispersants in Region IV* document (USEPA, Region IV Regional Response Team, 1996). The State indicated in the letter that this change was requested due to the enormous changes that have occurred in communication and response technologies since the preapproval was first agreed to in 1996. The State indicated that they felt that the *Use of Dispersants in Region IV* document needed to be updated to reflect technological advances and lessons learned during the response to the *Deepwater Horizon* oil spill (State of Florida, Dept. of Environmental Protection, 2011).

For a deepwater (>1,000-ft [305-m] 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. However, the window of opportunity for successful dispersant application may be somewhat narrower for some deepwater locations that are dependent upon the physical and chemical properties of oil, which tend to be somewhat heavier than those found closer to shore. A significant reduction in the window of opportunity for dispersant application may render this response option ineffective.

Due to the unprecedented volume of dispersants applied for an extended period of time in situations not previously envisioned or incorporated in existing dispersant use plans (i.e., during the *Deepwater Horizon* oil-spill response), the National Response Team has developed guidance for monitoring atypical dispersant operations. The guidance document, which was approved on May 30, 2013, is titled *Environmental Monitoring for Atypical Dispersant Operations: Including Guidance for Subsea Application and Prolonged Surface Application*. The subsea guidance generally applies to the subsurface ocean environment and focuses on operations in water depths below 300 m (984 ft) and below the pycnocline or in the interface between an upper mixed density gradients and a lower stable density gradient. The surface application guidance supplements and complements the existing protocols as outlined within the existing Special Monitoring of Applied Response Technologies monitoring program where the duration of the application of dispersants on discharged oil extends beyond 96 hours from the time of the first application (U.S. National Response Team, 2013). This guidance is provided to the Regional Response Teams by the National Response Team to enhance existing Special Monitoring of Applied Response Technologies protocols and to ensure that their planning and response activities are consistent with national policy.

The most popular application method for dispersants in the offshore GOM is from small and large fixed-wing aircraft. Based on the present location of dispersant stockpiles and dispersant application equipment available to the Oil Spill Removal Organizations used by offshore operators in the GOM, it is expected that the dispersant application aircraft called out for an oil-spill response to an offshore spill in the proposed lease sale area would come from Houma, Louisiana; Kiln, Mississippi; Mesa, Arizona; Concord, California; and/or Salisbury, Maryland. Stockpiles of dispersants are located at each of the designated staging airports. 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 Multisale EIS assumes that dispersant application applied to the water surface would be effective on 20-50 percent (S.L. Ross Environmental Research Ltd., 2000) of the treated oil.

If an oil spill occurs during a storm, the dispersant application would occur following the storm. Aerial and vessel dispersant application would not be possible while storm conditions continued. 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).

Other Spill Treating Agents

Surface washing agents, emulsion breakers and inhibitors, recovery enhancers, solidifiers, and sinking agents are other types of chemical treatment agents that are available, if approval is obtained, for treating oil spills. The use of these chemical products is subject to approval in the same manner as dispersants. The use of bioremediation agents also requires approval in the same manner as dispersants. The U.S. Environmental Protection Agency's NCP Product Schedule Notebook presents manufacturers' summary information that describes (1) the conditions under which each of the products is recommended for use, (2) handling and worker precautions, (3) storage information, (4) recommended application procedures, (5) physical properties, (6) toxicity information, and (7) effectiveness information (USEPA, 2014b).

3.2.7.2.3 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 ideal circumstances, *in-situ* burning requires less equipment and much less labor than other cleanup techniques (Fingas, 2013). *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, which is a specialized boom that has been constructed to withstand the high temperatures from burning oil. 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. *In-situ* burning was successfully used in 411 burns during the *Deepwater Horizon* oil-spill response, successfully eliminating between 220,000 and 300,000 bbl of oil from the water surface (Allen, 2010), approximately 5 percent of the *Macondo* oil spilled (Lubchenco et al., 2010).

Because of the successful use of this technology during the *Deepwater Horizon* oil-spill response, the Gulf of Mexico's Oil Spill Removal Organizations have procured fire boom, which they have strategically stockpiled throughout the GOM region. Response times for bringing a fire-resistant boom onsite would vary, depending on the location of the equipment, the staging area, and the spill site. If an oil spill occurs during a storm, *in-situ* burning would occur following the storm. *In-situ* burning would not be possible while storm conditions continued.

3.2.7.2.4 Natural Dispersion

Depending upon environmental conditions and spill size, 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 that 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, such as a marsh habitat, when the potential damage caused by a cleanup effort could cause more damage than the spill itself. For more information on the transport and fate of oil spills, refer to **Chapter 3.2.1.3**.

3.2.7.3 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 (ACPs) 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 U.S. is accomplished through a mandated set of interrelated plans. The ACPs cover subregional geographic areas and represent the third tier of the National Response Planning System mandated by the Oil Pollution Act of 1990. The ACPs are a focal point of response planning, providing detailed information on response procedures, priorities, and appropriate countermeasures. The USCG has worked diligently to improve coastal oil-spill response since the *Deepwater Horizon* oil spill by improving the ACPs for each coastal USCG sector. The GOM coastal area that falls within the USCG's 8th District is covered by ACPs for areas covered by USCG Sector Corpus Christi, Sector Houston/Galveston, Sector Port Arthur, Sector Morgan City, Sector New Orleans, and Sector Mobile. The ACPs from the USCG's 7th District cover the remaining GOM coastal area. The Gulf of Mexico OCS Region's ACPs also include separate Geographic Response Plans (GRP), which are developed jointly with local, State, and other Federal entities to better focus spill-response tactics and priorities. These GRPs contain the resources initially identified for protection during a spill, response priorities, procedures, and appropriate spill-response countermeasures. The ACPs are written and maintained by Area Committees assembled from Federal, State, and local government 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 Office and are comprised of members from local or area-specific jurisdictions. Response procedures identified within an ACP or its GRP(s) reflect the priorities and procedures agreed to by members of the Area Committees.

If an oil slick reaches the coastline, the responsible party should be prepared to deploy any of the shoreline cleanup countermeasures that were specified for the protection of the prioritized sensitive areas that are identified within the appropriate GRPs that cover these areas. The single, most-frequently recommended, spill-response strategy for the areas identified for protection in all of the applicable ACPs or its GRPs 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. Since oil spilled at sea tends to move and spread rapidly into very thin layers, boom is deployed to corral the oil on the water to enhance recovery effectiveness of skimmers and other response technologies. Boom is also used to protect shoreline areas and to minimize the consequences of an oil spill reaching shore. There are tradeoffs in deciding where and when to place boom because, once deployed, boom is time consuming to tend and to relocate. For example, booming operations are sensitive to wind, wave, and currents and need to be tethered and secured to keep the boom from moving. Rough seas can tear, capsize, or shred boom. Currents over 1.5 knots (1.7 miles per hour) or even a wake from a boat can send oil over or under a boom. Untended boom can become a barricade to wildlife and ship traffic. Boom anchors can damage some habitats. During the *Deepwater Horizon* response, it was discovered that hard boom often did more damage in the marsh it was intended to protect than anticipated after weather conditions ended up stranding the boom back into the marsh.

If a shoreline is oiled, the selection of the type of shoreline remediation to be used would 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) jurisdictional considerations. To determine which cleanup method is most appropriate during a spill response, decision-makers must assess the severity and nature of the injury using Shoreline Cleanup and Assessment Team (SCAT) survey observations. These onsite decisionmakers must also estimate the time it would take for an area to recover in the absence of cleanup (typically considering short term to be 1-3 years, medium term to be 3-5 years, and long term greater than 5 years) (U.S. National Response Team, 2010). The variety of standard cleanup protocols that were used for removing *Macondo* oil from beaches, shorelines, and offshore water are identified in **Table 3-22**.

During the *Deepwater Horizon* shoreline response, oiling conditions generally included surface and buried oil layers, surface and buried oil/sand balls, stained sand, and sunken oil in the adjacent subtidal waters. Since waste minimization was a core principle considered when cleaning sand beaches, efforts were made to remove as little sediment as practical from the shore zone during cleaning operations. Treatment methods for sand beaches comprised manual and mechanical removal, an on-site treatment plant, and sediment relocation. Mechanical removal involved a range of commercial self-propelled or towed machines designed primarily to sieve debris and litter on recreational beaches. Field trials were conducted to evaluate which specific mechanisms were more appropriate for the different oiling conditions. The beach cleaners were used as scrapers on the more heavily oiled beaches in Louisiana, whereas the sieving function was more appropriate to recover oil particles on the beaches of Mississippi, Alabama, and Florida. Oiled wetlands included *Spartina* salt marshes and *Phragmites* (“roseau cane”) brackish-freshwater wetlands in the Mississippi Delta. Because previous spills in this region provided an understanding of the recovery potential for the oiled wetlands, natural recovery was the preferred strategy in most cases based on the generally light oiling conditions. Natural attenuation was relatively rapid if an area was only lightly oiled, as the *Macondo* well oil type had an API gravity of 35˚. A guiding principle for wetland treatment was to minimize physical intrusion and work from floating platforms, skiffs, or shallow-draft barges, whenever possible. Floating mechanical flushing machines, using concrete pump arms, were used on a limited scale to reach into oiled fringe wetlands to wash and recover mobile oil. Oiled rip rap, breakwaters, and groins and jetties were treated through manual removal of bulk oil and were washed using a range of temperatures and pressures depending on the character of the oil (Owens et al., 2011).

Shoreline Cleanup Countermeasures

When spilled oil contaminates shoreline habitats, responders should survey the affected areas to determine appropriate response. Although general approvals or decision tools for using shoreline cleanup methods can be developed during pre-spill planning stages, responders' specific treatment recommendations should integrate gathered, filed, and documented data on shoreline habitats, oil type, the degree of shoreline contamination, spill-specific physical processes, and ecological and cultural resource issues. Cleanup endpoints should be established early so that appropriate cleanup methods can be selected to meet the cleanup objectives. Shoreline surveys, as part of the SCAT program, should be conducted systematically because they are imperative to the cleanup decisions. Also, repeated surveys are needed to monitor the effectiveness of the ongoing treatment methods so that the need for changes in methodology, additional treatment, or constraints can be evaluated (USDOC, NOAA, 2013a).

The following assumptions and guidance regarding the cleanup of spills that contact coastal resources are identified in NOAA's *Characteristic Coastal Habitats: Choosing Spill Response Alternatives* job aid, which provides general guidance adopted in the Gulf of Mexico OCS Region's ACPs (USDOC, NOAA, 2010b). The ACPs applicable to the GOM coastal region encompass a vast geographical area. The differences in the response priorities and procedures among the various ACPs or the GRPs reflect the differences in the identified resources needing spill protection.

Sand Beaches

Predicted Oil Behavior

Light oil accumulations would be deposited as oily swashes or bands along the upper intertidal zone of sand beaches. Heavy oil accumulations would cover the entire beach surface. Oil would be lifted off of the lower beach with the rising tide. The maximum penetration of oil into fine-to-medium-grained sand is about 10-15 cm (4-6 in) and up to 25 cm (10 in) in coarse-grained sand. Burial of oiled layers by clean sand can be rapid (within 1 day), and burial to depths as much as 1 m (3 ft) is possible if the oil comes ashore at the beginning of a depositional period. Organisms living in the beach sediment may be killed by smothering or lethal oil concentrations in the interstitial water. Biological impacts include temporary declines in infauna, which can affect important shorebird foraging areas.

Response Considerations

Sand beaches are one of the easiest shoreline types to clean. Cleanup would concentrate on removing oil and oily debris from the upper swash zone once most of the oil has come ashore.

Manual cleanup, rather than road graders and front end loaders, is advised to minimize the volume of sand removed from the shore and requiring disposal. All efforts should focus on preventing vehicular and foot traffic from mixing oil deeper into the sediments. Mechanical reworking of lightly oiled sediments from the high-tide line to the middle intertidal zone can be effective along exposed beaches.

Salt to Brackish Marshes

Predicted Oil Behavior

Oil adheres readily to intertidal vegetation in salt and brackish marshes. The band of coating would vary widely depending upon the water level at the time of oiling. Large slicks would persist through multiple tidal cycles and will coat the entire stem from the high-tide line to the base. Heavy oil coating would be restricted to the outer fringe of thick vegetation, although lighter oils can penetrate deeper, to the limit of tidal influence. Medium to heavy oils do not readily adhere to or penetrate the fine sediments but can pool on the surface or in animal burrows and root cavities. Light oils can penetrate the top few centimeters of sediment and, under some circumstances, oil can penetrate burrows and cracks up to 1 m (3 ft).

Response Considerations

Under light oiling, the best practice is to let the area recover naturally. Natural removal processes and rates should be evaluated before conducting cleanup. Heavily pooled oil can be removed by vacuum, sorbents, or low-pressure flushing. During flushing, care should be taken to prevent transporting oil to sensitive areas down slope or along shore. Cleanup activities should be carefully supervised to avoid damaging vegetation. Any cleanup activity should not mix the oil deeper into the sediments, trampling of the plants and disturbance of soft sediments should be minimized. Lastly, aggressive cleanup methods should only be considered when other resources (e.g., migratory birds and endangered species) are at greater risk from oiled vegetation left in place.

Sand and Gravel Beaches

Predicted Oil Behavior

During small spills, oil could be deposited along and above the high-tide swash on sand and gravel beaches. Large spills would likely spread across the entire intertidal area. Oil penetration into the beach sediments may be up to 50 cm (20 in); however, the sand fraction can be quite mobile and oil behavior is much like on a sand beach if the sand fraction exceeded about 40 percent. The burial of oil may be deep at and above the high-tide line where oil tends to persist, particularly where beaches are only intermittently exposed to waves. In sheltered pockets on the beach, pavements of asphalted sediments can form if oil accumulations are not removed because most of the oil remains on the surface.

Response Considerations

First, heavy accumulations of pooled oil from the upper beach face should be removed. All oiled debris should be removed, but sediment removal should be limited as much as possible. Low-pressure flushing can be used to float oil away from the sediments for recovery by skimmers or sorbents. High-pressure spraying should be avoided because of the potential for transporting contaminated finer sediments (sand) to the lower intertidal or subtidal zones; mechanical reworking of oiled sediments from the high-tide zone to the middle intertidal zone can be effective in areas regularly exposed to wave activity; however, oiled sediments should not be relocated below the mid-tide zone. Lastly, in-place tilling may be used to reach deeply buried oil layers in the mid-tide zone on exposed beaches.

Exposed or Sheltered Tidal Flats

Predicted Oil Behavior

Oil does not usually adhere to the surface of sheltered or exposed tidal flats but instead moves across the flat and accumulates at the high-tide line. Deposition of oil on the sheltered or exposed flat may occur on a falling tide if concentrations are heavy. Oil would not penetrate water-saturated sediments but could penetrate burrows and desecration cracks or other crevices in muddy sediments in sheltered flats or coarse-grained sand in exposed flats. In areas of high suspended-sediment concentrations, the oil and sediments could mix, resulting in the deposition of contaminated sediments on the flats. Biological impacts could be severe.

Response Considerations

Sheltered tidal flats are high-priority areas for protection since cleanup options are limited. Cleanup of the sheltered tidal flat surface would be very difficult because of the soft substrate, and many methods may be restricted. Low-pressure flushing, vacuuming, and deployment of sorbents from shallow-water draft boats may be used on sheltered tidal flats. Currents and waves on exposed tidal flats can be effective in the natural removal of oil. Cleanup can only be done during low tide on exposed flats, thereby providing a narrow window of opportunity for response. The use of heavy machinery should be restricted on exposed tidal flats to prevent oil mixing into the sediments. Manual methods are preferred on exposed tidal flats.

Exposed, Solid Manmade Structures Such as Seawall/Piers

Predicted Oil Behavior

Oil is held offshore by waves reflecting off of the steep hard surfaces of exposed, solid manmade structures such as seawall/piers. Oil would readily adhere to the dry rough surfaces but it would not adhere to wet substrates. The most resistant oil would remain as a patchy band at or above the high-tide line.

Response Considerations

Cleanup is usually not required, and high-pressure water spraying may be conducted to remove risks of contamination of people or vessels or to improve aesthetics.

Mangroves

Predicted Oil Behavior

Oil can wash through mangroves if oil comes ashore at high tide. If a berm or shoreline is present, oil tends to concentrate and penetrate into the berm sediments or accumulated wrack/litter. Heavy and emulsified oil can be trapped in thickets of red mangrove prop roots or dense young trees. Oil readily adheres to prop roots and tree trunks. Re-oiling from resuspended or released oil residues may cause additional injury over time. Oiled trees start to show evidence of effects (leaf yellowing) weeks after oiling, and tree mortality may take months, especially for heavy oils.

Response Considerations

Oiled wrack can be removed once the threat of oiling has passed as wrack can actually protect the trees from direct oil contact. Sorbent boom can be placed in front of oiled forests to recover oil released naturally and, in most cases, no other cleanup activities are recommended. Where thick oil accumulations are not being naturally removed, low-pressure flushing or vacuum may be attempted at the outer fringe. No attempt should be made to clean interior mangroves except where access to the oil is possible from terrestrial areas, and it is extremely important that cleanup activities be conducted by boat so that disturbance of the substrate by foot traffic be prevented.

Seagrasses

Predicted Oil Behavior

Oil would usually pass over subtidal seagrass beds, with no direct contamination. Floating oil stranded on adjacent beaches can pick up sediment and then get eroded and deposited in adjacent seagrass beds.

Response Considerations

Care should be taken when deploying and anchoring booms to prevent physical damage to seagrass beds and to prevent sediment suspension and mixing with the oil and disturbance of roots and vegetation by foot traffic and boat activity. Seagrasses should not be cut unless species like sea turtles, manatees, or waterfowl are at substantial risk of contacting or ingesting oil. Also, dispersant use directly over subtidal seagrass beds may impact the highly sensitive communities. However, the use of booms or dispersants in offshore areas can reduce impacts to highly sensitive intertidal environments, as well as prevent shoreline stranding in mangroves that can be a chronic source of re-oiling of adjacent seagrass beds. Lastly, *in-situ* burning should only be considered outside the immediate vicinity of seagrass beds to protect sensitive intertidal environments because burn residues can sink and the potential effects of the residue would depend on the composition and amount of the oil to be burned and the location where it would sink.

Bays and Estuaries

Predicted Oil Behavior

Oil can impact bottom habitats (benthic organisms) when water is shallow. Stranded oil on nearby shorelines can become a prolonged source for oil re-released to the water column, and tides and freshwater can substantially influence spilled oil movement.

Response Considerations

Reducing impacts to organisms that live on or in the sea surface is often a high priority, reducing the extent of impacts to sensitive nearshore subtidal or intertidal habitats should be considered. Spill response is not conducted from a shoreline but from water-based vessels or aircraft. The use of certain response options is seasonally limited to protect species with sensitive life histories. Lastly, adverse effects to birds would be greatest during migration and overwintering when birds form large flocks.

3.3 Cumulative Activities and OCS Oil and Gas Program Scenario

3.3.1 Cumulative OCS Oil and Gas Program Scenario

The Cumulative OCS Oil and Gas Program scenario includes all activities (i.e., routine activities projected to occur and accidental events that could occur) from past, proposed, and future lease sales. This includes projected activity from (1) past lease sales, including lease sales still scheduled for the 2012-2017 Five-Year Program but for which exploration or development has either not yet begun or is continuing; (2) lease sales that would be held in this Five-Year Program; and (3) future lease sales that would be held as a result of future Five-Year Programs (four additional programs are included in this cumulative analysis). Activities that take place beyond the analysis timeframe as a result of future lease sales are not included in this analysis. **Tables 3-23 and 3-24** present projections of the major activities and impact-producing factors related to future Cumulative OCS Oil and Gas Program activities. **Table 3-24** can be found in **Chapter 3.3.1.7** below.

Table 3-23. Future Activity Projections Associated with the Cumulative OCS Oil and Gas Program (2017-2086), Including All Future Activities that are Projected to Occur from Past, Proposed, and Future Lease Sales.

Activity	Planning Area		Offshore Subareas (m)[1]						Totals[2]
			0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Exploration and Delineation Wells	GOM		939-2,562	253-1,166	110-170	153-240	97-278	119-301	1,671-4,717
	CPA/EPA		775-1,999	202-1,007	83-142	88-184	70-142	99-211	1,317-3,685
	WPA		164-563	51-159	27-28	65-56	27-136	20-90	354-1,032
Development and Production Wells[3]	GOM	Total	4,050-9,225	1,570-4,324	912-2,034	617-1,127	446-723	633-985	8,238-18,418
		Oil	438-987	164-453	446-993	280-487	230-372	310-482	1,868-3,774
		Gas	2,440-5,566	894-2,457	186-415	149-288	79-126	126-194	3,874-9,046
	CPA/EPA	Total	3,170-6,634	1,139-3,558	676-1,557	490-779	405-623	595-899	6,475-14,050
		Oil	354-740	122-379	326-750	240-385	207-319	289-437	1,538-3,010
		Gas	1,898-3,972	645-2,015	142-327	95-152	72-110	119-179	2,971-6,755
	WPA	Total	880-2,591	431-766	236-477	137-348	41-100	38-86	1,763-4,368
		Oil	84-247	42-74	120-243	40-102	23-53	21-45	330-764
		Gas	542-1,594	249-442	44-88	54-136	7-16	7-15	903-2,291
Installed Production Structures	GOM		2,168-5,121	558-1,638	36-71	26-38	16-38	23-42	2,827-6,948
	CPA/EPA		1,760-3,682	432-1,347	23-54	17-26	14-21	20-30	2,266-5,160
	WPA		408-1,439	126-291	13-17	9-12	2-17	3-12	561-1,788
Production Structures Removed Using Explosives	GOM		2,435-4,388	568-1,310	0	0	0	0	3,003-5,698
	CPA/EPA		2,051-3,315	440-1,065	0-0	0-0	0-0	0-0	2,491-4,380
	WPA		384-1,073	128-245	0-0	0-0	0-0	0-0	512-1,318
Total Production Structures Removed	GOM		3,381-6,148	784-1,796	39-69	36-44	20-33	21-31	4,281-8,121
	CPA/EPA		2,847-4,639	608-1,459	26-54	25-31	17-22	18-24	3,541-6,229
	WPA		534-1,509	176-337	13-15	11-13	3-11	3-7	740-1,892
Length of Installed Pipelines (km)[4]	GOM		2,181-15,822	1,432-10,511	1,078-8,037	1,268-8,265	700-7,001	704-7,359	7,363-56,995
	CPA/EPA		586-11,799	388-8,355	328-6,390	385-6,381	364-6,168	405-6,750	2,456-45,843
	WPA		1,595-4,023	1,044-2,156	750-1,647	883-1,884	336-833	299-609	4,907-11,152
Service-Vessel Trips (1,000's round trips)	GOM		2,443-6,998	645-2,300	284-942	213-556	134-498	187-577	3,909-11,873
	CPA/EPA		1,978-5,037	496-1,892	186-722	140-389	115-306	163-440	3,079-8,788
	WPA		465-1,960	150-408	98-221	72-167	19-192	23-137	830-3,085
Helicopter Operations (1,000's round trips)	GOM		11,714-55,063	4,511-25,155	270-1,162	183-651	139-422	183-546	17,000-83,000
	CPA/EPA		9,614-40,734	3,544-21,159	191-898	148-440	121-352	165-475	13,786-64,059
	WPA		2,098-14,329	966-3,996	78-264	34-211	17-70	17-70	3,214-18,941

[1]Refer to **Figure 3-1**.
[2]Subareas totals may not add up to the planning area total because of rounding.
[3]Development and Production Wells includes some exploration wells that were re-entered and completed. These wells were removed from the Exploration and Delineation well count.
[4]Projected length of pipelines does not include length in State waters.

It is reasonably foreseeable to assume that lease sales would continue to be proposed for many years to come in the Gulf of Mexico region, based on resource availability, existing infrastructure, and projected time lapses required for any other major energy sources to come online. However, the level of activities (exploration wells, production wells, and pipelines) becomes more speculative as time is projected into the future. The causes for this are uncertainty in oil prices, resource potential, cost of development, and drill rig availability, versus the amount of acreage leased from a lease sale.

Therefore, these scenarios do not predict future OCS oil- and gas-related 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 unknowns. Notwithstanding these unpredictable factors, the scenarios used in this Multisale 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 a BOEM 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. Methodologies for the Cumulative OCS Oil and Gas Program scenario are similar to those for a regionwide or individual planning area typical lease sale scenario analysis and are described in detail in **Chapter 3** above.

3.3.1.1 Cumulative OCS Oil and Gas Program Projected Production

As of 2014, 19.02 BBO of oil and 185.2Tcf of gas had been produced in the GOM (USDOI, BOEM, 2013; USDOI, BSEE, 2015e). While offshore oil production has remained fairly constant over the last 10 years, gas production rates offshore have declined (**Figure 3-13**). Projected future reserve/resource production estimates for the Cumulative OCS Oil and Gas Program scenario regionwide are 15.482-25.806 BBO and 57.875-108.513 Tcf of gas. These estimates represent all anticipated production from lands currently under lease plus all anticipated production from future lease sales over the 70-year analysis period (**Table 3-1**). **Table 3-23** presents all anticipated activity associated with production from lands currently under lease in regionwide plus all anticipated activity associated with production from future total OCS Program (WPA, CPA, and EPA) lease sales over the 70-year analysis period.

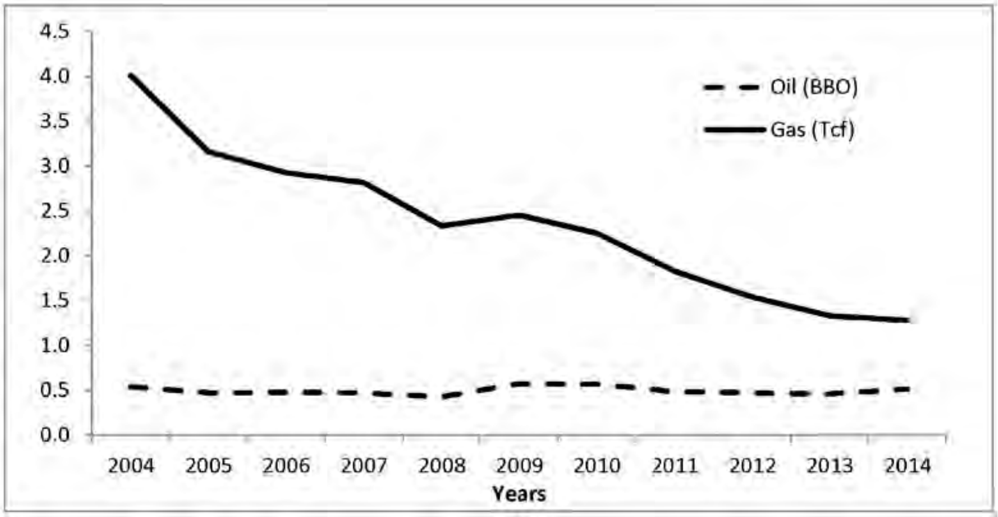

Figure 3-13. OCS Oil and Gas Production Between 2003 and 2013 (USDOI, BSEE, 2015e).

Projected future reserve/resource production estimates for the Cumulative OCS Oil and Gas Program scenario in the CPA and EPA are 13.707-22.152 BBO and 46.328-84.009 Tcf of gas. These estimates represent all anticipated production from lands currently under lease in the CPA and EPA plus all anticipated production from future leased lands in the CPA and EPA over the 70-year analysis period (**Table 3-1**). Projected production estimates in the CPA and EPA represents approximately 88.5-85.8 percent of the oil and 80-77.4 percent of the gas of the cumulative OCS Oil and Gas Program regionwide. **Table 3-23** presents all anticipated activity associated with production from lands currently under lease in the CPA and EPA plus all anticipated activity associated with production from future leased lands in the CPA and EPA over the 70-year analysis period.

Projected future reserve/resource production estimates for the Cumulative OCS Oil and Gas Program scenario in the WPA are 1.775-6.654 BBO and 11.547-24.504 Tcf of gas. These estimates represent all anticipated production from lands currently under lease in the WPA plus all anticipated production from future leased lands in the WPA over the 70-year analysis period (**Table 3-1**). Projected production estimates in the WPA represent approximately 11.5-14.2 percent of the oil and 20-22.5 percent of the gas of the cumulative OCS Oil and Gas Program regionwide. **Table 3-23** presents all anticipated activity associated with production from lands currently under lease in the WPA plus all anticipated activity associated with production from future leased lands in the WPA over the 70-year analysis period.

3.3.1.2 Cumulative Geological and Geophysical Surveys

Chapter 3.1.2.1 discusses OCS oil- and gas- related G&G survey activities. In order to forecast future programs as required in the cumulative case analysis, the baseline projection was scaled relative to the forecast of exploration wells drilled as defined by the cumulative case scenarios to obtain a longer term outlook. Cumulatively, G&G surveys are projected to follow the same trend as cumulative exploration drilling activities, which would peak in 2030-2040 and decline until 2060, and remain relatively low throughout the last quarter of the 70-year analysis period. It is important to note that the cycling of G&G data acquisition is not driven by the 50-year life cycle of a single productive lease but instead would tend to respond to new production or potential new production driven by new technology. Consequently, some areas would be resurveyed in 2-year cycles, while other areas, considered nonproductive, may not be surveyed for 20 years or more. Conservatively, BOEM assumes that, as a result of the Cumulative OCS Oil and Gas Program, one HRG survey would occur for every block leased (estimated by the number of platforms predicted), one HRG survey would occur for every 5 km (3 mi) of pipeline laid (the average length of a pipeline permit), and one VSP survey would be conducted on 15 percent of all exploration and development wells drilled. The table below reflects a reasonable level of cumulative G&G surveying activities that could be expected to occur in the Gulf of Mexico (2017-2086).

Survey Area	2D Surveys (mi)	2D Permits	3D Lease Blocks	3D Permits	Ancillary Permits	HRG Surveys	VSP Surveys
Regionwide	365,800-1,036,700	183-506	126,800-358,400	90-235	2,261-5,559	4,300-18,347	1,486-3,470
CPA/EPA	362,000-1,026,100	171-482	104,100-292,100	69-186	1,813-4,128	2,757-14,329	1,168-2,660
WPA	3,700-10,600	12-23	22,700-66,300	21-48	449-1,430	1,542-4,019	317-810

3.3.1.3 Cumulative Exploration and Delineation Plans and Drilling

Chapter 3.1.2.2 describes in detail exploration and delineation activities. Since the 1950's, approximately 18,954 exploratory wells have been drilled, of which 12,516 have been permanently abandoned (Marine Cadastre, 2015). The future projected exploration and delineation well estimate for the Cumulative OCS Oil and Gas Program scenario regionwide during the 70-year analysis period is 1,671-4,717 exploration and delineation wells drilled. Of these, 1,317-3,685 wells would be in the CPA/EPA and 354-1,032 wells would be in the WPA. **Table 3-23** shows the estimated range of exploration and delineation wells by water-depth range for the Cumulative OCS Oil and Gas Program scenario for each planning area of the GOM. Of the wells projected under the Cumulative OCS Oil and Gas Program Scenario, 71-79 percent are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and 29-21 percent are expected in water-depth ranges >200 m (656 ft).

3.3.1.4 Cumulative Development and Production Drilling

Chapter 3.1.3.1 describes in detail development and production activities. Since the 1950s, approximately 35,029 development wells have been drilled, of which, 13,941 have been permanently abandoned (Marine Cadastre, 2015). The future projected development and production well estimate for the Cumulative OCS Oil and Gas Program Scenario regionwide is

8,238-18,418 development and production wells drilled. Of these, 6,475-14,050 wells would be in the CPA/EPA and 1,763-4,368 wells would be in the WPA. **Table 3-23** shows the estimated range of development and production wells by water-depth range for the Cumulative OCS Oil and Gas Program scenario for each planning area of the GOM. Of the wells projected under the Cumulative OCS Oil and Gas Program scenario, 68-73.5 percent are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and 32-26.5 percent are expected in water-depth ranges >200 m (656 ft).

3.3.1.5 Infrastructure Emplacement/Structure Installation and Decommissioning Activities

As of 2013, 7,020 platforms had been installed regionwide in the OCS; however, active platforms were estimated at only approximately 2,634 (USDOI, BSEE, 2015f; **Figure 3-14**). **Chapter 3.1.3.2** describes in detail infrastructure emplacement and structure installation and commissioning activities. The projected estimate of additional production structures expected to be installed for the Cumulative OCS Oil and Gas Program scenario in the WPA, CPA, and EPA during the 70-year analysis period is 2,827-6,948 production structures. Of these, 2,266-5,160 structures would be in the CPA/EPA and 561-1,788 structures would be in the WPA. **Table 3-23** shows the estimated range of production structure installation range by water-depth range for the Cumulative OCS Oil and Gas Program scenario for each planning area of the GOM. Of the platforms projected under the Cumulative OCS Oil and Gas Program scenario, about 97 percent are expected to be on the continental shelf (0-200 m [0-656 ft] water depth) and 3 percent are expected in water-depth ranges >200 m (656 ft).

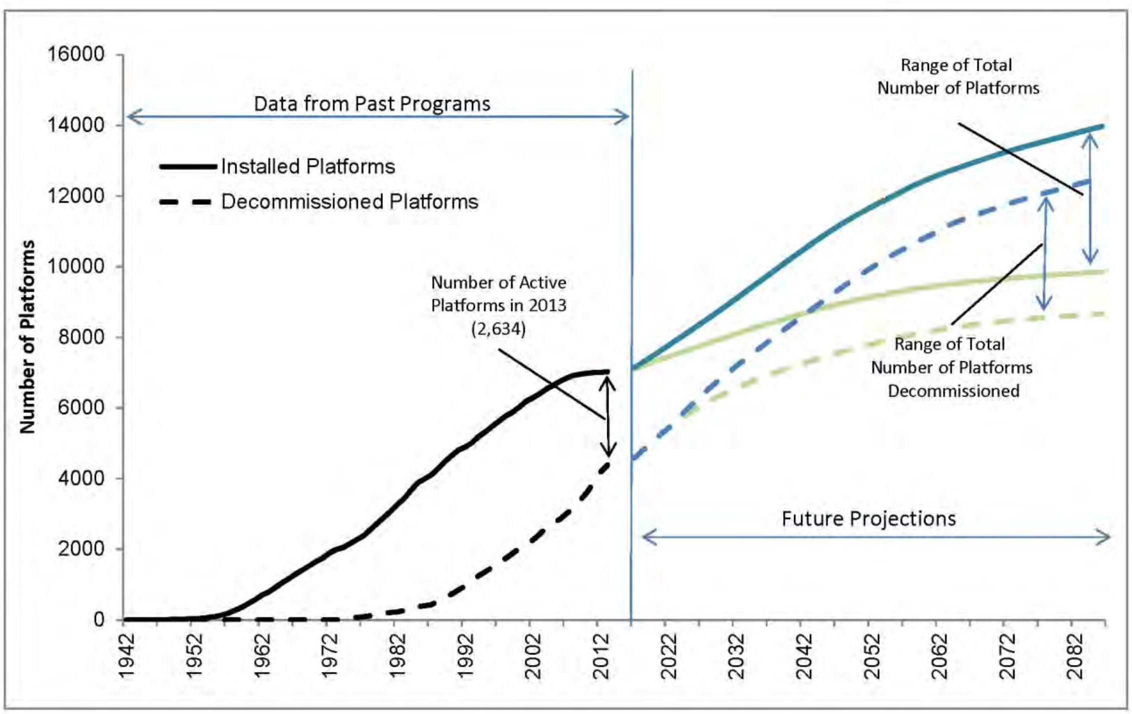

Figure 3-14. Number of Production Structures Installed and Decommissioned in Past Programs and the Range of Future Projections that May Occur as a Result of All Past, Present, and Future Actions (USDOI, BSEE 2015f).

Bottom-Area Disturbance: **Chapter 3.1.3.3.1** describes in detail infrastructure emplacement and structure installation and commissioning activities. Bottom area disturbance is calculated as a relationship between the structures projected (i.e., platforms, wells, subsea structures, and pipeline miles installed) and the associated disturbance of each. For the Cumulative OCS Oil and Gas Program scenario, between 294,821 and 605,178 ha (728,518-1,495,427 ac) of sea bottom is projected to be disturbed. Future activity is expected to disturb >1 percent of the seafloor regionwide. Of this, 241,116-460,238 ha (595,810-1,137,272 ac) of the disturbance is expected in the CPA/EPA and 53,705-144,939 ha (132,707-358,152 ac) of the disturbance is expected in the WPA.

3.3.1.6 Infrastructure Presence

Chapter 3.1.3.3 describes in detail activities associated with infrastructure presence. The maximum number of production structures operating simultaneously in the Cumulative OCS Oil and Gas Program scenario in the WPA, CPA, and EPA is 1,367 structures, including all depth ranges. Therefore, a maximum of 8,202 ha (20,268 ac) or approximately 6 ha (15 ac) of surface area would be temporarily unavailable to other activities in the OCS. To put this in perspective, <1 percent of the surface area of the GOM would be temporarily lost to the Cumulative OCS Oil and Gas Program. Additional impact-producing factors associated with offshore oil and gas infrastructure are oil spills and trash and debris. These are the factors 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.

3.3.1.7 Transport

Pipelines: **Chapter 3.1.4.1** describes in detail activities associated with oil and gas transportation via pipelines. BOEM estimates 7,363-56,995 km (10,789-35,415 mi) of pipeline would be installed regionwide as a result of the activities associated with the Cumulative OCS Oil and Gas Program scenario (**Tables 3-23 and 3-24**). About 30-27 percent of the new pipeline length would be in water depths <60 m (197 ft) and would require burial. As of 2015, 144 pipeline landfalls currently exist in coastal areas of the OCS (Smith, official communication, 2015).

Barging: **Chapter 3.1.4.2** describes in detail activities associated with barging. Barging is projected to continue to account for <1 percent of the oil transported (**Table 3-24**).

Tankering: The OCS oil- and gas-related tankering began in 2012. Since 2012, tankering has increased to account for around 2 percent of the yearly production of oil. **Chapter 3.1.4.3** describes in detail activities associated with tankering. BOEM estimates 5-14 FPSO systems could be installed regionwide (a maximum of two per decade) as a result of the Cumulative OCS Oil and Gas Program scenario. Zero to five systems are projected within the WPA and 5-9 systems are projected within the CPA/EPA. As a result of these additional systems, up to 9 percent of the oil during any given year may be tankered to a processing facility (**Table 3-24**).

Table 3-24. Future Oil Transportation Projections Associated with the Cumulative OCS Oil and Gas Program (2017-2086), Including All Future Transportation that is Projected to Occur from Past, Proposed, and Future Lease Sales.

Activity	Region	Offshore Subareas (m)[1]						Totals[2]
		0-60	60-200	200-800	800-1,600	1,600-2,400	>2,400	
Percent Oil Piped[3]	GOM	94-95%	100%	100%	100%	89.6-87.4%	87.4-85.7%	91.6-90.6%
	CPA/EPA	94-95%	100%	100%	100%	97.8-96.3%	94.9-95.3%	90.8-91.0%
	WPA	100%	100%	100%	100%	100-89%	100-86.4%	100-95.1%
Percent Oil Barged	GOM	6-5%	0%	0%	0%	0%	0%	0.2%
	CPA/EPA	6-5%	0%	0%	0%	0%	0%	0.2%
	WPA	0%	0%	0%	0%	0%	0%	0%
Percent Tankered[4]	GOM	0%	0%	0%	0%	10.4-12.6%	12.6-14.3%	8-9%
	CPA/EPA	0%	0%	0%	0%	12.2-13.7%	5.1-4.7%	9-8.75%
	WPA	0%	0%	0%	0%	0-11%	0-13.6%	0-4.85%

[1]Refer to **Figure 3-1**.
[2]Subareas totals may not add up to the planning area total because of rounding.
[3]100% of gas is assumed to be piped.
[4]Tankering is forecasted to occur only in water depths >1,600 m.

Service Vessels: **Chapter 3.1.4.4** describes in detail activities associated with service vessels. The Cumulative OCS Oil and Gas Program scenario estimates that 3,909,000-11,873,000 service-vessel trips would occur regionwide over the 70-year analysis period (**Table 3-23**) or 55,842-169,614 trips annually. **Table 3-6** indicates 875,000 vessel trips occurred on Federal navigation channels, ports, and OCS oil- and gas-related waterways in 2012. Annual OCS oil- and gas-related vessel traffic due to cumulative OCS oil- and gas-related activity represents between 6 and 19 percent of the total traffic in the GOM.

Helicopters: **Chapter 3.1.4.5** describes in detail activities associated with helicopters. The Cumulative OCS Oil and Gas Program scenario estimates that 17-83 million helicopter trips would occur regionwide over the 70-year analysis period (**Table 3-23**). This equates to an average rate of 240,000-1,190,000 operations annually.

Navigation Channels: BOEM conservatively estimates that there are approximately 4,850 km (3,013 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS traffic regionwide (**Table 3-6 and Figure 3-9**). No new navigation canals are expected to be created, however erosion of existing channels may occur. **Chapter 3.1.4.6** describes in detail activities associated with navigation channels. Using the estimated proportion of vessel traffic associated with the Cumulative OCS Oil and Gas Program scenario as a measurement of erosion, BOEM conservatively estimates the OCS Oil and Gas Program's contribution to bank erosion over the 70-year cumulative scenario to be 3,135-9,524 ac (1,269-3,854 ha). This number is considered conservative because open waterways were included in the total length of Federal navigation channels, bank armoring rates may increase, vessel size was not taken into consideration, and there are sources of erosion to navigation canals other than vessel traffic alone.

3.3.1.8 Discharges and Wastes

Detailed descriptions of discharges and wastes associated with the OCS Oil and Gas Program activity can be found in **Chapter 3.1.5**. Various laws, regulations, and NTLs would likely minimize the discharges and wastes from OCS oil- and gas-related activities in association with the Cumulative OCS Oil and Gas Program scenario. Cumulative effects of discharges and wastes are discussed in **Chapter 4.2**.

3.3.1.9 Decommissioning and Removal Operations

As of 2013, approximately 62.5 percent of structures had been decommissioned and removed (USDOI, BSEE, 2015f; **Figure 3-14**. **Chapter 3.1.6** describes in detail decommissioning and removal operations. **Table 3-23** shows the forecasted platform removals by water-depth range for the Cumulative OCS Oil and Gas Program scenario for each planning area of the GOM. Of the 4,281-8121 production structures estimated to be removed from the GOM in the Cumulative Oil and Gas Program scenario, 3,003-5,698 production structures (installed landward of the 800-m [2,625-ft] isobath) would likely to be removed using explosives.

3.3.1.10 Coastal Infrastructure

Refer to **Table 3-4** for information on existing coastal infrastructure that services the OCS Oil and Gas Program. **Chapter 3.1.7** describes coastal infrastructure in detail. The Cumulative OCS Oil and Gas Program scenario estimates no additional: service bases, heliports, platform fabrication yards, shipyards, or pipe-coating facilities and yards.

Expectations for new gas processing facilities being built (as a direct result of the Cumulative OCS Oil and Gas Program) are dependent on long-term market trends that are not easily predicable over the next 70 years. Existing facilities would likely experience equipment switch-outs or upgrades during this time. BOEM projects that expansions at existing LNG facilities and the construction of new facilities would not occur as a direct result of the cumulative OCS Oil and Gas Program. New refineries may be built, but there has been a trend toward constructing simple refineries instead of complex refineries.

3.3.1.11 Air Emissions

Chapter 3.1.8 describes in detail activities associated with the production of air emissions. BOEM is responsible for determining if air pollutant emissions from offshore oil and gas activities in the Gulf of Mexico influence the NAAQS' compliance status of Texas, Louisiana, Mississippi, Alabama, and Florida. As such, BOEM would continue to inventory emissions and model emissions whenever the USEPA updates the NAAQS. Effects to air quality from the Cumulative OCS Oil and Gas Program are discussed in **Chapter 4.1**.

3.3.2 Non-OCS Oil- and Gas-Related Impact-Producing Factors

The impact-producing factors considered in this chapter are defined as other past, present, and reasonably foreseeable future activities occurring within the same geographic range and within the same timeframes as the aforementioned projected routine activities and potential accidental events, but they are not related to the Cumulative OCS Oil and Gas Program. This chapter describes other impact-producing factors that could potentially affect an environmental or socioeconomic resource in addition to OCS oil- and gas-related activity.

While the scenario developed for the Cumulative OCS Oil and Gas Program scenario forecasts 70 years of activities, the scenarios developed as part of this chapter vary in the length of time projected depending on what would be considered reasonably foreseeable by impact-producing factors based on the data available and the ability to predict future actions without being speculative.

3.3.2.1 State Oil and Gas Activity

All of the five Gulf Coast States have had some historical oil and gas exploration activity and, with the exception of Florida and Mississippi, all currently produce oil and gas in State waters. The coastal infrastructure that supports the OCS Program also supports State oil and gas activities.

State oil and gas infrastructure consists of the wells that extract hydrocarbon resources, facilities that produce and treat the raw product, pipelines that transport the product to refineries and gas plants for further processing, and additional pipelines that transport finished product to points of storage and final consumption. The type and size of infrastructure that supports production depends upon the size, type, and location of the producing field, the time of development, and the life cycle stage of operations.

Texas

The first offshore well in Texas was drilled in 1938, but the first oil discovery was not made until 1941 off of Jefferson County. The Oil and Gas Division of the Railroad Commission of Texas is the agency charged by the Texas Legislature with the regulation of the oil and gas industry (i.e., exploration, production, and transportation) in the State of Texas. According to the Railroad Commission of Texas, since June 2015 cumulative total State offshore production of oil was reported at over 42 million bbl and offshore gas production totals were reported at over 4.1 billion Mcf (Railroad Commission of Texas, 2015). Texas was the leading crude-oil producing state in the Nation in 2013 and exceeded production levels even from the Federal offshore areas (USDOE, Energy Information Administration, 2014b).

The Lands and Minerals Division of the Texas General Land Office holds lease sales for oil and gas on State lands, and the Texas General Land Office manages Texas State resources for the benefit of public education. The Texas General Land Office generally holds lease sales every 4 months in January, April, July, and October. The Texas General Land Office's Mineral Leasing Division uses a sealed bid process for the leasing of State lands. BOEM expects that Texas would conduct regular oil and gas lease sales in State waters during the next 70 years, although the lease sales' regularity could differ from current practices.

Louisiana

Louisiana has been the second most important oil- and gas-producing state after Alaska. Oil production in Louisiana began in 1902, with the first oil production in the coastal zone in 1926. The State of Louisiana issued its first offshore oil and gas lease in 1936, and in 1937 the Pure Oil Company discovered the first Louisiana oil field 1.2 mi (1.9 km) offshore of Cameron Parish using a platform built on timber pilings in water 15 ft (4.6 m) deep. Southern Louisiana produces mostly oil and northern Louisiana produces mostly gas.

The nine contiguous parishes of the coastal zone produced more than 50 percent of the State's oil during the 1950's. Oil and gas production peaked in the 1970's in Louisiana. Over the last 60 years, Louisiana averaged around 27 MMbbl of oil and 12 Tcf of gas per year (State of Louisiana, Dept. of Natural Resources, 2015a and 2015b).

Louisiana's leasing procedure is carried out by the Petroleum Lands Division of the Office of Mineral Resources within the Louisiana Department of Natural Resources and proceeds along the following procedural steps (State of Louisiana, Dept. of Natural Resources, 2015c):

(1) industry nominates acreage for leasing every month (by law, nominated tracts cannot exceed 5,000 ac [2,023 ha], but by Mineral Board policy, the size limit of a nominated tract is further limited to only 2,500 ac [1,012 ha].);

(2) the nominated tracts are then advertised in official State and parish journals;

(3) competitive, sealed bidding then takes place on bonus, royalty, and rental to be received by the State (The sealed bids are opened and read into the record at a public meeting of the Louisiana Mineral Board at the time and place advertised.); and

(4) if it determines that the bids are sufficient, the Louisiana Mineral Board awards the leases to the highest bidder after evaluating data provided from staff geologists from the Geology and Engineering Division of the Office of Mineral Resources. The term of the lease is limited to 3 years for inland tracts and 5 years for offshore tracts.

BOEM expects that Louisiana would conduct regular oil and gas lease sales in State waters during the next 70 years.

Mississippi

At present, Mississippi only has an onshore oil and gas leasing program; however, it is expected that the State would start issuing leases for offshore activity in State waters in the near future. In 2004, the Mississippi Legislature limited offshore natural oil and gas exploration to areas located predominantly south of the barrier islands. After this legislation went into effect, the State Mineral Leasing Office was moved to the Mississippi Development Authority, which was given the responsibility to publish rules and regulations regarding offshore mineral leasing and seismic activity. The rules and regulations would allow the State of Mississippi to issue seismic permits and lease mineral rights for natural gas and oil exploration and production (Mississippi Energy Future, 2012). On December 19, 2011, the Mississippi Development Authority published draft regulations; the public comment period closed on January 20, 2012 (Mississippi Development Authority, 2011). However, recent efforts to open Mississippi State waters for G&G and leasing activities have been challenged in court (Davis, 2014).

Most of the State's onshore crude oil is located in southern Mississippi. Compared with other states, the production is small and accounts for a 1.2-percent share of U.S. production. Over approximately the last 30 years, Mississippi has produced on average 24 MMbbl of oil and 116 Bcf of natural gas per year (USDOE, Energy Information Administration, 2015e). Mississippi falls behind several other states and is ranked 12th in gas production. In 2007, Mississippi was selected by the DOE as a new storage site for the Strategic Petroleum Reserve. The new site is a group of salt domes located inland in Richton, Mississippi (USDOE, Energy Information Administration, 2015e).

BOEM expects Mississippi to institute a lease sale program in the near future and to begin leasing in State waters during the next 70 years.

Alabama

The State Oil and Gas Board of Alabama is the regulatory agency of the State of Alabama with statutory charge of oil and gas development. The earliest exploration wells in Alabama's offshore waters were drilled in Mobile Bay by Gulf Refining Company in late 1951 and early 1952. These two early wells were plugged and abandoned at depths of 10,000 and 11,000 ft (3,048 and 3,253 m) after failing to encounter any substantial show of oil and gas. A period of more than 27 years lapsed before another test well was drilled, but this next attempt was successful and led to the active drilling and development of the large gas reserve lying more than 20,000 ft (6,096 m) below coastal waters (State of Alabama, Oil and Gas Board, 2015).

From 1989 to 2014, a total of 8,278,884 MMcf of gas has been produced in State waters, averaging approximately 331,155 MMcf of gas production per year. From 1989 to 2012, a total of 293,730,516 bbl of oil were produced, averaging approximately 12,770,892 bbl/yr (State of Alabama, Oil and Gas Board, 2015).

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. BOEM does not expect Alabama to institute a lease sale program in the near future, although there is at least a possibility of a lease sale in State waters during the next 70 years.

Florida

The Florida Department of Environmental Protection’s Mining Mitigation and Delineation Program is the permitting authority for the exploration and production of oil and gas in Florida. By 1944, Florida had leased much of its State waters along the Gulf Coast for oil and gas exploration and development. The first Federal lease sale off Florida (Lease Sale 5) was held in 1959 and resulted in 23 blocks leased and three wells drilled off south Florida. The next Federal lease sale (Lease Sale 32) was not be held until 1973 (Reef Relief, 2015).

In the late 1970’s and early 1980’s, Florida encouraged and supported efforts to find and produce oil and gas off its shores. As late as 1983, Getty Oil drilled a 1,200-ft (366-m) exploration well in <25 ft (8 m) of water near Pensacola. This “zero-discharge,” heavily bonded and monitored exploration well reportedly yielded a natural gas find. This was the last oil and gas exploration well drilled in State waters (Reef Relief, 2015).

A total of 19 wells were drilled in Florida State waters from 1947 to 1983 (State of Florida, Dept. of Natural Resources, 1991). Offshore exploratory drilling in Federal waters of the EPA included six wells completed in 1988 and 1989; one of these was the discovery in the Destin Dome Area and was classified by the Federal Government as a producible field (State of Florida, Dept. of Natural Resources, 1991). In July 1990, all offshore drilling activity in Florida State waters was prohibited and the State’s policy on offshore oil and gas drilling changed. Since 1989, the Florida State Congress has prohibited new leasing off Florida in the EPA. In May 2002, DOI announced an agreement in principle to settle litigation, and the two leases remaining in the unit, held by Murphy Oil, would be suspended until at least 2012 and could not be developed without agreement with DOI and Florida. The Gulf of Mexico Energy Security Act of 2006 (GOMESA) extended the moratorium on new oil and gas leasing off of Florida until June 30, 2022. In January 2003, Florida received notice from the U.S. Department of Commerce that Chevron’s appeal of Florida’s CZMA objection to the DPP for the Destin Dome 56 Unit had been dismissed for good cause (i.e., Chevron withdrew its applications). The two leases held by Murphy Oil in the Destin Dome Area remain active. The GOMESA also implemented revenue sharing with petroleum-producing coastal states; however, Florida is not considered a producing state, thus it does not share in revenues. The GOMESA also required DOI to develop regulations to grant existing leases within 100 mi (161 km) of Florida in the EPA with credits they could use to buy leases in other areas of the Gulf of Mexico or use for payment of debt should they not be allowed to develop their lease in the EPA.

With current State policy and regulations prohibiting oil and gas exploration and development in State waters, BOEM does not expect Florida to institute a lease sale program in the near future. If State policy and regulations change and the moratorium is allowed to expire, the potential for a lease sale in State waters could be a possibility during the next 70 years.

3.3.2.1.1 State Pipeline Infrastructure

The existing pipeline network in the Gulf Coast States is the most extensive in the world and has unused capacity (Cranswick, 2001). The network carries oil and gas onshore and inland to refineries and terminals, and a network of pipelines distributes finished products such as diesel fuel or gasoline to and between refineries and processing facilities onshore (Peele et al., 2002, Figure 4.1). Expansion of this network is projected to be primarily small-diameter pipelines to increase the interconnectivity of the existing network and a few major interstate pipeline expansions. However, as discussed in **Chapter 3.1.4.1**, there is spare capacity in the existing pipeline infrastructure to move oil and gas to market, and deepwater ports can serve onshore facilities, including intrastate as well as interstate pipelines.

Texas: There are 14 pipelines that make landfall on the Texas shoreline. The Railroad Commission of Texas reports that there are slightly over 150,000 mi (242,402 km) of petroleum-product-carrying intrastate pipelines, but no differentiation was provided for the length of pipeline in the 11 coastal counties contiguous to the GOM (Railroad Commission of Texas, 2009).

Louisiana: There are currently 122 pipeline landfalls in the Louisiana Coastal Area (**Table 3-4**).

Alabama: There are currently five pipeline landfalls on the Alabama shoreline. This includes one natural gas pipeline that runs from Alabama to Florida.

Mississippi: There are currently three pipeline landfalls on the Mississippi shoreline.

Florida: There is currently one pipeline landfall on the shore of Florida. This is a natural gas pipeline that runs from Alabama to Florida.

3.3.2.1.2 Artificial Reefs

Use of artificial reefs to enhance fisheries along the U.S. coastline was documented as early as the mid-19th century (Stone, 1974; McGurrin et al., 1989; Christian et al., 1998). For nearly 200 years, purpose-built structures (e.g., wooden huts, cinder block reefs, and concrete pyramids) and obsolete materials (e.g., decommissioned vessels and damaged concrete pipe) have been intentionally deposited in estuarine and marine environments to add bottom relief, attract fishes, and improve angler access and success. As a result of research into the potential benefits and adverse impacts resulting from specific artificial reef designs, materials, and siting, the National Artificial Reef Plan and subsequent revision in 2007 were developed to provide guidance to artificial reef coordinators, fisheries managers, and other parties on recommended siting, construction, management, and monitoring of artificial reefs. The Secretary of the Army, through the COE, is responsible for the artificial reef permitting process and for coordination of the appropriate State and Federal agencies (USDOC, NOAA, 2007). The Wallop-Breaux Amendment provided increased Federal funding to State agencies for sport fish restoration, contributing to the National Fisheries Enhancement Act's objectives through support of habitat enhancement projects, research, and monitoring (Christian et al., 1998).

Offshore oil and gas platforms have been contributing hard substrate to the GOM since the 1930's, and fishermen quickly found fishing success was enhanced in the vicinity of OCS oil- and gas-related structures (State of Louisiana, Dept. of Wildlife and Fisheries, 1987). By the late-1970's some artificial reef advocates and recreational fishermen had begun viewing the decommissioning and removal of OCS oil- and gas-related structures as a lost opportunity. The increased interest and participation in fishing at offshore oil and gas platforms and national support for effective artificial reef development coincided with research and fisheries management efforts, which led to passage of the National Fishing Enhancement Act of 1984 and the development of the first National Artificial Reef Plan. In 1987, Louisiana published a State artificial reef plan that specifically addressed the need to support public interest through development of artificial reef planning areas and the addition of decommissioned OCS platforms as artificial reef substrate (State of Louisiana, Dept. of Wildlife and Fisheries, 1987). Texas' Artificial Reef Act of 1989 explicitly identified decommissioned platforms as the preferred substrate for the construction of artificial reefs (State of Texas, Parks and Wildlife Dept., 1990). Currently, all five Gulf Coast States have active artificial reef programs, which develop and manage artificial reefs on the Federal OCS.

The OCSLA and implementing regulations establish decommissioning obligations for lessees, including the removal of platforms. The Rigs-to-Reefs Policy provides a means by which lessees may request a waiver to the removal requirement. For additional information, refer to **Chapter 3.1.6.2**. Since the first Rigs-to-Reefs conversion, approximately 11 percent of the platforms decommissioned from the Gulf of Mexico OCS have been redeployed within designated State artificial reefs. Scientific and public interest in the ecology of offshore structures and the potential benefits of contributing hard substrate to a predominantly soft bottom environment have led to increased emphasis on the development of artificial reefs. The current paradigm posits oil and gas structures act as both fish-attracting and production-enhancing devices, depending upon the species (Carr and Hixon, 1997; Gallaway et al., 2009; Shipp and Bortone, 2009; and Dance et al., 2011). However, determination of specific and cumulative impacts resulting from construction of artificial reefs within permitted areas is very difficult. As recommended by the National Artificial Reef Plan (USDOC, NOAA, 2007), well-defined objectives, clear management strategies, and long-term monitoring are critical elements of an artificial reef program and are necessary if managers intend to use artificial reefs as a fisheries management tool.

3.3.2.2 Marine Vessel Activity

3.3.2.2.1 Marine Transportation

Under current conditions, freight and cruise ship passenger marine transportation within the analysis area should continue to grow at a modest rate or remain relatively unchanged based on historical freight and cruise traffic statistics. In 2013, the Sabine-Neches Waterway had the highest vessel capacity, followed by the Port of New Orleans in terms of tonnage handled. The Port of Houston was the third largest port in the United States (USDOT, MARAD, 2015a). Tankers carrying mostly petrochemicals account for about 60 percent of the vessel calls in the Gulf of Mexico. Dry-bulk vessels, including bulk vessels, bulk containerships, cement carriers, ore carriers, and wood-chip carriers, account for another 17 percent of the vessel calls. The GOM also supports a popular cruise industry. In 2011, there were 149 cruise ship departures from Galveston, 139 cruise ship departures from New Orleans, and 199 cruise ship departures from Tampa (USDOT, MARAD, 2012).

Total port calls, or vessel stops at a port, in the U.S. is increasing as a whole, and total port calls within the GOM is also increasing. Gulf of Mexico port calls represent approximately 33 percent of total U.S. port calls. Trends for GOM port calls relative to total U.S. port calls shows an approximate 3 percent average increase of GOM port calls between 2003 and 2012, from 18,034 to 24,730 port calls (USDOT, MARAD, 2015a) (**Table 3-25**).

Table 3-25. Number of Vessel Calls at U.S. Gulf Ports Between 2002 and 2011[1].

<table>
<tr><th>Vessel Type</th><th>2003</th><th>2004</th><th>2005</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th><th>2012[11]</th></tr>
<tr><td>Tanker-Product[2,3]</td><td>5,143</td><td>5,764</td><td>6,171</td><td>6,594</td><td>6,784</td><td>6,597</td><td>6,451</td><td>7,000</td><td>8,413</td><td rowspan="2">15,032</td></tr>
<tr><td>Tanker-Crude[2,4]</td><td>4,227</td><td>4,361</td><td>4,303</td><td>4,343</td><td>4,614</td><td>4,574</td><td>4,502</td><td>5,150</td><td>5,626</td></tr>
<tr><td>Container[5]</td><td>1,263</td><td>1,284</td><td>1,378</td><td>1,354</td><td>1,306</td><td>1,372</td><td>1,641</td><td>1,934</td><td>2,338</td><td>2,047</td></tr>
<tr><td>Dry Bulk[6]</td><td>4,837</td><td>4,959</td><td>4,575</td><td>5,289</td><td>4,988</td><td>4,563</td><td>4,021</td><td>3,475</td><td>3,917</td><td>4,888</td></tr>
<tr><td>RO-RO (Roll-on Roll-off)[7]</td><td>398</td><td>370</td><td>337</td><td>423</td><td>386</td><td>374</td><td>491</td><td>549</td><td>566</td><td>547</td></tr>
<tr><td>Gas[8]</td><td>624</td><td>548</td><td>558</td><td>622</td><td>628</td><td>462</td><td>441</td><td>500</td><td>604</td><td>612</td></tr>
<tr><td>Combo[9]</td><td>375</td><td>258</td><td>201</td><td>155</td><td>135</td><td>116</td><td>102</td><td>94</td><td>66</td><td>NA</td></tr>
<tr><td>General[10]</td><td>1,167</td><td>1,141</td><td>1,160</td><td>1,246</td><td>1,362</td><td>1,363</td><td>1,300</td><td>1,387</td><td>1,459</td><td>1,604</td></tr>
<tr><td>All Types</td><td>18,034</td><td>18,685</td><td>18,683</td><td>20,026</td><td>20,203</td><td>19,421</td><td>18,949</td><td>20,089</td><td>22,989</td><td>24,730</td></tr>
</table>

[1]The data in this report are only for oceangoing self-propelled vessels of 10,000 deadweight (DWT) capacity or greater. In 2005, these vessels accounted for 98 percent of the capacity calling at U.S. ports.
[2]Petroleum tankers and chemical tankers.
[3]10,000-69,999 DWT.
[4]>70,000 DWT.
[5]Container carriers, refrigerated container carriers.
[6]Bulk vessels, bulk containerships, cement carriers, ore carriers, wood-chip carriers.
[7]RO/RO vessels, RO/RO containerships, vehicle carriers.
[8]Liquefied natural gas carriers, liquefied natural gas/liquefied petroleum gas carriers, liquefied petroleum carriers.
[9]Ore/bulk/oil carriers, bulk/oil carriers.
[10]General cargo carriers, partial containerships, refrigerated ships, barge carriers, livestock carriers.
[11]In 2012, product and crude tankers were not distinguished.

Source: USDOT, MARAD, 2015a.

It is expected that the usage of GOM ports would continue to increase by approximately 3 percent annually over the next 50 years. As such, it is anticipated that port calls by all ship types would be bounded annually by a lower limit of current use and an upper limit of approximately 99,417 vessel port calls per year.

3.3.2.2.2 Other Marine Vessel Traffic

Non-OCS oil- and gas-related vessels other than those listed in **Chapter 3.3.2.2.1** utilize the GOM. These ships include research vessels, recreational vessels and commercial vessels. Commercial and recreational fishing in the Gulf of Mexico are regulated by the NMFS. For more information on recreational fishing vessels, refer to **Chapter 4.11**. For more information on commercial fishing vessels, refer to **Chapter 4.10**. Research activities, including surveys, genetic research, capture, relocation, or telemetric monitoring, may affect organisms or ecosystems in the GOM. If any of these activities could involve the take of an endangered species, the activity is required to obtain a permit through the NMFS. Vessels involved in the photography of marine mammals may also require a permit through the NMFS.

3.3.2.2.3 Anchoring

Any of the non-OCS oil- and gas-related vessels listed in **Chapter 3.3.2.2** could affect marine resources by anchoring. Effects would be similar to those discussed in the OCS oil- and gas-related anchoring **Chapter 3.1.3.3.1**. While commercial vessels acting under regulation may be more alert of sensitive areas, recreational vessels may be less aware of sensitive areas. For example, OCS oil- and gas-related vessels are required to survey for undiscovered archaeological resources; however, these resources may be damaged by anchors of non-OCS oil- and gas-related vessels that do not perform surveys.

3.3.2.2.4 Tankering

Non-OCS oil- and gas-related tankering includes ships carrying crude or ships carrying product. Overall, tankering (including U.S. ships and foreign ships) in the U.S. increased by 28 percent between 2003 and 2011 (USDOT, MARAD, 2013). While U.S. tankering port of calls declined between 2003 and 2011, foreign ship tankering port of calls increased; as listed below.

Ship Origin	2003	2011
U.S. Tankers	3,759	2,956
Foreign Tankers	14,744	20,722

Source: USDOT, MARAD, 2013.

Due to the double-hulled ships' ability to reduce or prevent oil spills, double-hulled ships have replaced almost all single-hulled ships. In 2003, 60-70 percent of all tankers were double hulled, but by 2011, 97-100 percent of all tankers were double hulled.

3.3.2.3 Non-OCS Oil- and Gas-Related Wastes and Discharges

Current and historic marine activities, unrelated to the OCS oil and gas program, are considered in the cumulative scenario for water quality in the GOM. These include regulated effluents from State oil and gas activities and the discharge of bilge, ballast water, and sanitary wastes from commercial shipping, similar to OCS oil- and gas-related service vessels (**Chapter 3.1.5**). Other non-OCS oil- and gas-related wastes are associated with dredged material disposal, potentially polluting shipwrecks, military activities, disposal of military chemical weapons and industrial wastes, land-based discharges, and non-OCS oil- and gas-related sources of trash and debris.

3.3.2.3.1 Potentially Polluting Shipwrecks

There are thousands of shipwrecks in U.S. waters. Some of the vessels involved in those wrecks are likely to contain oil, as fuel and possibly cargo, and may eventually result in pollution to the marine environment. Warships and cargo vessels sunk in wartime may also contain munitions, including explosives and chemical warfare agents, which may pose a continued threat because of their chemical composition. The NOAA maintains a large database of shipwrecks, dumpsites, navigational obstructions, underwater archaeological sites, and other underwater cultural resources (USDOC, NOAA, 2013b). This internal database, Resources and Undersea Threats, includes approximately 20,000 shipwrecks in U.S. waters. Shipwrecks in the Resources and Undersea Threats database were ranked to identify the most ecologically and economically significant, potentially polluting wrecks in U.S. waters for inclusion in the Remediation of Underwater Legacy Environmental Threats Program. Under this Program, wrecks are ranked based on age, size, hull material, type, location, historical information on the vessel, engineering analysis, archaeological site formation, whether they are currently leaking, and modeling of the trajectory, fate, and consequences of an oil release from a shipwreck. The NOAA identified 87 priority wrecks on the 2012 Remediation of Underwater Legacy Environmental Threats Program (those with the highest probability of discharge). Of these, 53 sank during an act of war and 34 sank as a result of collision, fire, grounding, storms, or other causes. Priority wrecks located in the Gulf of Mexico include *R.W. Gallagher*, which contains 80,855 bbl of Bunker C fuel oil, located about 40 mi (64 km) south of Terrebonne Parish, Louisiana, and *Joseph M. Cudahy*, which contains 77,444 bbl of crude and lubricating oil, located about 65 mi (105 km) northwest of Key West, Florida. The NOAA Wreck Oil Removal Program provides for the removal of oil from priority wrecks, where feasible.

Another shipwreck of note is *Tank Barge DBL 152*, which, on November 11, 2005, struck the submerged remains of a pipeline service platform in West Cameron Block 229 (about 50 mi [80 km] southeast of Sabine Pass, Texas). The platform had previously collapsed during Hurricane Rita. The barge was carrying a cargo of approximately 119,793 bbl of a blended mixture of low-API gravity oil (i.e. heavy oil, likely to sink). A portion of the oil was released at the point of impact, which sank to the seafloor. The barge was towed toward shallow water to facilitate salvage; however, it grounded and capsized approximately 12 mi (19 km) to the west-northwest, releasing additional oil to the seafloor. An estimated 45,846 bbl of oil were released during the incident, of which about 2,355 bbl were recovered by divers. In January 2006, recovery of additional oil was deemed infeasible and cleanup operations were discontinued, leaving approximately 43,491 bbl of oil unrecovered on the seafloor (USDOC, NOAA, 2013c).

3.3.2.3.2 Discharges Associated with Military Activities

A full description of military activities is discussed in **Chapter 3.3.2.6.1** below. Military operations within military warning areas (MWAs) and Eglin Water Test Areas (EWTAs) vary in types of missions performed and their frequency of use. Such missions may include carrier maneuvers, missile testing, rocket firing, pilot training, air-to-air gunnery, air-to-surface gunnery, minesweeping operations, submarine operations, air combat maneuvers, aerobatic training, and instrument training. To eliminate potential impacts from multiple-use conflicts related to the warning and test areas, a standard Military Areas Stipulation is routinely applied to all GOM leases (example in **Appendix D.3**).

Between the years of 1995 through 1999, Eglin Air Force Base in Florida conducted nearly 39,000 training sorties per year in the eastern Gulf. Potential impacts from these activities are discussed in the *Eglin Gulf Test and Training Range, Final Programmatic Environmental Assessment* (Air Force Air Armament Center, 2002). These military activities may result in marine impacts from chaff, fuel releases, flares, chemical materials, and debris.

Chaff, which is composed of short aluminum fibers similar in appearance to human hair, metalized glass fiber, or plastic, is dispensed by military aircraft as a countermeasure to distract radar-guided missiles from their targets. The Air Force Air Armament Center identified a remote potential that chaff could be mistaken as a food source and be ingested by aquatic organisms; however, the quantity of chaff used was not stated (Air Force Air Armament Center, 2002, page 4-18).

During in-flight emergencies, fuel may be released in the air or a fuel tank may be jettisoned and impact the surface. Drones may also be shot down and release fuel upon surface impact. The type of fuel used, JP-8, is very volatile and, when released at altitude, evaporates quickly. The Air Force Air Armament Center concluded that temporary localized effects to air and water quality may result from fuel releases; however, the frequency of fuel releases is extremely low (Air Force Air Armament Center, 2002, pages ES-1 and ES-2).

Flares may be ejected from aircraft to confuse and divert enemy heat-seeking or heat-sensitive missiles, and may also be used to illuminate surface areas during nighttime operations. Flares are composed primarily of aluminum, magnesium, and Teflon™. Upon burning, the magnesium (as magnesium oxide) in the flare may be deposited on the water surface. The Air Force Air Armament Center characterizes the impact to water from flares to be less than the natural concentrations of magnesium found in the Gulf (Air Force Air Armament Center, 2002, pages 4-20 and 4-21).

The Air Force Air Armament Center stated that chemical materials are introduced into the marine environment through drones, gun ammunition, missiles, chaff, flares, smokes and obscurants. The Air Force Armament Center concluded that potential chemical contamination concentrations were extremely low and not likely to impact marine species.

Debris may be released into the GOM as a result of military activities, including ordnance and shrapnel deposits from bombs and missiles, drones, chaff and flare cartridges, and intact inert bombs. This debris generally falls into the major categories of aluminum, steel, plastic, concrete, and other components (i.e., copper and lead) and originates largely from inert bombs, missiles, and downed drones (Air Force Armament Center, 2002, page 2-21).

3.3.2.3.3 Historical Chemical Weapon Disposal Areas

After World War I, chemical weapons were routinely disposed of in the world's oceans, including the GOM. In some instances, conventional explosives and radiological wastes were dumped along with chemical weapons. Army records document several instances of mustard and phosgene bombs being disposed of in the Gulf of Mexico, originating from New Orleans, Louisiana, and Mobile, Alabama. Chemical weapons disposed of in other locations, and potentially in the Gulf of Mexico, contained hydrogen cyanide, arsenic trichloride, cyanogen chloride, lewisite, tabun, sarin, and VX (Bearden, 2007).

Six former explosives dumping areas are noted on NOAA's chart of the Gulf of Mexico (USDOC, NOAA, 2015a) and likely contain disposed chemical weapons. These include two areas offshore Texas (about 65 nmi [75 mi; 120 km] southeast of Aransas Pass and about 100 nmi [115 mi;185 km] south of Galveston); two areas offshore Louisiana (both about 35-40 nmi [42-46 mi;65-74 km] south of the mouth of the Mississippi River); one area offshore Alabama (about 70 nmi [81 mi; 130 km] southeast of Mobile Bay); and one offshore Florida (about 130 nmi [150 mi; 241 km] west of Tampa Bay).

The Marine Protection, Research, and Sanctuaries Act of 1972, also known as the Ocean Dumping Act, was promulgated to regulate ocean dumping and to set aside certain areas as national marine sanctuaries. Section 101 of the Act (33 U.S.C. § 1411) prohibits ocean dumping, except as authorized by permit issued by the USEPA pursuant to Section 102 (33 U.S.C. § 1412). Section 102 specifically states that radiological, chemical, and biological warfare agents, high-level radioactive waste, and medical waste would not be permitted for ocean disposal after 1972.

3.3.2.3.4 Historical Industrial Waste Dumping Areas

Between 1940 and 1970, certain offshore locations of the United States were used for the disposal of various industrial wastes and low-level radioactive wastes, these activities being large, unrecorded, and unregulated (USDOC, NOAA, 2015b).

Section 102 of the Ocean Dumping Act (33 U.S.C. § 1412) authorizes the issuance of permits for ocean disposal of certain waste streams and requires that the USEPA determine that such dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities.

In 1973, the USEPA permitted two interim industrial waste disposal sites in the Gulf of Mexico, the charting of which has been maintained by the NOAA. Disposal Site A, located within the WPA, is situated on the upper part of the Texas-Louisiana continental shelf, about 125 nmi (144 mi; 232 km) south of Galveston, Texas. Disposal Site B is located in the CPA off the western side of the

Mississippi Delta about 60 nmi (75 mi; 120 km) south of the mouth of the Mississippi River. These sites are each approximately 300 mi^2 (777 km^2) in area.

The National Academy of Sciences' report, *Assessing Potential Ocean Pollutants* (National Academy of Sciences, 1975), provides an understanding of the disposal site conditions. At Site A (depth of about 610 m [2,001 ft]), uncontained wastes were discharged through a submerged pipe into the turbulent wake of a barge. At Site B (depth of about 655 m [2,149 ft]), waste materials were placed in barrels before discharge. Chemical wastes discharged at these sites reportedly had various concentrations of chlorinated hydrocarbons, calcium and sodium metals, formaldehyde, cyanide, and other metals (i.e., antimony, mercury, arsenic, zinc, manganese, and iron). Seven permits issued by the USEPA in 1973 allowed for the disposal of 84,500 tons of uncontained waste at Site A and 208,500 waste barrels at Site B, of which approximately 55,000 bbl contained chlorinated hydrocarbons. Chlorinated hydrocarbons were used during the Vietnam War to produce pesticides and defoliants (e.g., Agent Orange).

An additional industrial waste site is shown on NOAA's chart of the Gulf of Mexico (USDOC, NOAA, 2015a), and it is centered about 180 nmi (207 mi; 333 km) south-southeast of Galveston, Texas. This site, which is labeled on NOAA's chart as "organochlorine wastes," is approximately 2,300 mi^2 (5,957 km^2) in area and lies in 500-1,000 m (1,640-3,281 ft) of water. This site was not discussed in the National Academy of Sciences' report and may be subsequent disposal of the same waste stream at Site B discussed above.

3.3.2.3.5 Dredged Material Disposal

Dredged material is described in 33 CFR part 324 as any material excavated or dredged from navigable waters of the United States. Materials from maintenance dredging are primarily disposed of offshore on existing dredged-material disposal areas and in ocean dredged-material disposal sites (ODMDSs). Additional dredged-material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by the U.S. Army Corps of Engineers (COE) and relevant State agencies prior to construction. The ODMDSs are regulated by the USEPA under the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act.

If funds are available, the COE uses dredge materials beneficially for restoring and creating habitat, for beach nourishment projects, and for industrial and commercial development (**Chapter 3.3.2.8.3**). The applicant would need funds to cover the excess cost over the least cost environmentally acceptable alternative (the Federal Standard). The material must also be suitable for the particular beneficial use. Virtually all ocean dumping that occurs today is maintenance dredging of sediments from the bottom of channels and bodies of water in order to maintain adequate channel depth for navigation and berthing. There are four authorized open-water disposal areas in Louisiana and Mississippi along stretches of the main Gulf Intracoastal Waterway (GIWW) between Louisiana and Mississippi: in Louisiana, Disposal Area 66 (1,593 ac; 645 ha); and in Mississippi, Disposal Area 65A (1,962 ac; 794 ha), Disposal Area 65B (815 ac; 330 ha), and

Disposal Area 65C (176 ac; 71 ha) (U.S. Dept. of the Army, COE, 2008, Table 1). Dredged materials from the GIWW are disposed of at these locations. The ODMDSs utilized by the COE are located in the cumulative activities area and can be found on the Ocean Disposal Database website (U.S. Dept. of the Army, COE, 2015a).

There are two primary Federal environmental statutes governing dredge material disposal. The Marine Protection, Research, and Sanctuaries Act (also called the Ocean Dumping Act) govern transportation for the purpose of disposal into ocean waters. Section 404 of the Clean Water Act governs the discharge of dredged or fill material into U.S. coastal and inland waters. The USEPA and COE are jointly responsible for the management and monitoring of ocean disposal sites. The responsibilities are divided as follows: (1) the COE issues permits under the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act; (2) the USEPA has lead for establishing environmental guidelines/criteria that must be met to receive a permit under either statute; (3) permits for ODMDS disposal are subject to USEPA review and concurrence; and (4) the USEPA is responsible for designating ODMDSs.

The COE's Ocean Disposal Database reports the amount of dredged material disposed in ODMDSs by district (U.S. Dept. of the Army, COE, 2015a). **Table 3-26** shows the quantities of dredged materials disposed of in ODMDSs between 2004 and 2013 by the Galveston, New Orleans, and Mobile Districts.

Table 3-26. Quantities of Dredged Materials Disposed of in Ocean Dredged-Material Disposal Sites Between 2004 and 2013.

Year	New Orleans District		Galveston District		Mobile District	
	yd^3	m^3	yd^3	m^3	yd^3	m^3
2004	21,156,300	16,175,160	4,078,900	3,118,544	9,902,000	7,570,626
2005	21,403,200	16,363,928	1,250,900	956,382	3,796,900	2,902,940
2006	13,493,400	10,316,449	9,182,200	7,020,299	3,219,100	2,461,180
2007	17,550,700	13,418,479	6,361,200	4,863,489	1,952,800	1,493,023
2008	16,800,900	12,845,216	5,664,800	4,331,052	3,725,093	2,848,039
2009	7,618,900	5,825,070	16,295,000	12,458,427	10,351,223	7,914,082
2010	15,386,100	11,763,523	6,226,300	4,760,350	4,361,670	3,334,738
2011	15,613,143	11,937,110	3,502,600	2,677,931	3,749,570	2,866,753
2012	14,680,727	11,224,226	10,875,772	8,315,128	1,592,204	1,217,328
2013	3,669,836	2,805,792	4,452,299	3,404,028	3,473,019	2,655,315
Average	14,737,321	11,267,495	6,788,997	5,190,563	4,612,358	3,526,402

Source: U.S. Dept. of the Army, COE, 2015a.

The New Orleans District dredges an average annual 14.7 million yd^3 (11.3 million m^3). Current figures estimate that approximately 38 percent of that average is available for the beneficial use of dredge materials program (U.S. Dept. of the Army, COE, 2013). The remaining 62 percent of the total material dredged yearly by the COE's New Orleans District is disposed of at placement areas regulated under Section 404 of the Clean Water Act, at ODMDSs, or is stored in temporary staging areas located inland (e.g., the Pass a Loutre Hopper Dredge Disposal Site at the head of the Mississippi River's main "birdfoot" distributary channel system).

Evaluation of dredged material for ocean disposal under the Marine Protection, Research, and Sanctuaries Act relies largely on biological (bioassay) tests. The ocean testing manual, commonly referred to as the Green Book (USEPA, 1991), provides national guidance for determining the suitability of dredged material for ocean disposal. Benthic and water-column impacts of dredged material disposal are evaluated prior to disposal through analysis of representative samples of the material to be disposed, unless the sand source is previously characterized. Sample evaluation may include physical analysis (i.e., grain size, total solids, and specific gravity) and chemical analysis for priority pollutants (i.e., metals, semivolatile and volatile organic compounds, PCBs, and pesticides).

BOEM anticipates that, over the next 70 years, the amount of dredged material disposed of at ODMDSs would fluctuate generally within the trends established by the COE district offices. Between 2004 and 2013, the New Orleans District has averaged about 14.7 million yd^3 (11.2 million m^3) of material dredged per year disposed of at ODMDSs, while the Mobile District is about one-quarter of that quantity, or 4.6 million yd^3 (3.5 million m^3). Quantities disposed of at ODMDSs may decrease as more beneficial uses of dredged material onshore are identified and evaluated.

3.3.2.3.6 Land-Based Discharges

As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating point sources on land that discharge pollutants into waters of the United States. Point sources are discrete conveyances (outfalls) such as pipes or manmade ditches that may contain process water flows and/or precipitation from impervious surfaces. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. In most cases, the NPDES permit program is administered by authorized states (USEPA, 2015a).

The NPDES program includes periodic characterization of outfall flow to limit pollutants entering surface water. The Mississippi River basin drains 41 percent of the 48 contiguous states of the United States. The basin covers more than 1,245,000 mi^2 (3,224,535 km^2) and includes all or parts of 31 states and two Canadian provinces (U.S. Dept. of the Army, COE, 2015b). Nonpoint-source contributions to the Mississippi River from erosion, uncontained runoff, and groundwater discharge are primary sources of freshwater, sediment, suspended solids, organic matter, and pollutants (including nutrients, heavy metals, pesticides, oil and grease, and pathogens). As a result, water quality in coastal waters of the northern GOM is highly influenced by seasonal variation in river flow. The Mississippi River introduces approximately 3,680,938 bbl of oil and grease per year from land-based sources (NRC, 2003, Table I-9, page 242; **Chapter 3.3.2.4**) into the waters of the Gulf. Nutrients carried in waters of the Louisiana and Texas rivers contribute to seasonal formation of hypoxic zones (**Chapter 3.3.3.12**) on the Louisiana and Texas shelf. Additional information regarding water quality in the northern GOM can be found in **Chapter 4.2**.

3.3.2.3.7 Trash and Debris

Marine debris originates from both land-based and ocean-based sources. Forty-nine percent of marine debris originates from land-based sources, 18 percent originates from ocean-based sources, and 33 percent originates from general sources (sources that are a combination of land-based and sea-based activities) (USEPA, 2009a). Some of the sources of land-based marine debris are beachgoers, storm-water runoff, landfills, solid waste, rivers, floating structures, and ill-maintained garbage bins. Marine debris also comes from combined sewer overflows and typically includes medical waste, street litter, and sewage. Ocean-based sources of marine debris include galley waste and other trash from ships, recreational boaters, fishermen, and offshore oil and gas exploration and production facilities. Commercial and recreational fishers produce trash and debris by discarding plastics (e.g., ropes, buoys, fishing line and nets, strapping bands, and sheeting), wood, and metal traps. Some trash items, such as glass, pieces of steel, and drums with chemical or chemical residues, can be a health threat to local water supplies and as a result to biological, physical, and socioeconomic resources, to beachfront residents, and to users of recreational beaches. To compound this problem, there is population influx along the coastal shorelines. These factors, combined with the growing demand for manufactured and packaged goods, have led to an increase in nonbiodegradable solid wastes in our waterways.

3.3.2.4 Non-OCS Oil- and Gas-Related Spills

The NRC (2003) computed petroleum hydrocarbon inputs into North American marine waters for several major categories. The results show that three activities – extraction, transportation, and consumption – are the main sources of anthropogenic petroleum hydrocarbon pollution in the sea.

Non-OCS oil- and gas-related spills include the loss of petroleum products as a result of the extraction-, transportation-, and refinery-related activities from State oil and gas leases offshore Louisiana and Texas. The major sources of petroleum hydrocarbon discharges into the marine waters by transportation activities, including non-OCS oil- and gas-related sources, are tank vessel spills, operational discharges from cargo washings, coastal facilities spills, and gross atmospheric deposition of VOC releases from tankers. Non-OCS oil- and gas-related offshore spills are possible during the extensive maritime barging and tankering operations that occur in offshore waters of the GOM. Spills from transportation activities include a wide variety of petroleum products (not just crude oil), each of which behaves differently in the environment and may contain different concentrations of toxic compounds.

Consumption-related sources of petroleum releases to the marine environment include land-based sources (i.e., river discharge and runoff), two-stroke vessel discharge, non-tank vessel spills, operational discharges, gross atmospheric deposition, and aircraft dumping. Releases that occur during the consumption of petroleum, whether by individual car and boat owners, non-tank vessels, or run-off from increasingly paved urban areas, contribute the vast majority of petroleum introduced to the environment through human activity. Nearly 85 percent of the 29 million gallons of petroleum that enter North American ocean waters each year as a result of human activities comes from land-based runoff, polluted rivers, and aircraft. Land runoff and two-stroke engines account for nearly three quarters of the petroleum introduced to North American waters from activities associated with petroleum consumption, activities almost exclusively restricted to coastal waters. Unlike other sources, inputs from consumption occur almost exclusively as slow chronic releases. The estimates for land-based sources of petroleum are the most poorly documented and the uncertainty associated with the estimates range over several orders of magnitude. On occasion, aircraft carry more fuel than they can safely land with so fuel is jettisoned into offshore marine waters. The amount of 1,120 bbl (160 tonnes) of jettisoned fuel per year was estimated for the GOM.

Tables 3-27 and 3-28 provide the NRC (2003) estimates of hydrocarbon inputs into marine waters. In general, response activities to non-OCS oil- and gas-related spills would be similar to those described for an OCS oil- and gas-related spill (**Chapter 3.2.7**).

Table 3-27. Average Annual Inputs of Petroleum Hydrocarbons to Coastal Waters of the Gulf of Mexico, 1990-1999.

Inputs	Western Gulf of Mexico		Eastern Gulf of Mexico	
	(tonnes)	(bbl)	(tonnes)	(bbl)
Extraction of Petroleum				
Platforms Spills	90	630	trace[1]	trace
Atmospheric Releases (VOCs)	trace	trace	trace	trace
Permitted Produced-Water Discharges	590	4,130	trace	trace
Sum of Extraction Inputs	680	4,760	trace	trace
Transportation of Petroleum				
Pipeline Spills	890	6,230	trace	trace
Tank Vessel Spills	770	5,390	140	980
Coastal Facilities Spills[2]	740	5,180	10	70
Atmospheric Releases (VOCs)[3]	trace	trace	trace	trace
Sum of Transportation Inputs[4]	2,400	16,800	160	1,120
Consumption of Petroleum				
Land-Based Sources[5]	11,000	77,000	1,600	11,200
Recreational Vessels	770	5,390	770	5,390
Vessel >100 GT (spills)	100	700	30	210
Vessel >100 GT (operational discharges)	trace	trace	trace	trace
Vessel <100 GT (operational discharges)	trace	trace	trace	trace
Deposition of Atmospheric Releases (VOCs)	90	630	60	420
Aircraft Jettison of Fuel	N/A	N/A	N/A	N/A
Sum of Consumption	12,000	84,000	2,500	17,500

[1]Trace indicates <70 bbl (10 tonnes).
[2]Coastal facility spills do not include spills in coastal waters related to exploration and production spills or spills from vessels. The category "Coastal Facilities" includes aircraft, airport, refined product in coastal pipeline, industrial facilities, marinas, marine terminals, military facilities, municipal facilities, reception facilities, refineries, shipyards, and storage tanks.
[3]Volatization of light hydrocarbons during tank vessel loading, washing, and voyage.
[4]Sums may not match.
[5]Inputs from land-based sources during consumption of petroleum are the sum of diverse sources. Three categories of wastewater discharge are summed: municipal; industrial (not related to petroleum refining); and petroleum refinery wastewater. Urban runoff is included. It results from oil droplets from vehicles washing into waterways from parking lots and roads, and the improper disposal of oil containing consumer products.
GT = gross tons.
N/A = not available.
VOCs = volatile organic compounds.

Source: NRC, 2003.

Table 3-28. Average Annual Inputs of Petroleum Hydrocarbons to Offshore Waters of the Gulf of Mexico, 1990-1999.

Inputs	Western Gulf of Mexico		Eastern Gulf of Mexico	
	(tonnes)	(bbl)	(tonnes)	(bbl)
Natural Sources				
Seeps	70,000	490,000	70,000	490,000
Extraction of Petroleum				
Platform Spills	50	350	trace[1]	trace
Atmospheric Releases (VOCs)	60	420	trace	trace
Permitted Produced-Water Discharges	1,700	11,900	trace	trace
Sum of Extraction	1,800	12,600	trace	trace
Transportation of Petroleum				
Pipelines Spills	60	420	trace	trace
Tank Vessels Spills	1,500	10,500	10	70
Atmospheric Releases (VOCs)	trace	trace	trace	trace
Sum of Transportation	1,600	11,200	10	70
Consumption of Petroleum				
Land-Based Consumption[2]	N/A	N/A	N/A	N/A
Recreational Vessel Consumption[3]	N/A	N/A	N/A	N/A
Vessel >100 GT (spill)	120	840	70	490
Vessel >100 GT (operational discharges)	25	175	trace	trace
Vessel <100 GT (operational discharges)	trace	trace	trace	trace
Deposition of Atmospheric Releases (VOCs)	1,200	8,400	1,600	11,200
Aircraft Jettison of Fuel	80	560	80	560
Sum of Consumption[4]	1,400	9,800	1,800	12,600

[1]Trace indicates <70 bbl (10 tonnes).
[2]Limited to coastal zone.
[3]Limited to within 3 mi (5 km) of the coast.
[4]Sums may not match.
GT = gross tons.
N/A = not available.
VOCs = volatile organic compounds.

Source: NRC, 2003.

3.3.2.5 Non-OCS Oil- and Gas- Related Air Emissions

There are many air emissions sources related to non-OCS oil- and gas-related activities. Air emissions are caused by non-OCS onshore oil and gas activities and offshore State oil and gas activities, including combustion sources from power and heat generation, and the use of compressors, pumps, and reciprocating engines (i.e., boilers, turbines, and other engines); emissions resulting from flaring and venting of gas; and fugitive emissions. For instance, at the northern border between Texas and Louisiana (Haynesville Shale), there is a very large reserve of recoverable natural gas with recent extensive leasing and exploration activities. The economic impact is important in the region; however, it also generates significant amounts of ozone precursors as revealed by air quality modeling scenarios ranging from limited, moderate, and aggressive development reported in Kemball-Cook et al. (2010). Such precursors, nitrogen oxides and VOCs, are emitted during drilling, subsequent rock fracturing, venting, well completion, dehydration of natural gas, and fugitive emissions from compressor engines, wells, and pipeline components. The principal pollutants from these air emissions could also include NO_x, SO_x, CO, PM_{10}, $PM_{2.5}$, H_2S, VOC, benzene, ethylbenzene, toluene, xylene, glycols, and polycyclic aromatic hydrocarbons (PAHs).

Non-OCS oil- and gas-related activities can also include emissions from commercial and home heating, naturally occurring forest fires, motor vehicles, industrial activities in territorial seas and coastal waters, and industrial and transportation activities onshore. These activities can range from large, highly regulated industrialized sources such as electric utilities that burn fuel down to individual human sources such as outdoor grilling, jet skis, or using gasoline-powered equipment. In addition, sand borrowing and transportation in State territorial waters also generate emissions that can affect air quality. The principal pollutants from these air emissions sources include NO_x, SO_x, CO, PM_{10}, $PM_{2.5}$, and VOC. For more information on sources of air quality issues, refer to **Chapter 4.1.2**.

3.3.2.6 Other Non-OCS Oil- and Gas-Related Activities

3.3.2.6.1 Military Warning and Water Test Areas

The Gulf of Mexico (GOMEX) Range Complex contains four separate operating areas: Panama City and Pensacola, Florida; New Orleans, Louisiana, and Corpus Christi, Texas. The operating areas within the GOMEX Range Complex are not contiguous but are scattered throughout the GOM. The GOMEX Range Complex includes special-use airspace with associated warning areas and restricted airspace, and surface and subsurface sea space of the four operating areas. The air space over the GOM is used by the DOD for conducting various military operations. Twelve MWAs and six EWTAs are located within the GOM (**Figure 2-7**). These MWAs and EWTAs are multiple-use areas where military operations and oil and gas development have coexisted without conflict for many years. Several military stipulations are planned for leases issued within identified military areas.

The WPA includes all or parts of the following military warning areas: W-147, W-228, and W-602. Naval Mine Warfare Command Operational Area D contains 17 blocks in the WPA and is used by the Navy for mine warfare testing and training. In addition to Naval Mine Warfare Command Operational Area D, the WPA has four warning areas that are used for military operations. The areas total approximately 21.3 million ac or 75 percent of the total acreage of the WPA (**Figure 2-7**).

To eliminate potential impacts from multiple-use conflicts on the aforementioned area and on blocks that the Navy has identified as needed for testing equipment and for training mine warfare personnel, a standard Military Areas Stipulation is routinely applied to all GOM leases (**Appendix D.3**).

In addition, BOEM's Gulf of Mexico OCS Region issued NTL 2014-BOEM-G04, which provides links to the addresses and telephone numbers of the individual command headquarters for the military warning and water test areas in the GOM. The NTL 2014-BOEM-G04 can be found on BOEM's website at http://www.boem.gov/Notices-to-Lessees-and-Operators/.

Within the CPA, wholly or partially, lie six designated MWAs and three EWTAs that are used for military operations (**Figure 2-7**). The MWAs within the CPA total approximately 13.3 million ac or about 23 percent of the total acreage of the CPA. The EWTAs within the CPA total approximately 7 million ac or about 12 percent of the total acreage of the CPA.

The EPA has 64,563,679 total acres; approximately 43,217,494 ac are in EWTAs and approximately 15,670,911 ac are in MWAs (**Figure 2-7**). The EWTAs and MWAs account for 91 percent of the acreage within the EPA. The EPA portion of the proposed lease sale area is not within any of the MWAs; however, the entire EPA portion of the proposed lease sale area (657,905 ac) is within EWTA boundaries. In addition to the previously noted standard Military Areas Stipulation, blocks leased within the EWTAs will also be subject to the Evacuation Stipulation (**Appendix D.4**) and the Coordination Stipulation (**Appendix D.5**).

BOEM anticipates that, over the next 50 years, the military use areas currently designated regionwide would remain the same and that none of them would be released for nonmilitary use. Over the cumulative activities scenario, BOEM expects to continue to require military coordination stipulations in these areas. The intensity of the military's use of these areas, or the type of activities conducted in them, is anticipated to fluctuate with military mission needs.

3.3.2.6.2 Offshore Deepwater Ports and Nearshore Liquefied Natural Gas Terminals

Deepwater ports are designed to provide access for tankers and LNG carriers to offshore offloading facilities for hydrocarbon products, i.e., crude oil and natural gas. Crude oil passing through an offshore port may be temporarily stored and then transported to shore via pipeline. The term "deepwater port" includes all associated components and equipment, including pipelines, pumping stations, service platforms, mooring buoys, and similar features or equipment to the extent that they are located seaward of the high water mark (USDOT, MARAD, 2015b).

The Deepwater Port Act of 1974, as amended by the Maritime Transportation Security Act of 2002, establishes a licensing system for ownership, construction, operation and decommissioning of deepwater port structures located beyond the U.S. territorial sea. The Deepwater Port Act sets out conditions that deepwater port license applicants must meet, including the minimization of adverse impacts on the marine environment and submission of detailed plans for construction, operation, and decommissioning of deepwater ports. The Deepwater Port Act also sets out detailed procedures for the issuance of licenses by the Secretary of Transportation and prohibits the issuance of a license without the approval of the Governors of the adjacent coastal states (USDOT, MARAD, 2015b). Since early 2015, 20 deepwater port license applications have been filed with the Maritime Administration (MARAD) for approval (18 applications for licenses to import LNG and 2 applications filed for licenses to import oil).

Gulf of Mexico Offshore Deepwater Ports

Currently in the U.S., there is one offshore deepwater port in operation in the GOM, i.e., the Louisiana Offshore Oil Port (LOOP). The LOOP has received and transferred over 11 Bbbl of crude oil since its inception (LOOP, LLC, 2015).The offloaded crude oil is transported to shore via 48-in (123-cm) diameter pipeline. The LOOP receives and temporarily stores crude oil supplies from three sources, including the following:

- tankers carrying foreign (imported oil from Arabian Gulf, Russia, West Africa, North Sea, Mexico, and South America) and domestic crude oil from FPSOs;
- domestic crude oil produced in the Gulf of Mexico (Mars and Thunder Horse platforms); and
- movement of domestic crude oil via the Houston to Houma (Ho-Ho) pipeline.

Another LNG deepwater port (Port Dolphin) has been proposed in the Gulf of Mexico, and it has been approved by MARAD and the USCG. Port Dolphin is in development and is obtaining the necessary permits for construction; in addition, Höegh LNG is currently evaluating the market potential that may affect the status of the project (Castro, official communication, 2015). Port Dolphin has approval from the Federal Energy Regulatory Commission (FERC) and MARAD for completion of construction of the deepwater port and pipeline until December 2018.Gulf Gateway Energy Bridge was an LNG deepwater port in the Gulf of Mexico, and it was decommissioned in

2013. Additional information on the licenses and applications of deepwater ports and LNG facilities specific to the Gulf of Mexico can be found on MARAD's website (USDOT, MARAD, 2015).

In 2015, Delfin LNG proposed an offshore floating LNG project in the U.S. which would be located approximately 45 mi (72 km) offshore of Cameron, Louisiana *Federal Register* (2015c). The proposed project schedule is to receive Federal approvals and the Deepwater Port Act license in 2016, to have offshore and onshore construction in 2017 to 2018, and to commence operations in 2019.

Gulf Gateway Energy Bridge, LLC (Gulf Gateway) operated in the Gulf of Mexico off the coast of Louisiana from 2005 to 2012. The decision to decommission the facility was due to irreparable hurricane damage to pipelines (Hurricane Ike in 2008) interconnecting with the deepwater port and a changing natural gas market, which impacted the operator's ability to receive consistent shipments (USDOT, MARAD, 2015b).

Nearshore Liquefied Natural Gas (LNG)

The FERC is responsible for authorizing the siting and construction of onshore and nearshore (State waters) LNG import or export facilities under Section 3 of the Natural Gas Act. The FERC, under Section 7 of the Natural Gas Act, also issues certificates of public convenience and necessity for LNG facilities engaged in interstate natural gas transportation by pipeline. There are more than 110 LNG facilities operating in the U.S. performing a variety of services. The LNG terminal means all natural gas facilities located onshore or nearshore (in State waters) that are used to receive, unload, load, store, transport, gasify, liquefy, or process natural gas that is

- imported to the U.S. from a foreign country,
- exported to a foreign country from the U.S., or
- transported in interstate commerce by a waterborne vessel.

Some facilities export natural gas from the U.S., some provide natural gas supply to the interstate pipeline system or local distribution companies, while others are used to store natural gas for periods of peak demand. There are also facilities that produce LNG for vehicle fuel or for industrial use. Depending on location and use, an LNG facility may be regulated by several Federal agencies and by State utility regulatory agencies. Projects that are approved and built are subject to FERC's oversight for as long as the facility is in operation. The FERC currently regulates 24 operational LNG facilities (USDOE, FERC, 2015b). In the Gulf of Mexico State waters (nearshore), there are currently five LNG terminals, of which all five are currently in operation and planned for expansion of the facilities to export of natural gas to foreign markets:

- Freeport LNG Import/Export Terminal (Freeport, Texas);
- Golden Pass LNG Import/Export Terminal (Sabine Pass, Texas);

- Sabine Pass LNG Import/Export Terminal (Sabine Pass, Texas);
- Cameron LNG Import/Export Terminal (Formerly Hackberry LNG) (Cameron, Louisiana); and
- Lake Charles LNG Import/Export Terminal (Lake Charles, Louisiana).

The Corpus Christi LNG import/export terminal (Corpus Christi, Texas) was recently reviewed and approved by FERC and DOE, and they subsequently began construction in May 2015 (Cheniere Energy, 2015).

While interest in deepwater port development peaked in the 2000-2010 period, economic conditions for LNG have changed since 2010. BOEM notes that interest in LNG offshore terminal projects is expected to diminish over at least the next decade, with potential and subsequent stabilization in the LNG market. It is possible that LNG facilities in the Gulf of Mexico, or elsewhere, presently in the permitting process or in early construction phases could be withdrawn from consideration, cancelled, or deferred until LNG economics improve or until facilities under construction for importing LNG could be modified for exporting LNG. BOEM anticipates that, over the next 50 years, two additional LNG facilities in the CPA would be licensed and operating. It is unclear as to whether these LNG facilities will occur during the period of a proposed action, although trends evident in the submittal, approval, and withdrawal of recent applications suggest that such development is unlikely. Additional information on LNG terminal applications, application review determinations, and operational status for the Gulf of Mexico offshore LNG facilities can be found on MARAD's website at http://www.marad.dot.gov/ports/.

3.3.2.6.3 Development of Gas Hydrates

Methane hydrates (or gas hydrates) are cage-like lattices of water molecules containing methane, the chief constituent of natural gas found under arctic permafrost, as well as beneath the ocean floor. These may represent one of the world's largest reservoirs of carbon-based fuel. However, with abundant availability of natural gas from conventional and shale resources, there is no economic incentive to develop gas hydrate resources, and no commercial-scale technologies to exploit them have been demonstrated (USDOE, Energy Information Administration, 2012).

In the Gulf of Mexico, a Joint Industry Project was formed to carry out an assessment of gas hydrates in deep water of the GOM and to better understand the impact of hydrates on safety and seafloor stability, climate change, and assessment of the feasibility of marine hydrate as a potential future energy source. The findings of the 13-year (2001-2014) study concluded that hydrates are a readily managed, shallow drilling hazard and that hazard mitigation can be accomplished using existing protocols; field data indicate the occurrence of high-saturation hydrate accumulations in the GOM; methods employed to locate and predict hydrates were effective and accurate; and development of prototype tools and methods to collect hydrate pressure cores were developed.

BOEM released the results of a systematic geological and statistical assessment of gas hydrates resources in the GOM (USDOI, MMS, 2008*a*). This assessment incorporates the latest science with regard to the geological and geochemical controls on gas hydrate occurrence. It indicated that a mean volume of 607 trillion m^3 (21,444 Tcf) of methane was in-place in hydrate form. The assessment has determined that a mean of 190 trillion m^3 (6,710 Tcf) of this resource occurs as relatively high-concentration accumulations within sand reservoirs that may someday be produced. The remainder occurs within clay-dominated sediments from which methane probably would never be economically or technically recoverable.

BOEM anticipates that, over the next 40 years, the Joint Industry Project would complete the third leg of its characterization project for GOM gas hydrates in the cumulative impacts area. Within 40 years, it is likely that the first U.S. domestic production from hydrates may occur in Alaska, where gas obtained from onshore hydrates would either support local oil and gas field operations or be available for commercial sale if and when a gas pipeline is constructed to the lower 48 states. However, it is not possible to discount the possibility that first U.S. domestic production of gas hydrates could occur in the GOM (Moridis et al., 2008). Despite the substantially increased complexity and cost of offshore operations, there is a mature network of available pipeline capacity and easier access to markets in the GOM.

3.3.2.6.4 Renewable Energy and Alternative Use

On August 8, 2005, President George W. Bush signed the Energy Policy Act of 2005 into law. Section 388 (a) of the Energy Policy Act amended Section 8 of the OCSLA (43 U.S.C. § 1337) to authorize DOI to grant leases, easements, or rights-of-way on the OCS for the development and support of energy resources other than oil and gas and to allow for alternate uses of existing structures on OCS lands.

A final programmatic EIS for the OCS renewable energy program was published by this Agency in October 2007 (USDOI, MMS, 2007a) and a Record of Decision was published in the *Federal Register* on January 10, 2008 (*Federal Register*, 2008). The Act authorized this Agency to develop a comprehensive program and regulations to implement the new authority. Final rules for BOEM's renewable energy program were published on April 29, 2009, as 30 CFR part 285 (*Federal Register*, 2009).

The two primary categories of renewable energy that have the potential for development in the coastal and OCS waters of the U.S. are wind turbines and marine hydrokinetic systems. The first and most technologically mature renewable energy is wind energy, a popular source of clean and renewable energy that has been in use for centuries. The DOE released a strategic plan for creating an offshore wind industry in the U.S. (USDOE, 2011). In this plan, DOE determined that offshore wind energy can help the Nation reduce its greenhouse gas emissions, diversify its energy supply, provide cost-competitive electricity to key coastal regions, and stimulate economic revitalization of key sectors of the economy. However, if the Nation is to realize these benefits, key barriers to the development and deployment of offshore wind technology must be overcome, including the relatively high cost of energy, technical challenges surrounding installation and grid interconnection, and the permitting processes governing deployment in both Federal and State waters. There are two critical objectives to realize the strategic plan's goals: (1) reduce the cost of offshore wind energy; and (2) reduce the timeline for deploying offshore wind energy (USDOE, 2011, page 2). Since April 29, 2009, when the regulations governing renewable energy on the OCS were publicized, no wind park developments have been proposed in OCS waters of the GOM; however, there have been proposals in Texas coastal waters.

In Fiscal Year 2010, the DOE instituted the Offshore Wind Innovation and Demonstration initiative to consolidate and expand its efforts to promote and accelerate responsible commercial offshore wind development in the United States. In 2012, the DOE's Wind Program announced Federal funding nationwide in three major categories: technology development; market acceleration; and advanced technology demonstration. The Wind Program is working with BOEM to advance a national strategy for offshore wind research and development (Navigant Consulting, Inc., 2013). According to the Navigant Consulting, Inc. report, there is a potential of 594 gigawatts of potential wind energy available in the GOM. Offshore wind could create approximately 20.7 direct jobs per annual megawatt (or 20,700 jobs per annual gigawatt) installed in U.S. waters. Baryonyx Rio Grande Wind Farms received $4 million to produce three demonstration turbines in State waters (refer to "Renewable Energy Projects in Texas State Waters" below).

The second category of potential offshore renewable energy technologies is marine hydrokinetic systems, which are in a more developmental stage relative to wind turbines. The marine hydrokinetic systems consist of devices capable of capturing energy from ocean waves and currents. There has been no interest expressed in wave or current technologies in the GOM because the conditions necessary for their deployment are not suitable to the Gulf of Mexico. The marine hydrokinetic current technologies are actively being considered for the east coast of Florida where the Gulf Stream would provide a strong and continuous source of energy to turn underwater turbines.

The Energy Policy Act clarifies the Secretary's authority to allow the existing oil and gas structures on OCS lands to remain in place after production activities have ceased and to transfer liability and extend the life of these facilities for non-oil and gas purposes, such as research, renewable energy production, aquaculture, etc., before being removed. With many bottom-founded platform structures located along the nearshore border of OCS waters, the GOM would seem to have some potential for the reuse of these facilities.

BOEM expects that, over the next 40 years, a limited number of alternative use projects would be proposed in the WPA. It is also likely that these alternative use projects would consist of wind energy projects based on the current development of that technology. BOEM's expectation is based on the fact that known projects are being proposed in Texas State waters. Likewise, the potential alternative use projects could consist of a combination of integrated existing GOM infrastructure with new-built facilities.

Renewable Energy Projects in Texas State Waters

On October 24, 2005, the Texas General Land Office announced authorization for the first offshore wind energy project in the United States to be built in State waters off the Texas coast. An 11,355-ac (4,595-ha) lease was awarded to Galveston-Offshore Wind, L.L.C., a subsidiary of Louisiana-based Wind Energy Systems Technologies (now Coastal Point Energy LLC), where 50 wind turbines would be placed for the 150-megawatt development. The lease area is located approximately 7 mi (11 km) southeast of Galveston Island. Wind Energy Systems Technologies (now Coastal Point Energy LLC) was awarded the rights for additional leases south of the Galveston-Offshore Wind, L.L.C. project area, which would be developed after the Galveston project. The Texas General Land Office leased acreage to Baryonyx Corporation to build two offshore wind projects. While Baryonyx Corporation received money during the first phase of the Offshore Wind and Innovation Demonstration initiative, they did not receive funding to continue into the second phase (USDOE, Office of Energy Efficiency and Renewable Energy, 2015). Approximately 26,201 ac (10,603 ha) were leased off Nueces County, Texas, for the Mustang Project and about 40,000 ac (16,187 ha) were leased for the Rio Grande Project off South Padre Island. Both projects range from 5 to 10 mi (8 to 16 km) offshore. Below are the statuses of the reported projects:

Project Name	Proposed Capacity (megawatts)	Number of Turbines	Status Notes	Target Completion Date
Galveston Offshore Wind (Coastal Point Energy)	150	55-75	Received lease from Texas General Land Office in 2007. Announced intention to install a 750-kilowatt test turbine.	2018
Baryonyx Rio Grande Wind Farms (North and South)	1,000	100-200	Received lease from Texas General Land Office in 2009. The COE's environmental studies are underway. Received the DOE Wind Program grant to produce 3 demonstration turbines by 2017.	2019

3.3.2.6.5 Aquaculture

Offshore aquaculture is the rearing of aquatic animals in controlled environments (e.g., cages or net pens) in Federal waters. The NOAA has published the rule to implement a Fishery Management Plan for regulating offshore aquaculture in the Gulf of Mexico (*Federal Register*, 2016). The rule establishes a comprehensive regulatory program for managing the development of an aquaculture industry in Federal waters of the Gulf of Mexico. An interagency group has been established and is working on the permitting process for future proposed aquaculture activities. This group consists of the three permitting agencies, i.e., NOAA, USEPA, and USACE, and other agencies with an interest or expertise on the OCS, including USCG, FWS, BOEM, and BSEE. This group will continue to coordinate the permitting process.

3.3.2.6.6 OCS Sand Borrowing

If OCS sand is desired for coastal restoration or beach nourishment, BOEM uses the following two types of lease conveyances: a noncompetitive negotiated agreement (NNA) that can only be used for obtaining sand and gravel for public works projects funded in part or whole by a Federal, State, or local government agency; and a competitive lease sale in which any qualified person may submit a bid. BOEM has issued 48 noncompetitive negotiated agreements but has never had a competitive lease sale for OCS sand and gravel resources. BOEM's Marine Minerals Program continues to focus on identifying sand resources for coastal restoration, investigating the environmental implications of using those resources, and processing noncompetitive use requests.

Since 2003, BOEM has participated in the multiagency Louisiana Sand Management Working Group to identify, prioritize, and define a pathway for accessing sand resources in the near-offshore OCS of Louisiana, an area where competitive space use mainly involves OCS oil- and gas-related infrastructure such as wells, platforms, and pipelines. **Table 3-29** shows the projected approximate volume of OCS sand uses for coastal restoration projects over the next 5 years. Approximately 76 million yd^3 (58 million m^3) are expected to be needed for coastal restoration projects, as reported by the Gulf of Mexico OCS Region's Marine Minerals Program. To visualize such a dimension, this volume of sand could fill the Louisiana Superdome stadium 16.5 times.

Table 3-29. Projected OCS Sand Resource Needs for Planned Restoration Projects.

Restoration Project	Maximum Sand (yd^3)	OCS Lease Area and Block Number (if known)
NRDA Breton Island	~6,000,000	Breton Sound 42-44; Main Pass 42-44, 53-55
NRDA Caillou Lake Headlands (Whiskey)	13,400,000	Ship Shoal 88
Mississippi Coastal Improvement Program (MsCIP)	23,000,000	Mobile 817-819, 861-864
Southwest Louisiana	~15,000,000	N/A
Raccoon Island	~1,100,000	Ship Shoal 88 and 89; South Pelto 12-14
Trinity and East Islands	~16,260,000	Ship Shoal 88 and 89; South Pelto 12-14
Timbalier Island	~10,700,000	Ship Shoal 88 and 89; South Pelto 12-14
East Timbalier Island Restoration	~11,230,000	South Pelto 12-14
Caminada Headland (I and II)	~11,300,000	South Pelto 12-14
Total	~108,490,000	

N/A = not available.
~ = approximately.

In 2005, BOEM began to conduct offshore sand studies to investigate available sources of OCS sand for restoring coastal areas in Louisiana, Texas, Alabama, and Mississippi that were damaged by Hurricanes Katrina and Rita. Sand sources identified through BOEM's cooperative effort with Louisiana would likely serve as the major source of material for the restoration of the barrier islands planned as part of the Louisiana Coastal Area ecosystem restoration study (U.S. Dept. of the Army, COE, 2004) and for projects identified in the Louisiana 2012 and 2017 Master Plans (State of Louisiana, Coastal Protection and Restoration Authority, 2012 and 2015), projects developed under the *Deepwater Horizon* Natural Resource Damage Assessment (NRDA); Coastal Wetlands Planning, Protection and Restoration Act; Coastal Impact Assessment Program; National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund; and the 2012 Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies of the Gulf Coast States Act (RESTORE Act) barrier island restoration efforts.

Since the dredging of OCS sand and the associated activities of oceangoing dredge vessels could present some use conflicts on blocks also leased for oil and gas extraction, BOEM initiated a regional offshore sand management program in Louisiana in 2003, which, over the course of 10 years and several meetings, has developed options and recommendations for an orderly process to manage the competing use of OCS sand resources in areas of existing OCS infrastructure. With input from the Sand Management Working Group, BOEM has developed guidelines for sand resource allocations, maintaining a master schedule of potential sand dredging projects, developing procedures for accessing sand under emergency conditions, and establishing environmental requirements for the use of offshore borrow areas.

Noncompetitive negotiated agreements have been issued in the following locations. No sand noncompetitive negotiated agreements have ever been issued for OCS sand in the WPA. The EPA has three noncompetitive negotiated agreements:

- Pinellas County, Florida;
- Longboat Key, Town of Longboat Key, Florida; and
- Collier County, Florida.

The following 11 noncompetitive negotiated agreements for OCS sand have been issued in the CPA:

- Holly Beach, Cameron Parish, Louisiana;
- South Pelto test area, Terrebonne Parish, Louisiana;
- Pelican Island shoreline restoration, Plaquemines Parish, Louisiana;
- Raccoon Island marsh creation, Terrebonne Parish, Louisiana;
- St. Bernard Shoals, St. Bernard and Plaquemines Parishes, Louisiana;
- Ship Shoal in South Pelto Area for Caminada Headland restoration, Lafourche and Jefferson Parishes, Louisiana;
- Sabine Bank, Cameron Parish, Louisiana;

- Caminada II, Lafourche and Jefferson Parishes, Louisiana;
- NRDA Whiskey Island, Terrebonne Parish, Louisiana;
- North Breton Island, Breton Island National Wildlife Refuge, Louisiana; and
- Mississippi Coastal Improvements Program, Gulf Island National Seashore, Mississippi.

In 2013, BOEM began working with the U.S. Dept. of the Interior, Geological Survey (USGS) and FWS on a North Breton Island Restoration Project work plan, which is included in the NRDA early restoration plan, Phase III (USDOC, NOAA, 2015c). The North Breton Island Restoration Project (Louisiana) would use sand from the Breton Sound Area to restore shorebird and brown pelican nesting habitat in the Breton National Wildlife Refuge. It is anticipated that the noncompetitive negotiated agreement would be signed in 2016, with dredging for the North Breton Island Restoration Project beginning in late 2017. BOEM issued two noncompetitive negotiated agreements in Louisiana in 2015: the first was for the *Deepwater Horizon* NRDA Whiskey Island Restoration Project in Terrebonne Parish using sand from Ship Shoal Block 88; and the second was for Phase Two of the Caminada Headland Restoration Project in Lafourche and Jefferson Parishes using sand from South Pelto Blocks 13 and 14. Dredging for these projects began in 2015 and is anticipated to be complete in 2017. Another project site, East Timbalier Island, has been severely degraded due to the impacts of several strong storms, subsidence, and other factors. Historically, the island served to define the seaward boundary of the eastern Terrebonne Basin estuary, reducing the transmission of GOM waves into Terrebonne Bay. The noncompetitive negotiated agreement is expected to be signed in 2017 using proposed borrow areas from Ship Shoal in South Pelto Blocks 12, 13, and 14. BOEM is also working with the COE's Mobile District and the National Park Service on the Mississippi Coastal Improvements Program, which would use OCS sand from the Mobile Area for barrier island restoration projects along East and West Ship Islands in the Gulf Islands National Seashore. The noncompetitive negotiated agreement Record of Decision was signed in 2015 and will utilize OCS sand from Mobile Blocks 817-819 and 861-864. Dredging associated with the Mississippi Coastal Improvements Program is expected to begin in late 2016 and is expected to continue until 2018.

BOEM is authorized by 30 CFR § 550.101 to ensure that operations conform to sound conservation practice to preserve, protect, and develop mineral resources of the OCS and to minimize or eliminate conflicts between the exploration, development, and production of oil and natural gas and the recovery of other resources. BOEM's responsibility as steward of significant sand resources on the OCS is outlined in NTL 2009-G04. This NTL provides guidance for the avoidance and protection of significant OCS sediment resources essential to coastal restoration initiatives in BOEM's Gulf of Mexico OCS Region. The use of OCS sediment resources is authorized by BOEM through its Marine Minerals Program. Additional measures have been implemented and continue to be developed to help safeguard the most significant OCS sediment resources, reduce multiple use conflicts, and minimize interference with oil and gas operations under existing leases or pipeline rights-of-way. Mitigating measures ensure activities (including surface or near-surface emplacement of platforms, wells, drilling rigs, pipelines, umbilicals, and cables) avoid or are removed from, to the maximum extent practicable, significant OCS sediment resources.

Over the next 50 years, increased use of OCS sand for restoration projects in states that fall within the CPA are likely. Currently, no WPA restoration projects have been specifically identified. The boundary between the OCS and Texas State waters (9 nmi [10 mi; 16 km]) allows that some offshore sand is within the jurisdiction of the State; however, the easternmost portion of the shelf in Texas State waters is relatively devoid of beach-quality sand deposits. The Texas General Land Office, in cooperation with BOEM and the Texas Bureau of Economic Geology, has investigated the potential for use of Heald and Sabine Banks and confirmed substantial reserves of restoration quality sand. However, the State of Texas has yet to identify specific projects. The COE has intermittently used OCS sand reserves, and it is expected that this trend would continue. With respect to Louisiana, some uncertainty exists as to the amount of offshore OCS sand that would eventually be sought for coastal restoration projects. The Louisiana Coastal Area Ecosystem Restoration Plan potentially may use up to 60 million yd^3 (46 million m^3) (U.S. Dept. of the Army, COE, 2009a). Recently, there has been an increase in requests from Louisiana for State-funded OCS sand resources projects. BOEM anticipates that this growing trend of State-led projects would continue into the future as restoration funding is made available directly to the State through the Coastal Impact Assistance Program, the Gulf of Mexico RESTORE Act, Coastal Wetlands Planning, Protection and Restoration Act, National Fish and Wildlife Foundation: Gulf Environmental Benefit Fund, the *Deepwater Horizon* NRDA restoration, and GOMESA. These programs are outlined in more detail in **Chapter 3.3.2.8.3**.

3.3.2.7 Noise from Non-OCS Oil- and Gas-Related Sources

Other noise sources in the GOM are from non-OCS oil- and gas-related activities: vessel propeller cavitation from commercial shipping vessels, research vessels, tourism vessels, and commercial and recreational fishing vessels; sources from other equipment used on vessels (e.g., pingers used in fisheries to prevent animals getting caught in nets); State drilling operations; aircraft; military operations; coastal infrastructure construction (e.g., pile driving); underwater explosions; and natural phenomena such as wind, large storms, or lightning strikes. It is not under BOEM's authority to regulate any of these non-OCS oil- and gas-related noise sources, although some do occur on the OCS. Noise related to non-OCS oil- and gas-related G&G activities can be found in **Chapter 3.3.2.2.5** above. Refer to **Chapter 3.1.9** for general information on OCS oil- and gas-related sources of noise in the GOM.

Non-OCS Oil- and Gas-Related Geological and Geophysical Surveys

The G&G surveys are conducted to (1) obtain data for hydrocarbon and mineral exploration and production in Federal or State waters; (2) aid in siting renewable energy structures and facilities, and pipelines; (3) locate and monitor the use of potential sand and gravel resources for development; (4) identify possible seafloor or shallow-depth geologic hazards; and (5) locate potential archaeological resources and benthic habitats that should be avoided (**Chapters 4.4 and 4.13**, Deepwater Benthic Communities and Archaeological Resources, respectively).

Detailed descriptions of G&G activities are provided in more detail in the Atlantic G&G Activities Programmatic EIS (USDOI, BOEM, 2014a). A Programmatic EIS is currently being developed for the GOM (refer to **Chapter 1.7**). The selection of a specific technique or suite of techniques is driven by data needs and the target of interest. These activities include the following:

- various types of deep-penetration seismic airgun surveys used for State oil and gas exploration and development;
- other types of surveys and sampling activities used only in support of State oil and gas exploration and development, including electromagnetic surveys, deep stratigraphic and shallow test drilling, and various remote-sensing methods;
- HRG surveys used in all three program areas to detect shallow geohazards and marine minerals, archaeological resources, and certain types of benthic communities; and
- geological and geotechnical bottom sampling used in all three program areas to assess the suitability of seafloor sediments for supporting structures (e.g., platforms, pipelines, cables, renewable energy facilities such as wind turbines) or to evaluate the quantity and quality of marine minerals and sand for beach nourishment or other potential marine mineral extraction projects.

Deep-penetration seismic surveys, in which survey vessels tow an airgun or an array of airguns that emit acoustic energy pulses through the overlying water then into the seafloor over long durations and over large areas, are the most extensive G&G activities that would be conducted. These surveys would occur almost exclusively in support of oil and gas exploration and development and could be conducted in State waters. The G&G activities in support of renewable energy development would consist mainly of HRG and geotechnical surveys in Federal and State waters less than 40 m (131 ft) deep (USDOI, MMS, 2007a); this area represents approximately 25.9 percent of the GOM. The G&G activities in support of marine mineral uses (e.g., sand and gravel mining) would consist mainly of HRG and geotechnical surveys in Federal and State waters greater than 30 m (98 ft) deep; this area represents approximately 19.5 percent of the GOM. The G&G activities beyond the outer boundary of the planning areas have not been determined but could include geophysical surveys in support of the U.S. Extended Continental Shelf Project, which aims to establish the full extent of the continental shelf of the U.S., consistent with international law.

3.3.2.8 Coastal Environments

3.3.2.8.1 Sea-Level Rise and Subsidence

As part of the Mississippi River's delta system, both the Delta Plain and the Chenier Plain of the Louisiana Coastal Area (LCA) are experiencing relatively high rates of subsidence. All coastlines of the world have been experiencing a gradual absolute rise of sea level that is based on measurements across the globe and that extends across the influence of a single sedimentary basin. There are two aspects of sea-level rise during the past 10,000 years (Holocene Epoch):

absolute sea-level rise and relative sea-level rise. Absolute sea-level rise refers to a net increase in the volume of water in the world's oceans. Relative sea-level rise refers to the appearance of sea-level rise, a circumstance where subsidence of the land is taking place at the same time that an absolute sea-level change may be occurring. Geologists tend to consider all sea-level rises as relative because the influence of one or the other is difficult to separate over geologic timeframes.

An absolute sea-level rise would be caused by the following two main contributors to the volume of ocean water on the Earth's surface: (1) change in the volume of ocean water based on temperature; and (2) change in the amount of ice locked in glaciers, mountain ice caps, and the polar ice sheets. For the period 1961-2003, thermal expansion of the oceans accounts for only 23 ± 9 percent of the observed rate of sea-level rise (Bindoff et al., 2007); the remainder is water added to the oceans by melting glaciers, ice caps, and the polar ice sheets. The measurement of sea-level rise over the last century is based on tidal gauges and, more recently, satellite observations, which are not model dependent. Projections for future sea-level rise are dependent on temperature. As determined by an analysis of air bubbles trapped in Antarctic ice cores, today's atmospheric concentration of CO_2 is the highest it has ever been over the last 2.1 million years (Karl et al., 2009; Luthi et al., 2008; Hönisch et al., 2009). Although the measured data for atmospheric CO_2 concentration or temperatures measurements since the Industrial Revolution are generally not in dispute, proxy data for climates of the geologic past are a source of debate, and the models constructed to make projections for how climate may change remain controversial. Climate models are very sophisticated, but they may not account for all variables that are important or may not assign variables the weight of their true influence.

Although absolute sea-level rise is a contributor to the total amount of sea-level rise along the Gulf Coast, subsidence is the most important contributor to the total.

The Intergovernmental Panel on Climate Change (IPCC) reported that, since 1961, global average sea level (mean sea level) has risen at an average rate of 1.8 millimeter/year (mm/yr) (0.07 in/yr) and, since 1993, at 3.1 mm/yr (0.12 in/yr) (Bindoff et al., 2007). With updated satellite data to 2010, Church and White (2011) show that satellite-measured sea levels continue to rise at a rate close to that of the upper range of the IPCC projections (IPCC, 2012). It is unclear whether the faster rate for 1993-2010 reflects decadal variability or an increase in the longer-term trend. In the structured context used by the IPCC, there is high confidence that the observed sea-level rise rate increased from the 19th to the 20th century. Over the period 1901 to 2010, global mean sea level rose by 0.19 m (0.62 ft) (with a range of 0.17-0.21 m [56-69 ft]). The rate of sea-level rise since the mid-19th century has been larger than the mean rate during the previous two millennia (IPCC, 2014). The U.S. Global Change Research Program reported that, over the last 50 years, sea level has risen up to 8 in (203 mm) along parts of the Atlantic and Gulf Coasts, which included Louisiana and Texas (Karl et al., 2009), and that global sea level is currently rising at an increasing rate.

In comparison to other areas along the Gulf Coast, Louisiana's Mississippi Delta and Chenier Plains are built of young sediments deposited over the last 7,000 years. These deltaic sediments have been undergoing compaction and subsidence since they were deposited. The land is sinking at the same time that sea level is rising, contributing to high rates of relative sea-level rise along the Louisiana coast. Blum and Roberts (2009) posited four scenarios for subsidence and sea-level rise, and they concluded sediment starvation alone would cause approximately 2,286 mi^2 (592,071 ha) of the modern delta plain to submerge by 2100, without any other impacting factors (including sea-level rise) contributing to land loss.

A general value of approximately 6 mm/yr (0.23 in/yr) of subsidence from sediment compaction, dewatering, and oxidation of organic matter (Meckel et al., 2006; Dokka, 2006) is a reasonable rate to attribute to the Louisiana coastal area, with the understanding that subsidence rates along the Louisiana coast are spatially variable and influenced by subsurface structure and the timing and manner that the delta was deposited.

Stephens (2009 and 2010) reported that the influence of subsurface structure has not been taken into account in subsidence assessments in the LCA and along the Gulf Coast (Stephens, 2009, page 747). Most workers studying the effects of subsidence along the LCA have focused on surficial or near-surface geologic data sources and have made no attempt to integrate basin analysis into planning for coastal restoration or flood control project planning.

Results from the National Assessment of Coastal Vulnerability to Sea Level Rise estimate the rate of sea-level rise in the GOM, in particular the areas around Eugene Island, Louisiana, to be the highest (9.65 mm/yr; 3.17 ft/century) in the United States (USDOC, NOAA, 2015d). This classification is based upon variables such as coastal geomorphology, regional coastal slope, rate of sea-level rise, wave and tide characteristics, and historical shoreline change rates. As much as 88 percent of the northern GOM falls within the high vulnerability category. Areas ranked as the very low vulnerability category still have some sea-level rise. The lowest rate of rise is found in Panama City, Florida, with a rate of 1.6 mm/yr or 0.53 ft/century. Given this range, BOEM anticipates that, over the next 50 years, the northern GOM would likely experience a minimum relative sea-level rise of 80.7 mm (3.18 in) and a maximum relative sea-level rise of 482.6 mm (19.0 in). Sea-level rise and subsidence together have the potential to affect many important areas, including the OCS oil and gas industry, waterborne commerce, commercial fishery landings, and important habitat for biological resources (State of Louisiana, Coastal Protection and Restoration Authority, 2012a. Oil and gas infrastructure located within 15 in (381 mm) of the highest high tide in coastal areas along the Gulf of Mexico could potentially be affected by sea-level rise during this program. Programmatic aspects of climate change relative to the environmental baseline for the GOM are discussed in Chapter 4.2.1 of the Five-Year Program EIS.

Formation Extraction and Subsidence

Extracting fluids and gas from geologic formations can lead to localized subsidence at the surface. The Texas coast is experiencing high (5-11 mm/yr) (0.19-0.43 in) rates of relative sea-level rise that are the sum of subsidence and eustatic sea-level rise (Sharp and Hill, 1995). Even higher rates are associated with areas of groundwater pumping from confined aquifers. Berman (2005,

Figure 3) reported that 2 m (6 ft) of subsidence had occurred in the vicinity of the Houston Ship Channel by the mid-1970's as a result of groundwater withdrawal.

Morton et al. (2005) examined localized areas or "hot spots" corresponding to fields in the LCA where oil, gas, and brine were extracted at known rates. Morton et al. (2005, Figure 26) shows measured subsidence along transects across these fields that range from 18 to 4 mm/yr (0.7 to 0.15 in), with the greatest rates tending to coincide with the surface footprints of oil or gas fields. Mallman and Zoback (2007) interpreted downhole pressure data in several Louisiana oil fields in Terrebonne Parish and found localized subsidence over the fields; however, they could not link these localized rates to the subsidence measured and observed on a regional scale.

Down-to-the-basin faulting, also called listric or growth faulting, is a long recognized fault style along deltaic coastlines, and the Mississippi Delta is no exception (Dokka et al., 2006; Gagliano, 2005a). There is currently disagreement in the literature regarding the primary cause of modern fault movement in the Mississippi Delta region, and the degree to which it is driven by fluid withdrawal or sediment compaction resulting from the sedimentary pile pressing down on soft, unconsolidated sediments that causes downward and toward the basin movement along surfaces of detachment in the shallow and deep subsurface. Berman (2005) discussed the conclusions of Morton et al. (2005) and believed that they failed to make the case that hydrocarbon extraction caused substantial subsidence over the broader area of coastal Louisiana, a conclusion also reached by Gagliano (2005b).

Oil production on the LCA peaked at 513 MMbbl in 1970 and gas production peaked at 7.8 MMcf in 1969 (Ko and Day, 2004a). Between 2003 and 2012, oil production from Federal Gulf of Mexico waters has continued to decline (U.S. Dept. of Energy, Energy Information Administration, 2014a). From the peak, the level of production activity is slowly decreasing. The magnitude of subsidence caused by formation extraction is a function of how pervasive the activity is across the LCA. The oil and gas field maps in Turner and Cahoon (1987, Figure 4) and Ko and Day (2004a, Figure 1) seem an adequate basis to estimate the LCA's oil- and gas-field footprint at ~20 percent of the land area. The amount of subsidence from formation extraction is also occurring on a delta platform that is experiencing natural subsidence and sea-level rise. Fluid and gas extraction may lead to high local subsidence on the scale of individual oil and gas fields but not as a pervasive contributor to regional subsidence across the LCA.

3.3.2.8.2 Erosion

BOEM conservatively estimates that there are approximately 4,850 km (3,013 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS traffic regionwide (**Table 3-6**) and that the average canal is widening at a rate of 0.99 m/year (3.25 ft/year). Regionwide, this results in a total annual land loss of approximately 480 ac/yr (1,186 ha/yr).

In the Louisiana Coastal Master Plan (State of Louisiana, Coastal Protection and Restoration Authority, 2012), it is estimated that up to 1,750 mi^2 (4,500 km^2) of land would be lost in the next

50 years. Using BOEM's conservative estimate of approximately 4,850 km (3,014 mi) of Federal navigation channels, bayous, and rivers potentially exposed to OCS traffic in the LCA (**Table 3-6**) and the average canal widening rate of -0.99 m/yr (-3.25 ft/yr) (Thatcher et al., 2011), a total land loss of approximately 83,053 ac (33,611 ha) in navigation canals may be estimated over the next 70 years. Using this estimate and comparing it with the total expected land loss in coastal Louisiana over the next 50 years, BOEM estimates that approximately 2 percent of the total land loss in Louisiana would occur due to salt intrusion, hurricanes, and vessel traffic (OCS Program-related and non-OCS Program-related) in navigation canals. Because OCS Program-related vessel traffic constitutes such a small percentage (<1%) of the contributing factor to erosion in navigation canals, greater than 99 percent of the land loss in coastal Louisiana in the next 70 years can be attributed to non-OCS sources.

Net landloss due to navigation canals alone can be calculated by comparing erosion rates with beneficial activities such as land gained through the use of dredged sands. BOEM anticipates that, over the next 40 years, if current trends in the beneficial use of dredged sand and sediment are simply projected based on past land additions (U.S. Dept. of the Army, COE, 2009b), approximately 50,000 ac (20,234 ha) may be created or protected in the LCA through dredged materials programs.

3.3.2.8.3 Coastal Restoration Programs

The Mississippi Delta sits atop a pile of Mesozoic and Tertiary-aged sediments up to 7.5 mi (12.2 km) thick at the coast and it may be as much as 60,000 ft (18,288 m) or 11.4 mi (18.3 km) thick offshore (Gagliano, 1999). Five major lobes are generally recognized within about the uppermost 50 m (164 ft) of sediments (Britsch and Dunbar, 1993; Frazier, 1967, Figure 1). The oldest lobe contains peat deposits dated as 7,240 years old (Frazier, 1967). The youngest delta lobe of the Mississippi Delta is the Plaquemines-Balize lobe that has been active since the St. Bernard lobe was abandoned about 1,000 years ago. The lower Mississippi River has shifted its course to the GOM every thousand years or so, seeking the most direct path to the sea while building a new deltaic lobe. Older lobes were abandoned to erosion and subsidence as the sediment supply was shut off. Because of the dynamics of delta building and abandonment, the Louisiana coastal area (U.S. Dept. of the Army, COE, 2004) experiences relatively high rates of subsidence relative to more stable coastal areas eastward and westward. Coastal Louisiana wetlands make up the seventh largest delta on Earth and undergo about 90 percent of the total coastal wetland loss in the continental United States. In fact, from 1932 to 2010, coastal Louisiana has undergone a net change in land area of about 1.2 million ac (0.48 million ha). Trend analyses conducted from 1985 to 2010 shows that the coastal Louisiana wetland loss rate is 16.57 mi^2 (42.92 km^2) per year. If this loss were to occur at a constant rate, it would equate to Louisiana losing an area the size of one football field per hour (Couvillion et al., 2011).

Coastal Wetlands Planning, Protection and Restoration Act

The first systematic program authorized for coastal restoration in the LCA was the 1990 Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA), otherwise known as the "Breaux Act." Individual CWPPRA projects are designed to protect and restore between 10 and

10,000 ac (4 and 4,047 ha), require an average of 5 years to transition from approval to construction, and are funded to operate for 20 years (U.S. Government Accountability Office, 2007), which is a typical expectation for project effectiveness (Campbell et al., 2005).

The 1990 CWPPRA introduced an ongoing program of relatively small projects to partially restore the coastal ecosystem. As the magnitude of Louisiana's coastal land losses and ecosystem degradation became more apparent, it was identified that a more systematic approach to integrate smaller projects with larger projects to restore natural geomorphic structures and processes was needed. Projects have ranged from small demonstration projects to projects that cost over $50 million. The Coast 2050 report (State of Louisiana, Dept. of Natural Resources, 1998) combined previous restoration planning efforts with new initiatives from private citizens, local governments, State and Federal agency personnel, and the scientific community to converge on a shared vision to sustain the coastal ecosystem. The LCA Ecosystem Restoration Study (U.S. Dept. of the Army, COE, 2004a) built upon the Coast 2050 Report. The LCA's restoration strategies generally fell into one of the following categories: (1) freshwater diversion; (2) marsh management; (3) hydrologic restoration; (4) sediment diversion; (5) vegetative planting; (6) beneficial use of dredge material; (7) barrier island restoration; (8) sediment/nutrient trapping; and (9) shoreline protection, as well as other types of projects (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2006, Table 1).

As of March 2015, 200 authorized CWPPRA projects were approved, 101 of which have been constructed. Another 18 projects are under construction, 31 are in the engineering and design phase, and 50 have been deauthorized or transferred to another program. Over 81,000 "anticipated total acres" (32,780 ha) have been projected from completed projects, and 53 projects that were not yet completed as of mid-2015 are reported to result in greater than 17,000 anticipated total acres (6,879 ha) (LaCoast.gov, 2015). Of the 101 completed projects listed on LaCoast.gov (2015), more than half were one of three categories types: shoreline protection projects (30 projects); hydrologic restoration projects (24 projects); and marsh creation projects (17 projects).

Following Hurricanes Katrina and Rita in 2005, an earlier emphasis on coastal or ecosystem restoration of the LCA was reordered to add an equal emphasis on hurricane flood protection. The Department of Defense Appropriations Act of 2006 required Louisiana to create a State organization to sponsor the hurricane protection and restoration projects that resulted. The State legislature established the Coastal Protection and Restoration Authority (CPRA) and charged it with coordinating the efforts of local, State, and Federal agencies to achieve long-term, integrated flood control and wetland restoration. The CPRA has since produced comprehensive master plans for a sustainable coast (State of Louisiana, Coastal Protection and Restoration Authority, 2007 and 2012) as their vision of an integrated program that identified 109 high-performing projects that could substantially increase flood protection for communities and create a sustainable coast (State of Louisiana, Coastal Protection and Restoration Authority, 2012).

Anticipating which projects are undertaken for COE's comprehensive range of flood control, coastal restoration, and hurricane protection measures for the LCA would feed into the CPRA's

Annual Plan for authorization and which ones would ultimately be completed is challenging. Past completed projects have the potential of protecting up to 100,000 ac (40,469 ha) of Louisiana's wetlands (State of Louisiana, Coastal Protection and Restoration Authority, 2014); however, because CWPPRA projects compete for annual appropriations, there is no simple way to establish projections for land added or preserved over the cumulative activities scenario period (2017-2086) and the potential protection those projects will provide. Nor is there a way to anticipate which projects under the protection of the State's CPRA are admitted to its Annual Plan and completed.

Louisiana Coastal Master Plan

Since 2007, the CPRA has built or improved 159 mi (256 km) of levees, benefited 19,405 ac (7,853 ha) of coastal habitat, secured $17 billion in State and Federal funding, moved over 150 projects into design and construction, and constructed 32 mi (51 km) of barrier islands/berms (State of Louisiana, Coastal Protection and Restoration Authority, 2012). The projects included in the Louisiana Coastal Master Plan have the potential to build between 580 and 800 mi^2 (1,502 and 2,072 km^2) of land over the next 50 years, depending on future coastal conditions.

In 2012, Louisiana's CPRA released a Final Coastal Master Plan, which expanded upon the 2007 Master Plan. The objectives of the 2012 Master Plan focused on: flood protection, harnessing natural processes, supporting coastal habitats, sustaining cultural heritage, and promoting a working coast (State of Louisiana, Coastal Protection and Restoration Authority, 2012). The 2012 Louisiana Coastal Master Plan was based on a $50 billion budget and targeted use of these funds allows for improved protection for communities and could (with additional funding and depending how future coastal conditions change) turn the tide of land loss in Louisiana for the first time in a century. The $50 billion budget was determined by an estimate of money that Louisiana could receive in the next 50 years for coastal protection and restoration from sources such as the Gulf of Mexico Energy Security Act, Energy and Water Act, Coastal Wetlands Planning and Restoration Act, *Deepwater Horizon* Natural Resources Damage Assessment, *Deepwater Horizon* Clean Water Act penalties, carbon and nutrient credits, future State funding, and Louisiana's Coastal Protection and Restoration Fund.

The CPRA is actively working on the 2017 Coastal Master Plan, which would carry the 2007 and 2012 Master Plans forward while improving methods, ensuring that projects are completed efficiently and effectively while maintaining the vision of the future and adapting to future conditions (State of Louisiana, Coastal Protection and Restoration Authority, 2015). In order to develop the list of candidate projects for inclusion, the CPRA solicited proposals for new projects to be evaluated. Two solicitation periods occurred, one closing on August 21, 2014, and the second closing on October 31, 2014. A variety of project ideas were submitted, including bank stabilization, diversions, hydrologic restoration, marsh creation, oyster barrier reef restoration, ridge restoration, shoreline protection, and structural protection. Project sponsors included agencies, parishes, elected officials, nongovernment organizations, and private landowners.

As funding becomes available, the CPRA's Annual Plan is the vehicle for outlining how projects are prioritized and implemented. Each Annual Plan would provide project and funding details for the current year as well as 2 years into the future. The Annual Plan would provide an easy way for citizens and legislators to track progress of the 2012 and 2017 Coastal Master Plans.

Coastal Impact Assistance Program

The Energy Policy Act of 2005 was signed into law by President George W. Bush on August 8, 2005. Section 384 of Energy Policy Act amended Section 31 of the OCSLA (43 U.S.C. § 1356(a)) to establish the Coastal Impact Assistance Program (CIAP). The authority and responsibility for the management of CIAP is vested in the Secretary of the Interior; the Secretary delegated this authority and responsibility to BOEM until September 30, 2011. Under Section 384, Congress directed the Secretary to disburse $250 million for each of the fiscal years 2007 through 2010 to eligible OCS oil- and gas-producing States and coastal political subdivisions.

On October 1, 2011, the FWS took over administration of CIAP as directed by the Secretary because the program aligned with FWS's conservation mission and similar grant programs run by the FWS. The eligibility requirements for States, coastal political subdivisions, and fundable projects remained largely the same after the transfer.

The CIAP provides Federal grant funds derived from Federal offshore lease revenues to oil-producing states for conservation, protection, or restoration of coastal areas. The funds can be directed to a number of different projects, including restoration of wetlands; mitigation of damage to fish, wildlife, or natural resources; planning assistance and payment of the administrative costs of complying with these objectives; implementation of a federally approved marine, coastal, or comprehensive conservation management plan; and mitigation of the impacts of OCS oil- and gas-related activities through the funding of onshore infrastructure projects and public service needs.

Eligible CIAP States	Eligible CIAP Coastal Political Subdivisions
Alabama	Baldwin and Mobile Counties
Alaska	Municipality of Anchorage and Bristol Bay, Kenai Peninsula, Kodiak Island, Lake and Peninsula, Matanuska-Susitna, North Slope, and Northwest Arctic Boroughs
California	Alameda, Contra Costa, Los Angeles, Marin, Monterey, Napa, Orange, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, and Ventura Counties
Louisiana	Assumption, Calcasieu, Cameron, Iberia, Jefferson, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Martin, St. Mary, St. Tammany, Tangipahoa, Terrebonne, and Vermilion Parishes
Mississippi	Hancock, Harrison, and Jackson Counties
Texas	Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Harris, Jackson, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, Orange, Refugio, San Patricio, Victoria, and Willacy Counties

CIAP = Coastal Impact Assistance Program.

Natural Resource Damage Assessment

The Oil Pollution Act of 1990, as provided in 33 U.S.C. § 2706, allowed the designation of the Natural Resource Damage Assessment Trustee Council (Trustee Council), which included certain Federal agencies, States, and Indian Tribes. Executive Order 13554, which was signed on October 5, 2010, recognized the role of the Trustee Council under the Oil Pollution Act and "designated trustees as provided in 33 U.S.C. 2706, with trusteeship over those natural resources injured, lost, or destroyed as a result of the *Deepwater Horizon* oil spill." Specifically, Executive Order 13554 recognized the importance of carefully coordinating the work of the Gulf Coast Ecosystem Task Force with the Trustee Council, "whose members have statutory responsibility to assess natural resource damages from the *Deepwater Horizon* oil spill, to restore trust resources, and seek compensation for lost use of those trust resources" (The White House, 2012). The Task Force, on the other hand, was charged with creating a plan to improve the overall health of the Gulf of Mexico area and has focused on a number of stressors to the Gulf Coast ecosystem beyond those caused by the *Deepwater Horizon* explosion, oil spill, and response. While the work of the Task Force has been independent from the work of the Trustees, the valuable information gathered by the Task Force will be useful to the Trustees in their restoration planning efforts (USDOC, NOAA, 2015e).

The NRDA activities for the BP oil spill have been divided into the categories below and focus on specific species, habitats, or uses (USDOC, NOAA, 2015f):

- marine mammals and sea turtles;
- fish and shellfish;
- birds;
- deepwater habitat (e.g., deepwater coral);
- nearshore habitats (including seagrasses, mud flats, and coral reefs);
- shoreline habitats (including salt marsh, beaches, and mangroves);
- land-based wildlife and habitat; and
- public uses of natural resources (including recreational fishing, boating, beach closures).

The Trustee Council is currently in Phase III of early restoration, and the data collection, analysis, and restoration are ongoing (USDOI, 2015). The final Phase III plan proposes $627 million for 44 new early restoration projects across the Gulf Coast States. It also includes plans to prepare a programmatic EIS and programmatic restoration plan for early restoration (USDOC, NOAA, 2015g).

Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act

In July 2012, in response to the *Deepwater Horizon* explosion, oil spill, and response and other environmental challenges in the Gulf Coast region, Congress passed the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act or the RESTORE Act, (Gulf Coast Ecosystem Restoration Council, 2015). In September 2012, an Executive Order was released affirming the Federal Government's Gulf Coast ecosystem restoration efforts in light of the recent passage of the RESTORE Act, which created a Gulf Coast Restoration Trust Fund (Trust Fund), outlined a structure for allocating the Trust Fund, and established the Gulf Coast Ecosystem Restoration Council (Council) (The White House, 2012). The Council is comprised of governors from the five affected Gulf Coast States, the Secretaries from the U.S. Departments of the Interior, Commerce, Agriculture, and Homeland Security, as well as the Secretary of the Army and the Administrator of the U.S. Environmental Protection Agency. The Gulf Coast States recommended and President Obama appointed the Secretary of Commerce as the Council's Chair. As an independent entity, the Council has responsibilities with respect to 60 percent of the funds made available from a Gulf Coast Restoration Trust Fund and is charged with developing a comprehensive plan for ecosystem restoration on the Gulf Coast (Comprehensive Plan), as well as any future revisions to the Comprehensive Plan (Gulf Coast Ecosystem Restoration Council, 2014).

The Initial Comprehensive Plan, approved in August 2013, establishes the Council's goals defined as: (1) restore and conserve habitat; (2) restore water quality; (3) replenish and protect living coastal and marine resources; (4) enhance community resilience; and (5) restore and revitalize the GOM economy (The White House, 2012). In July 2014, the Council approved a proposal submission and evaluation process to select projects for inclusion on the draft Funded Priorities List, which will be included as an addendum to the Initial Comprehensive Plan. This first Funded Priorities List addendum would contain projects and programs that will be funded with available Transocean Deepwater Inc. funds. Future amendments to this Funded Priorities List and the process by which projects are selected for inclusion would evolve over time as new information becomes available, adaptive management activities occur, and as funding uncertainties are resolved (Gulf Coast Ecosystem Restoration Council, 2014). As a result of the settlement of Clean Water Act civil claims against Transocean Deepwater Inc. and related entities, a total of approximately $800 million, plus interest, was deposited in the Trust Fund between 2013 and 2015. Thus, based upon the RESTORE Act and the payment schedule agreed to by the court for the Transocean settlement, by February 20, 2015, 30 percent of that total amount (i.e., $240 million plus interest) was deposited in the Trust Fund for allocation by the Council under the Council-Selected Restoration Component (Gulf Coast Ecosystem Restoration Council, 2013).

Among its other duties, the Council is tasked with establishing additional advisory committees as may be necessary to assist the Council, including a scientific advisory committee and a committee to advise the Council on public policy issues; gathering information relevant to Gulf

Coast restoration, including thorough research, modeling, and monitoring; and providing an annual report to Congress on implementation progress (The White House, 2012).

As outlined in the RESTORE Act, the Council submitted a 2014 Annual Report to Congress on the implementation progress (Gulf Coast Ecosystem Restoration Council, 2014). In 2015, the Council proposed regulation that would establish the formula allocating funds made available from the Gulf Coast Restoration Trust Fund among the Gulf Coast States of Alabama, Florida, Louisiana, Mississippi and Texas (*Federal Register*, 2015d). The Council also released a draft initial-funded priorities list (Gulf Coast Ecosystem Restoration Council, 2015).

National Fish and Wildlife Foundation: Gulf Environmental Benefit Fund

In early 2013, a U.S. District Court approved two plea agreements resolving certain criminal cases against BP and Transocean, cases which arose from the 2010 *Deepwater Horizon* explosion, oil spill, and response. The agreements direct a total of $2.544 billion to the National Fish and Wildlife Foundation to fund projects benefiting the natural resources of the Gulf Coast that were impacted by the spill.

Between 2013 and 2018, the National Fish and Wildlife Foundation's newly established Gulf Environmental Benefit Fund will receive a total of $1.272 billion for barrier island and river diversion projects in Louisiana; $356 million each for natural resource projects in Alabama, Florida, and Mississippi; and $203 million for similar projects in Texas. Funding priorities include projects that

- restore and maintain the ecological functions of landscape-scale coastal habitats, including barrier islands, beaches, and coastal marshes, and ensure their viability and resilience against existing and future threats, such as sea-level rise;
- restore and maintain the ecological integrity of priority coastal bays and estuaries; and
- replenish and protect living resources including oysters, red snapper and other reef fish, Gulf Coast bird populations, sea turtles, and marine mammals (National Fish and Wildlife Foundation, 2015a).

As of 2015, the Gulf Environmental Benefit Fund has supported 50 projects worth nearly $390 million. In making the awards, the National Fish and Wildlife Foundation has worked closely with key State and Federal resource agencies to select projects that remedy harm and eliminate or reduce the risk of future harm to Gulf Coast natural resources. For example, funding was awarded from the Gulf Environmental Benefit Fund for engineering and construction of both Caminada Beach and Dune Increment II and East Timbalier Island, both involving the use of OCS sediment resources (National Fish and Wildlife Foundation, 2015b).

3.3.2.8.4 Saltwater Intrusion

Saltwater intrusion is one of many factors that impact coastal environments, contributing to coastal land loss. Such impacts can be natural, as when storm surge brings GOM water inland, or anthropogenic, as when navigation or pipeline canals allow tides to introduce high salinity water to interior marshes. In addition, produced water from oil wells in the coastal zones can be a source of water of extreme high salinity, well over 100 parts per thousand. Produced water, which is regulated, often contains pollutants such as heavy metals and hydrocarbons, as well.

Marsh plants are exposed to salinity stress when higher salinity GOM waters reach interior marshes, exposing plants to salinities above their tolerance levels. This can result in decreased plant growth and/or mortality depending on the tolerance of the plant species and the amount, rate, and duration of salinity increase (Mendelssohn and McKee, 1987). Plant dieback can be followed by subsequent erosion of the marsh substrate and eventual land loss (Ko and Day, 2004; Boesch et al., 1994).

The freshwater-adapted habitats (i.e., fresh or intermediate marsh and forested wetlands) are more sensitive to saltwater intrusion than the other more salt-tolerant habitats, such as brackish and saline marsh. Saltwater intrusion can result in conversion of freshwater to saline habitats or can simply kill fresh or intermediate marshes, thus converting them to open water (Johnston et al., 2009).

The leveeing of the Mississippi River and the construction of numerous water control structures are generally thought to have accelerated coastal land loss by isolating coastal wetlands from the freshwater, sediment, and nutrients of the Mississippi River, which previously served to nourish and sustain these wetlands. Among other impacts, this isolation effect results in the loss or reduction in freshwater flow, and thus a greater marine influence on the coastal wetlands, which in turn results in saltwater intrusion (Johnston, et al., 2009).

Saltwater intrusion into coastal environments can also impact estuarine species distribution, shifting patterns of habitat usage. Marine species penetrate farther inland when salinities are within their tolerance, and less salt-tolerant species are restricted to the fresher areas. This can also lead to a shift in the pattern of availability of preferred fish species to fishermen.

3.3.2.8.5 Maintenance Dredging and Federal Channels

Along the Texas Coast there are eight federally maintained navigation channels in addition to the GIWW. Most of the dredged materials from the Texas channels have high concentrations of silt and clay. Beneficial uses of dredged material include beach nourishment for the more sandy materials and storm reduction projects or ocean disposal for much of the finer-gained material. Ocean disposal locations along the Texas coast are situated so that materials are placed on the down drift side of the channel (U.S. Dept. of the Army, COE, 1992,).

There are 10 Federal navigation channels in the LCA, ranging in depth from 4 to 14 m (12 to 45 ft) and in width from 38 to 300 m (125 to 1,000 ft), that were constructed as public works projects beginning in the 1800's (Good et al., 1995, Table 1). The combined length of the Federal channels in Good et al. was reported as 2,575 mi (1,600 km), with three canals considered deep-draft and seven considered shallow (Good et al., 1995, page 9). The Federal navigation channels in Louisiana identified by Good et al. (1995, Table 1) are as follows: (1) GIWW East of Mississippi River; (2) Mississippi River Gulf Outlet; (3) GIWW between the Atchafalaya and Mississippi Rivers; (4) GIWW West of Atchafalaya River; (5) Barataria Bay Waterway; (6) Bayou Lafourche; (7) Houma Navigation Canal; (8) Mermentau Navigation Channel; (9) Freshwater Bayou; and (10) Calcasieu River Ship Channel. The Mississippi River Gulf Outlet has been decommissioned and sealed with a rock barrier as of July 2009 (Shaffer et al., 2009, page 218).

The GIWW is a Federal, shallow-draft navigation channel constructed to provide a domestic connection between GOM ports after the discovery of oil in East Texas in the early 1900's, as well as to provide a pathway to support the growing need for interstate transport of steel and other manufacturing materials in the early 20th century. It extends approximately 1,400 mi (2,253 km) along the Gulf Coast from St. Marks in northwestern Florida to Brownsville, Texas, with the Louisiana part reported to be 994 mi (1,600 km) in length (Good et al., 1995). With the exception of the east-west GIWW in Louisiana, Federal channels are approximately north-south in orientation, making them vulnerable to saltwater intrusion during storms (refer to **Chapter 3.3.2.8.4** above).

Cumulative impacts include the displacement of wetlands by original channel excavation and disposal of the dredged material. Turner and Cahoon (1987, Table 4-5) estimated that immediate impacts from the construction of navigation channels were between 58,000 and 96,000 ac (23,472 and 38,850 ha). Indirect cumulative land losses resulted from hydrologic modifications, saltwater intrusion, or bank erosion from vessel wakes (Wang, 1988). Once cut, navigation canals tend to widen as banks erode and subside, depending on the amount of traffic using the channel. Good et al. (1995, Table 1) estimated indirect impacts on wetland loss from bank erosion at 35,000 ac (14,164 ha).

The COE reported that the New Orleans District has the largest channel maintenance dredging program in the U.S., with an annual average of 70 million yd^3 (53.5 million m^3) of material dredged (U.S. Dept. of the Army, COE, 2009a). Maintenance dredging activity from 2004 through 2013 for Federal channels by COE's Galveston District, New Orleans District, and Mobile District are reported in COE's Ocean Disposal Database (U.S. Dept. of the Army, COE, 2015a) (**Table 3-26**). The average amount of material disposed of in the 10-year period is highest for the New Orleans District (14,737,321 yd^3 [11,267,495 m^3]), followed by the Galveston District (6,788,997 yd^3 [5,190,563 m^3]) and the Mobile District (4,612,358 yd^3 [3,526,402 m^3]). Federal channels and canals are maintained throughout the onshore cumulative impact area by the COE, State, county, commercial, and private interests. Proposals for new and maintenance dredging projects are reviewed by Federal, State, and local agencies as well as by private and commercial interests to identify and mitigate adverse impacts upon social, economic, and environmental resources.

Maintenance dredging is performed on an as-needed basis. Typically, the COE schedules surveys every 2 years on each navigation channel under its responsibility to determine the need for maintenance dredging. Dredging cycles may be from 1 to as many as 11 years from channel to channel and from channel segment to channel segment. The COE is charged with maintaining all larger navigation channels in the cumulative activities area. The COE dredges millions of cubic meters of material per year in the cumulative activities area, most of which is under the responsibility of the New Orleans District. Some shallower port-access channels may be deepened over the next 10 years to accommodate deeper draft vessels. Vessels that support deepwater OCS oil- and gas-related activities may include those with drafts to about 7 m (23 ft).

Construction and maintenance dredging of rivers and navigation channels can furnish sediment for a beneficial purpose, a practice the COE calls beneficial use of dredge materials program. Drilling, production activity, and maintenance at most coastal well sites in Louisiana require service access canals that undergo some degree of aperiodic maintenance dredging to maintain channel depth, although oil and gas production on State lands peaked in 1969-1970 (Ko and Day, 2004a, page 398). In recent years, dredged materials have been sidecast to form new wetlands using the beneficial use of dredge materials program. Potential areas suited for beneficial use of dredged material are considered most feasible within a 10-mi (16-km) boundary around authorized navigation channels in the New Orleans District, but the potential for future long-distance pipelines for disposal of dredged material could increase the potential area available for the beneficial use of dredge materials program considerably (U.S. Dept. of the Army, COE, 2009a, page 27).

As discussed in **Chapter 3.3.2.3.5**, the New Orleans District dredges an average annual 14.7 million yd^3 (11.3 million m^3) of material. Current figures estimate that approximately 38 percent of that average is available for the beneficial use of the dredge materials program (U.S. Dept. of the Army, COE, 2013). The COE reported that, over the last 20 years, approximately 12,545 ha (31,000 ac) of wetlands have been created with dredged materials, most of which are located on the LCA delta plain (U.S. Dept. of the Army, COE, 2013).

3.3.2.9 Natural Events and Processes

3.3.2.9.1 Physical Oceanography

Physical oceanographic processes in the GOM include the Loop Current, Loop Current eddies, and whirlpool-like features that appear underneath the Loop Current and Loop Current eddies that interact with the bottom. Infrequently observed processes include a limited number of high-speed current events, at times approaching 100 cm/s (39 in/s). These events were observed at depths exceeding 1,500 m (4,921 ft) in the northern GOM (Hamilton and Lugo-Fernandez, 2001; Hamilton et al., 2003) and as very high-speed currents in the upper portions of the water column observed in deep water by several oil and gas operators.

Caribbean Sea waters colliding with the Yucatan Peninsula turn northward and enter the Yucatan Channel as a strong flow called the Yucatan Current. This current exhibits two basic arrangements inside the Gulf of Mexico. First, the Yucatan Current enters the GOM and turns immediately eastward, exiting the GOM towards the Atlantic Ocean via the Florida Straits to become the Gulf Stream. The second arrangement consists of a northward penetration of the Yucatan Current into the Gulf of Mexico reaching to 26º-28º N. latitudes, then curls clockwise turning south, and exiting via the Florida Straits into the Atlantic Ocean to become, again, the Gulf Stream. This circulation inside the GOM is called the Loop Current. The Loop Current transports warm and salty water year round into the GOM at a rate of 25-30 million cubic meters per second, and it is the main energy source for oceanographic processes inside the Gulf of Mexico. At its climatic northern position, the Loop Current becomes unstable, breaks, and sheds a large (200- to 400-km diameter [124- to 248-mi diameter]) clockwise whirlpool that travels southwestwards at speeds of 4-8 km/day (2-5 mi/day). The southwest trip of Loop Current eddies continues until colliding with the Texas and Mexico continental slope in the western GOM, where they disintegrate. This sequence connects the eastern with the western Gulf, which otherwise appear disconnected.

Mean seasonal circulation patterns of inner-shelf and outer-shelf currents on the Louisiana-Texas continental shelf, the northeastern GOM shelf, and the West Florida shelf are primarily wind driven and are also influenced by riverine outflow. Cold water from deeper off-shelf regions moves onto and off the continental shelf by cross-shelf flow associated with upwelling and downwelling processes in some locations (Collard and Lugo-Fernandez, 1999). There are also a number of secondary whirlpools with smaller diameters (50-100 km; 31-62 mi) that affect the exchange between the shelf and deepwater, and these smaller whirlpools interact with the larger Loop Current eddies (Donohue et al., 2008). Additionally, wind events such as tropical cyclones (especially hurricanes), extratropical cyclones, and cold-air outbreaks can result in extreme waves and cause currents with speeds of 100-150 cm/s (39-59 in/s) over continental shelves.

Deepwater currents of the GOM can be approximated as a two-layer system with an upper layer about 800- to 1,000-m (2,625- to 3,281-ft) deep that is dominated by the Loop Current and associated clockwise whirlpools and a lower layer below ~1,000 m (3,281 ft) that has near uniform currents (Cox et al., 2010; Welsh et al., 2009; Inoue et al., 2008). The coupling between these two layers is generally absent, but it appears that motions at the layer interface are needed to transmit the energy from the Loop Current and eddies downward (Cox et al., 2010; Welsh et al., 2009; Inoue et al., 2008, Donohue et al., 2008). Mean deep flow around the edges of the GOM circulates in a counterclockwise direction, as observed at ~2,000 m (6,562 ft) (Sturges et al., 2004) and at ~900 m (2,953 ft) (Weatherly, 2004), with current speeds generally decreasing with depth.

3.3.2.9.2 Natural Seeps

"Natural seeps" is used here to mean the naturally occurring seepage of crude oil and tar into the GOM. These seeps are geographically common and have likely been active throughout history. Natural seeps account for approximately 47 percent of the crude oil entering the marine environment (Kvenvolden and Cooper, 2003). Mitchell et al. (1999) estimated a range of 280,000-700,000 bbl per year (40,000-100,000 tonnes per year), with an average of 490,000 bbl (70,000 tonnes) for the northern GOM, excluding the Bay of Campeche. Using this estimate and assuming seep scales are proportional to surface area, the NRC (2003) estimated annual seepage for the entire GOM at ~980,000 bbl (140,000 tonnes) per year, or about 3 times the estimated amount of oil spilled by the

1989 *Exxon Valdez* event (~270,000 bbl) (Steyn, 2010) or a quarter of the amount released into the environment by the *Deepwater Horizon* explosion and oil spill (4.1 MMbbl of oil) (Lubchenco et al., 2010). As seepage is a natural occurrence, the rate of ~980,000 bbl (140,000 tonnes) per year is expected to remain unchanged throughout the cumulative analysis period. Refer to **Chapter 4.4** for more information on natural seeps.

3.3.2.9.3 Hurricanes

Climatic cycles in tropical latitudes typically last 20-30 years or even longer (USDOC, NOAA, 2005). As a result, the North Atlantic experiences alternating periods of above-normal or below-normal hurricane seasons. There is a two- to three-fold increase in hurricane activity during eras of above-normal activity. The hurricane activity from 1995 to 2007 is representative of an era of above-normal hurricane activity (Elsner et al., 2008, page 1,210).

Twenty-one hurricanes made landfall in the WPA, CPA and EPA during the 1995-2015 hurricane seasons, disrupting OCS oil- and gas-related activity in the GOM (**Table 3-30**). Half of these hurricanes reached a maximum strength of Category 1 or 2 while in the CPA or WPA, while the other half were powerful hurricanes reaching maximum strengths of Category 4 or 5. The current era of heightened Atlantic hurricane activity began in 1995; therefore, the Gulf of Mexico could expect below average hurricanes in the GOM in the near term due to a strong El Nino. Increased hurricanes may occur if El Nino wanes during the first half of the 50-year analysis period and levels return to below-normal activity during the remaining half to three-quarters of the 50-year analysis period.

Table 3-30. Hurricane Landfalls in the Northern Gulf of Mexico from 1995 through 2015.

Event	Year	Affected State	Storm Name	Intensity at Landfall
1	1995	AL, FL	Opal	Hurricane Category 3
2	1995	FL	Erin	Hurricane Category 2
3	1997	LA, AL	Danny	Hurricane Category 1
4	1998	FL	Earl	Hurricane Category 1
5	1998	MS, AL	Georges	Hurricane Category 2
6	1999	TX	Bret	Hurricane Category 3
7	2002	LA	Lili	Hurricane Category 1
8	2003	TX	Claudette	Hurricane Category 1
9	2004	FL	Charley	Hurricane Category 4
10	2004	FL	Frances	Hurricane Category 2
11	2004	MS, AL	Ivan	Hurricane Category 3
12	2005	LA, MS	Cindy	Hurricane Category 1
13	2005	FL, AL	Dennis	Hurricane Category 3
14	2005	LA, MS	Katrina	Hurricane Category 5
15	2005	TX, LA	Rita	Hurricane Category 3
16	2005	FL	Wilma	Hurricane Category 3
17	2007	TX, LA	Humberto	Hurricane Category 1

Event	Year	Affected State	Storm Name	Intensity at Landfall
18	2008	LA	Gustav	Hurricane Category 2
19	2008	TX, LA	Ike	Hurricane Category 4
20	2008	TX	Dolly	Hurricane Category 1
21	2012	LA	Isaac	Hurricane Category 1

Note: There were no hurricane landfalls in the northern Gulf of Mexico in 2009-2011 and 2013-2015.

Source: USDOC, NOAA, 2016a.

Hurricanes Ivan, Katrina, Rita, Gustav, and Ike entered the GOM and destroyed 181 structures and 1,673 wells on the OCS (Kaiser, 2015a). In general, they caused extensive damage to OCS platforms, topside facilities, and pipeline systems (**Table 3-31**). During Hurricanes Ivan, Katrina, and Rita, 9 jack-up rigs and 19 moored rigs were either toppled or torn from their mooring systems. Sixty platforms were destroyed as a result of Hurricanes Gustav and Ike in 2008, 31 platforms had extensive damage, and 93 platforms had moderate damage (USDOI, MMS, 2008b). The number of destroyed platforms by Hurricanes Gustav and Ike exceeds the number destroyed by Hurricane Katrina. Hurricane Isaac made landfall near the mouth of the Mississippi River on August 28, 2012, as a Category 1 hurricane, which only caused very minor damage to the offshore oil or gas infrastructure in the GOM. However, after Hurricane Isaac, tarballs and tar mat fragments were found along Alabama's shoreline (Auburn University, 2012). It was also observed that Hurricane Isaac resulted in the suspension of small amounts of tarballs and some oil from sediments (Mulagabal et al., 2013). Refer to **Chapter 3.2.4** for additional details for pipeline failures caused by hurricanes.

Table 3-31. Oil Spilled from Pipelines on the Federal OCS, 2002-2009.

Regulator	Area	Total Oil Spilled (bbl)	Oil Spilled due to Hurricanes (bbl)	Proportion of Total Oil Spilled due to Hurricanes (%)
BOEM	Federal OCS	5,522	5,179	94
DOT	Federal OCS	5,667	3,272	58
DOT	State Waters	9,903	9,622	97

Source: USDOI, BOEMRE, 2011c.

3.3.2.9.4 Climate Change

Issues related to climate change, including global warming, sea-level rise, and programmatic aspects of climate change relative to the environmental baseline for the GOM are discussed in Chapter 4.2.1 of the Five-Year Program EIS.

3.3.2.10 Mississippi River Hydromodification

The Mississippi River has been anchored in place by engineered structures built in the 20th century and has been hydrologically isolated from the delta it built. The natural processes that allowed the river to flood and distribute alluvial sediments across the delta platform and channels to meander have been shut down. Hydromodifying interventions include construction of (1) levees along the river and distributary channel systems, (2) upstream dams and flood control structures that impound sediment and meter the river flow rate, and (3) channelized channels with earthen or armored banks. Once the natural processes that act to add sediment to the delta platform to keep it emergent are shut down, subsidence begins to outpace deposition of sediment.

Of total upstream-to-downstream flow, the Old River Control Structure (built 1963) diverts 70 percent of flow down the levee-confined channels of the Mississippi River and 30 percent down the unconfined Atchafalaya River, which has been actively aggrading its delta plain since 1973 (*LaCoast.gov*, 2011). Blum and Roberts reported that the time-averaged sediment load carried by the Mississippi and Atchafalaya Rivers before installation of the Old River Control Structure was ~400-500 million tons per year and that the average suspended load available to either river after construction of the Old River Control Structure was ~205 million tons per year (Blum and Roberts, 2009, Figure 2). Modern sediment loads are, therefore, less than half that is required to build and maintain the modern delta plain, a figure largely in agreement with previous work reporting decreases in suspended sediment load of nearly 60 percent since the 1950's (Turner and Cahoon, 1987; Tuttle and Combe, 1981).

Blum and Roberts (2009, Figure 3b) posited three scenarios for subsidence and sea-level rise, and concluded that sediment starvation alone would cause ~2,286 mi^2 (592,071 ha) of the modern delta plain to submerge by 2050 without any other impacting factors contributing to land loss. The use of sediment budget modeling, a relatively new tool for land loss assessment, appears to indicate that hydrographic modification of the Mississippi River has been the most profound man-caused influence on land loss in the LCA. Sediment starvation of the deltaic system is allowing rising sea level and subsidence to outpace the constructive processes building and maintaining the delta.

BOEM anticipates that, over the next 50 years, there might be minor sediment additions resulting from new and continuing freshwater diversion projects managed by the COE. Refer to **Chapter 3.3.2.8.3** for more information on coastal restoration.

3.3.2.11 Mississippi River Eutrophication

The Mississippi River Basin drains 41 percent of the contiguous United States. The basin covers more than 1,245,000 mi^2 (3,224,535 km^2) and includes all or parts of 31 states and 2 Canadian provinces (U.S. Dept. of the Army, COE, 2015b). Dissolved pollutants, including nutrients, enter surface water within the Mississippi River Basin via uncontained runoff and groundwater discharge (nonpoint sources).

The sources of nutrients in surface waters can be broadly divided as natural and anthropogenic. Natural sources are generally ubiquitous; however, their contribution is usually low because, over the course of time, natural systems have established balances between the production and consumption of nutrients. Anthropogenic sources arise from many activities. In the agricultural setting of the Mississippi River drainage basin, farmers increase the productivity and yield of their crops by use of chemical fertilizers. If more fertilizers are applied than are used by the crops, they can move into ground and surface waters and become a major source of nutrients in rivers. Additionally, fertilizer that is bound to soil or "loose" fertilizer may be subject to erosion by wind or water and affect surface waters. Information regarding nutrient management can be found on the U.S. Department of Agriculture's Natural Resources Conservation Service website (USDA, NRCS, 2015). Other major sources of nutrients in surface waters are domestic and animal wastes. Although municipal wastewater is treated, only a fraction of the nutrients is removed. In addition to the nutrients derived from human sewage, municipal wastewater also contains nutrients from such things as lawn fertilizers, household cleaners, and detergents. Other anthropogenic sources of nutrients are industrial, either from the manufacture of fertilizers or as by-products of other manufacturing processes (Antweiler et al., 1995).

The most significant inorganic forms of two elements, nitrogen and phosphorus, include four nutrient compounds: nitrate (NO_3^-); nitrite (NO_2^-); ammonium (NH_4^+); and orthophosphate (PO_4^{-3}). Of these four major nutrient compounds, only nitrate is found in concentrations approaching the USEPA's maximum contaminant level of 10 mg/L. Orthophosphate usually is present in low concentrations, and concentrations of ammonium and nitrite usually are insignificant (USDOI, GS, 1995).

Nutrient enrichment results in eutrophication, causing growth of algae (algal bloom) and other aquatic plants. A second effect of eutrophication is the increased uptake of dissolved oxygen by bacteria in response to higher concentrations of organic matter. If oxygen is taken up by decaying organic matter faster than it is imported from the atmosphere or produced by photosynthesis, it becomes depleted, and the aquatic species that require it are adversely affected. Furthermore, oxygen depletion causes basic changes in the chemical environment (i.e., a reduced environment) that allow materials (including many metals) that were formerly associated with the solid phase sediments (e.g., sorbed) to become soluble and, therefore, more mobile in the aqueous phase (USDOI, GS, 1995).

On October 21, 2014, the U.S. Department of the Interior and the U.S. Department of Agriculture announced a new partnership to strengthen the effectiveness of State and Federal nutrient-reduction strategies (USDOI, GS, 2014). As a result of this and other efforts, states are beginning to impose Best Management Practices on growers within the Mississippi River Basin to develop nutrient management plans, including fertilizer applicator certification programs, and monitoring to minimize excess nutrients from washing into waterways.

3.3.2.12 Hypoxia

The Gulf of Mexico hypoxic zone is a band of oxygen-stratified water that stretches along the Texas-Louisiana shelf each summer where the dissolved oxygen concentrations are less than 2 mg/L (USEPA, 2015b). Other small hypoxic areas infrequently form at the discharge of smaller rivers along the Gulf Coast; however, in the Gulf of Mexico, the hypoxic zone resulting from the Mississippi and Atchafalaya Rivers is by far the predominant feature. The hypoxic zone is the result of excess nutrients, primarily nitrogen, carried downstream by rivers to discharge to coastal waters. Density stratification results where the less dense, nutrient-rich freshwater spreads on top of the denser seawater and prevents oxygen from replenishing the bottom waters. The excess nutrients cause phytoplankton blooms that eventually die and sink to the bottom, where bacterial decomposition consumes dissolved oxygen. The oxygen-depleted bottom waters occur seasonally and are affected by the timing of the Mississippi and Atchafalaya Rivers' discharges carrying nutrients and freshwater to shelf surface waters. Hypoxic zones are sometimes called "dead zones" because of the absence of commercial quantities of shrimp and fish in the bottom layer.

The hypoxic zone on the Louisiana-Texas shelf is the largest such zone in the United States and the entire western Atlantic Ocean (Turner et al., 2005). The Louisiana Universities Marine Consortium generally forecasts the seasonal maximum size of the Louisiana-Texas hypoxic zone based on nitrogen loading in the Mississippi River (as measured in May of each year), and the actual size reported is based on cruise data collected by the Louisiana Universities Marine Consortium in July of each year. Recent estimates of the area of low oxygen by NOAA (USDOC, NOAA, 2015) as of August 3, 2015, measured 6,474 mi^2 (16,700 km^2) (**Figure 3-15**), an increase from the size measured in 2014 (5,052 mi^2) and larger than the estimated size (5,838 mi^2) forecast by the Louisiana Universities Marine Consortium (2015) in June 2015 and three times larger than the Action Plan Goal of 5,000 km^2 or 1,991 mi^2 (Louisiana Universities Marine Consortium, 2014). The hypoxic zone extends up to 60-70 km (37-43 mi) from the shoreline, well into OCS waters.

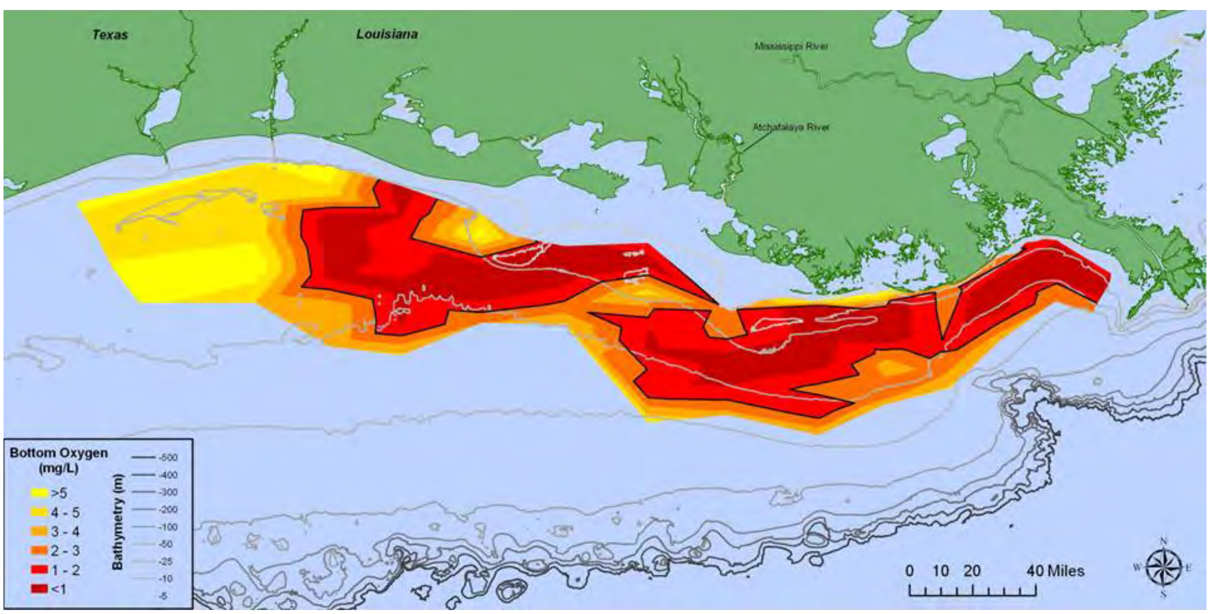

Figure 3-15. 2015 Gulf of Mexico Hypoxic Zone (USDOC, NOAA, 2015h).

Rabelais (2005) and Bierman et al. (2008) evaluated the potential contributions of carbon and nitrogen in discharged produced waters on the hypoxic zone. Both studies found that the effects due to produced water were minimal compared with those of the Mississippi River. As such, the Louisiana-Texas hypoxic zone is considered to be unrelated to OCS oil- and gas-related activities but is discussed here as a potential cumulative effect.

3.3.2.13 Sedimentation

The lower Mississippi River, from Cairo, Illinois, to the Gulf of Mexico, transported an average of 150 million tons (with a range of 70-230 million tons) of sediment annually between 1963 and 2005. Historically, the quantity of sediment derived from catchment erosion has been affected by changes in land use and river management, increasing in the 19th and early 20th centuries before decreasing due to soil conservation and improved land management. Seasonal analysis shows that, in the spring, the median load is approximately four times the median total load in the fall. The median sediment size is mostly silt, but it coarsens during the winter and spring when 10 percent of the sediment load is coarser than fine sand (U.S. Dept. of the Army, European Research Office, 2008).

Suspended sediment and bed load enter the GOM from the outlets of the Mississippi and Atchafalaya Rivers. Suspended sediment is circulated along the Louisiana-Texas continental shelf where it settles out and may later become resuspended during storms. Bed-load sediment discharge builds the Mississippi and Atchafalaya River deltas and may be redistributed on the continental shelf by currents and wave action. Sediment on the continental shelf may ultimately be intercepted by the Mississippi Canyon where it is transported downslope to the Mississippi Fan in deep water.

Since the marine environment is a dynamic system, sediment quality and water quality can affect each other. For example, a contaminant may react with the mineral particles in the sediment and be removed from the water column (e.g., adsorption). Thus, under appropriate conditions, sediments can serve as sinks for contaminants such as metals, nutrients, or organic compounds. However, if sediments are resuspended (e.g., due to dredging or a storm event), the resuspension can lead to a temporary redox flux, including a localized and temporal release of any formally sorbed metals as well as nutrient recycling. Resuspension events are less likely in deepwater environments (Caetano et al., 2003; Fanning et al., 1982).

Several studies have addressed offshore water and sediment quality in deep waters. Water at depths >1,400 m (4,593 ft) is relatively homogeneous with respect to temperature, salinity, and oxygen (Nowlin,1972; Pequegnat, 1983; Gallaway et al., 1988; Jochens et al., 2005). Limited analyses of trace metals and hydrocarbons for the water column and sediments exist (Trefry, 1981; Gallaway et al., 1988). Continental Shelf Associates, Inc. completed an Agency-funded field study of four drilling sites located in water depths of 1,033-1,125 m (3,389-3,691 ft) (CSA, 2006). The sampling design called for before and after exploratory or development drilling and captured the drilling-related changes that occur in sediments and sediment pore water. Chemical impacts of drilling were detected at all four sites. Impacts noted within the near-field zone included elevated barium, synthetic-based fluids, total organic carbon concentrations, and low sediment oxygen levels. One of the study locations was Viosca Knoll Block 916, which was considered to be relatively pristine prior to drilling. No drilling had ever been performed at Viosca Knoll Block 916, and the closest drilling activity had occurred 1.4 mi (2.3 km) north-northwest 2 years prior to the study. The site was located at a water depth of 1,125 m (3,691 ft) and 70 mi (120 km) from the mouth of the Mississippi River. At this relatively pristine location, mean concentrations of sediment barium increased by approximately 30-fold at near-field stations following exploratory drilling (from 0.108% to 3.32%). As well, mean concentrations of sediment mercury and total PAHs increased in the near-field. At this site, sediment cadmium concentrations did not change substantially following exploratory drilling.

Several studies have assessed the occurrence and distribution of hydrocarbons in sediments since the *Deepwater Horizon* explosion, oil spill, and spill response in 2010 from Mississippi Canyon Block 252. Montagna et al. (2013) reported results of monitoring cruises conducted in the fall of 2010 to measure potential impacts on two soft bottom benthic invertebrate groups, i.e., macrofauna and meiofauna. The most severe relative reduction of faunal abundance and diversity extended to 3 km (2 mi) from the wellhead in all directions, covering an area of 24 km^2 (9 mi^2). Moderate impacts were observed up to 17 km (11 mi) toward the southwest and 8.5 km (5.3 mi) toward the northeast of the wellhead, covering an area of 148 km^2 (57 mi^2). Benthic effects were correlated to hydrocarbon concentrations and distance from the wellhead but not distance to natural hydrocarbon seeps.

A study by Valentine et al. (2014) used the concentration of the marker compound hopane in more than 3,000 sediment samples from 534 locations to evaluate the extent of oil on the seafloor. The pattern of contamination was described as similar to a “bathtub ring” formed from an oil-rich layer of water impinging laterally on the continental slope at a depth of about 900-1,300 m (2,953-4,265 ft). A secondary “fallout plume” from the oil-rich layer was reported to impact a zone of sediments at a depth of about 1,300-1,700 m (4,265-5,577 ft). The combined areas of impact were estimated to span 3,200 km^2 (1,236 mi^2). Based on the horizontal and vertical distribution of hopane in the sediments, the authors concluded that the contamination was consistent with the recent *Deepwater Horizon* explosion and oil spill as the source and not natural ongoing seeps. Calculations presented in the study indicate that oil in the “bathtub ring” represents 4-31 percent of the approximately 2 MMbbl of oil estimated to be sequestered in the oil-rich layer of water at depths of 1,000-1,300 m (3,287-4,265 ft).

Sammarco et al. (2013) conducted a regional study using approximately 70 sediment samples in coastal waters from Galveston, Texas, to the Florida Keys. Sediment total petroleum hydrocarbon and total PAH concentrations peaked in samples near Pensacola, Florida, and Galveston, Texas.

Chapter 4

Description of the Affected Environment and Impact Analysis

What's in This Chapter

- **Chapter 4** describes the affected environment and potential environmental consequences of a single proposed lease sale.
- Resources analyzed are as follows:
  - Air Quality
  - Water Quality
  - Coastal Habitats (Estuarine Systems, and Coastal Barrier Beaches and Associated Dunes)
  - Deepwater Benthic Communities
  - *Sargassum* and Associated Communities
  - Live Bottom Habitats (Topographic Features, and Pinnacles and Low-Relief Features)
  - Fishes and Invertebrate Resources
  - Birds
  - Protective Species (Marine Mammals, Sea Turtles, Beach Mice, Protected Birds, and Protected Corals)
  - Commercial Fisheries
  - Recreational Fishing
  - Recreational Resources
  - Archaeological Resources
  - Socioeconomic Issues (Land Use and Coastal Infrastructure, Economic Factors, and Social Factors, Including Environmental Justice)
- Impact-producing factors and impact-level definitions are identified for each resource.
- The analyses of environmental consequences consider the potential impacts from routine activities, accidental events, and cumulative impacts; and incomplete or unavailable information.
- Other analyses in this chapter include the following:
  - Unavoidable Adverse Impacts of a Proposed Action
  - Irreversible and Irretrievable Commitment of Resources
  - Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

4 DESCRIPTION OF THE AFFECTED ENVIRONMENT AND IMPACT ANALYSIS

As discussed in **Chapter 1.3**, BOEM makes individual decisions on whether and how to proceed with each lease sale pursuant to the OCSLA's staged leasing process. Additional NEPA reviews (e.g., a Determination of NEPA Adequacy, an EA or, if determined necessary, a Supplemental EIS) will be conducted prior to subsequent lease sale decisions. Therefore, **Chapter 4** describes the environment that would potentially be affected by a single lease sale or the alternatives. The environmental resources include air and water quality; coastal environments; deepwater habitats; *Sargassum* and associated communities; live bottom habitats; fishes and invertebrate resources; birds; protected species (including marine mammals, sea turtles, beach mice, birds, fishes, and corals); commercial and recreational fishing; recreational resources; archaeological resources; coastal infrastructure and land use ; economics; and social factors (including environmental justice). Also, this chapter describes the potential impacts of routine activities, reasonably foreseeable accidental events, and cumulative impacts caused by a proposed lease sale and the alternatives on these resources.

Analysts concentrated on providing a focused analysis, using illustrations to communicate key concepts, and including more detailed, technical information in supporting appendices. Furthermore, supporting technical information in previous NEPA reviews have been developed as white papers and are summarized and incorporated by reference as appropriate. These white papers include the *OCS Regulatory Framework* (Cameron and Matthews, 2016), *Catastrophic Spill Event Analysis* (USDOI, BOEM, 2016c) and *Essential Fish Habitat Assessment* (USDOI, BOEM, 2016d).

This Multisale EIS also tiers from and uses information contained in the *Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022, Programmatic Environmental Impact Statement* (Five-Year Program EIS; USDOI, BOEM, 2016b). Programmatic aspects of climate change relative to the environmental baseline for the Gulf of Mexico OCS Program are discussed within each resource and in the Five-Year Programmatic EIS.

This Multisale EIS was prepared with consideration of potential changes to or new information about the baseline conditions of the physical, biological, and socioeconomic resources. Past events such as Hurricanes Katrina and Rita and the *Deepwater Horizon* explosion, oil spill, and response have the potential to adversely affect multiple resources over a large area. The level of adverse effect depends on many factors, including the sensitivity of the resource as well as the sensitivity of the environment in which the resource is located. All effects may not currently be known and some could take years to fully develop (refer to the "Incomplete or Unavailable Information" section below). The analyses of impacts from the *Deepwater Horizon* explosion, oil spill, and response on the physical, biological, and socioeconomic resources are based on credible scientific information that was publicly available at the time this document was prepared. This credible scientific information was applied using accepted methodologies, including numerical modeling of data and scientific writing methods to convey the information of BOEM's subject-matter experts' technical knowledge and experience. However, BOEM and the Deepwater Horizon Natural Resource Damage Assessment (NRDA) Trustee Council continue to study, measure, and interpret impacts arising out of that spill. Thus, there are instances in which BOEM is faced with incomplete or unavailable information (see below) that may be relevant to evaluating reasonably foreseeable significant adverse impacts on the human environment.

Organization

This chapter is organized by groups of resources. The chapter is divided into the physical factors (air and water quality), biological factors (habitat resources followed by the fauna that are found in or utilize these habitats), and finally land use and the social environment.

- Air Quality (**Chapter 4.1**)
- Water Quality (**Chapter 4.2**)
- Habitat Resources
  - Coastal Habitats (**Chapter 4.3**)
  - Deepwater Benthic Communities (**Chapter 4.4**)

   - *Sargassum* and Associated Communities (**Chapter 4.5**)
   - Live Bottom Habitats (**Chapter 4.6**)
- Faunal Resources
   - Fish and Invertebrate Resources (**Chapter 4.7**)
   - Birds (**Chapter 4.8**)
   - Protected Species (**Chapter 4.9**)
- Social Environment
   - Commercial Fisheries (**Chapter 4.10**)
   - Recreational Fishing (**Chapter 4.11**)
   - Recreational Resources (**Chapter 4.12**)
   - Archaeological Resources (**Chapter 4.13**)
   - Human Resources and Land Use (**Chapter 4.14**)

The habitat resource chapters focus on the impact-producing factors that would affect their environment while the other chapters concentrate on the biological effects of impact-producing factors on fauna and human resources. To decrease repetition, the habitat information is generally not restated in the fauna chapters and vice versa. Each resource chapter includes a description of the affected environment and an analysis of the potential environmental consequences of the alternatives.

Environmental Consequences

The environmental consequences in each resource section include an analysis of applicable impact-producing factors from routine activities, accidental events, and cumulative impacts, and also discuss incomplete or unavailable information that would occur under any of the action alternatives (A, B, C, and D). The potential impacts as a result of these impact-producing factors are then based on the level of activity and the geographic area for each alternative. The impact level conclusions reached in each resource area consider the applicable impact-producing factors, the level of activity, and geographic area of each alternative.

Under all four action alternatives, postlease activities would be reviewed on a case-by-case basis and the applicable commonly applied mitigating measures (refer to **Appendix B**) would be identified during site-specific reviews of plans and permits. This avoids excessive replication of discussion of similar if not identical impacts throughout the entire document, allowing the reader to focus on the differences between the alternatives.

Routine Activities

The types of routine activities that could occur from all operations as a result of a single lease sale are described in **Chapter 3.1**. The major types of routine activities include geological and geophysical surveys; exploration, development, and production drilling; infrastructure emplacement and presence; transportation, including pipelines, vessels, and helicopters; discharges and wastes; decommissioning and removal; coastal infrastructure; air emissions; noise; and safety issues. The time period for postlease activities related to a single lease sale is 50 years.

Accidental Events

A summary of the information on accidental events that are reasonably foreseeable from all operations conducted under the OCS Program, as well as information on the number and sizes of spills from non-OCS sources is provided in **Chapter 3.2**. The types of accidental events that could reasonably be expected as a result of postlease activities include oil spills, losses of well control, accidental air emissions, pipeline failures, vessel and helicopter collisions, chemical and drilling-fluid spills, and spill response as a result of a proposed lease sale.

Cumulative Impacts

The cumulative analysis considers impacts to physical, biological, and socioeconomic resources that may result from the incremental impact of a proposed lease sale when added to all past, present, and reasonably foreseeable future human activities. However, most resources consider the past and present cumulative impacts as part of the baseline environmental conditions, and they are covered where relevant in the affected resource description. It is reasonably foreseeable to assume that lease sales would continue to occur, as they have historically, for many years to come in the Gulf of Mexico region, based on resource availability, existing infrastructure, and projected time lapses required for any other major energy sources to come online. However, the level of activities (exploration wells, production wells, and pipelines) becomes more speculative as time is projected further into the future. The causes for this are uncertainty in long-term oil price forecasts, resource potential, cost of development, and drill rig availability versus the amount of acreage leased from a lease sale. Furthermore, OCSLA provides for phased decisionmaking, each of which is a decision subject to NEPA. The OCSLA stages include the Five-Year Program stage to identify a schedule of leases over the period; the lease sale stage; the exploration stage; the development and production stage; and ultimately decisions on how a lessee may proceed with decommissioning. These reviews require consideration of cumulative impacts that would factor in changing environmental baselines, oil and gas price forecasts, and technology advancements, among others. Additionally, even though continued consumer demand is likely, new advances in technology (both on upstream development and production ends and downstream user ends) can potentially change the level of projected activities and how they are conducted. These could further minimize environmental risks. Technology advancements and organizational effectiveness could also further reduce projected air emissions, wastewater quantities, and other impact producing factors such as helicopter and vessel trips and accidental events.

Therefore, cumulative impact assessment for this Multisale EIS considers existing environmental baseline conditions, past OCS and non-OCS activities in the GOM, projected future activities as a result of past lease sales, 50 years of incremental projected activities as a result of the proposed lease sales during this Five-Year Program, and reasonably assumes projected activities for future lease sales based on current trends. Non-OCS oil- and gas-related activities include, but are not limited to, import tankering; marine transportation; State oil and gas activity; recreational, commercial, and military vessel traffic; offshore liquefied natural gas activity; recreational and commercial fishing; onshore development; and natural processes. The time period for reasonably foreseeable future actions are dependent upon the nature of each resource and are therefore defined in each resource chapter. The types of cumulative activities that could occur are described in **Chapter 3.3**.

Incomplete or Unavailable Information

Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts; if so, whether it was essential to a reasoned choice among alternatives; and, if it was essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether scientifically credible information using generally accepted scientific methodologies can be applied in its place (40 CFR § 1502.22).

The most notable incomplete or unavailable information relates to some aspects of the effects from the *Deepwater Horizon* explosion, oil spill, and response. Credible scientific data regarding the potential short-term and long-term impacts from the *Deepwater Horizon* explosion, oil spill, and response on some GOM resources are becoming available but remain incomplete at this time, and it could be many years before this information becomes available. The Deepwater Horizon NRDA Trustee Council has released the *Deepwater Horizon Oil Spill Draft Programmatic Damage Assessment and Restoration Plan and Draft Programmatic Environmental Impact Statement*. However, the information collected during the NRDA process that the draft assessment, plan, and EIS used as a basis for their determinations are not yet publicly available (e.g., NRDA technical working group reports). The final plan may address much of what has been currently unavailable with regard to impacts to the environment from the *Deepwater Horizon* explosion, oil spill, and response. There remains information being developed through the NRDA process, but it is not yet available as a final report. Nonetheless, BOEM's subject-matter experts acquired and used newly available, scientifically credible information; determined that other additional information was not available absent exorbitant expenditures or could not be obtained regardless of cost in a timely manner; and where gaps remained, exercised their best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information. While incomplete or unavailable information could conceivably result in potential future shifts in baseline conditions of habitats that could affect BOEM's decisionmaking, BOEM has determined that it can make an informed decision at this time without this incomplete or unavailable information. BOEM's subject-matter experts have applied other scientifically credible information using accepted theoretical approaches and research methods, such as information on related or surrogate species. Moreover, BOEM will continue to monitor these resources for effects caused by the *Deepwater Horizon* explosion, oil spill, and response, and will ensure that future BOEM environmental reviews take into account any new information that may emerge.

Furthermore, BOEM has considered the reasonably foreseeable impacts of a low-probability catastrophic oil spill in a white paper. These types of events, such as the one that resulted from the *Deepwater Horizon* explosion, are not reasonably expected to occur and therefore are not part of a proposed action. BOEM has prepared the *Catastrophic Spill Event Analysis* white paper, which provides a summary of existing credible scientific evidence related to this issue and BOEM's evaluation of the potential impacts to the physical, biological, and socioeconomic resources and conditions based upon theoretical approaches or research methods generally accepted in the scientific community (USDOI, BOEM, 2016c). The white paper was included in previous lease sale EISs as an appendix. To avoid repetition and redundancies, the white paper is incorporated by reference and is publicly available on BOEM's website at http://www.boem.gov/nepaprocess/. BOEM updated the analysis in the white paper and will update it again should new information become available relevant to the reasonably foreseeable impacts of a catastrophic spill event.

Impact Levels

It must be emphasized that, in arriving at the overall conclusions for certain environmental resources (e.g., birds, fisheries, and wetlands) for each alternative, the conclusions are based on potential impacts to the resources or species population as a whole, not to individuals, small groups of animals, or small areas of habitat. Each resource topic discussion includes a threshold effects determination and includes a resource-specific definition of impact level. Additionally, potential beneficial effects of a proposed action have also been considered and identified in individual resource chapters. For example, implementation of a proposed lease sale is anticipated to have beneficial impacts in the Area of Interest for economics due to the direct and indirect spending associated with the oil and gas industry. For this Multisale EIS, effects thresholds are defined using four categories of significance.

- **Negligible** – Impacts may or may not cause observable changes to natural conditions; regardless, they do not reduce the integrity of a resource.
- **Minor** – Impacts cause observable and short-term changes to natural conditions but they do not reduce the integrity of a resource.
- **Moderate** – Impacts cause observable and short-term changes to natural conditions and/or they reduce the integrity of a resource.
- **Major** – Impacts cause observable and long-term changes to natural conditions and they reduce the integrity of a resource.

The conclusions developed by BOEM's subject-matter experts regarding the potential effects of a proposed lease sale for most resources are necessarily qualitative in nature; however, they are based on the expert opinion and judgment of the highly trained subject-matter experts. Staff approach this effort utilizing credible scientific information and apply it to the subject resources using accepted methodologies. It is important to note that, barring another catastrophic oil spill, which is a low-probability accidental event not expected to occur and therefore not part of a proposed action, the adverse impacts associated with a proposed lease sale are expected to be small, and beneficial impacts are projected as well for certain activities and species. This is because of BOEM's potential use of lease sale stipulations and mitigations, site-specific mitigations that may become conditions of plan or permit approval at the postlease stage, and mitigations required by other State and Federal agencies that help to reduce or minimize many of the impacts. Over the years, a suite of lease stipulations and mitigating measures has been developed to eliminate or ameliorate potential environmental effects, where implemented. BOEM's primary mitigative method is the avoidance of impacts, which are primarily implemented during approval of postlease activities. In many instances, these were developed in coordination with other natural resource agencies such as the NMFS and FWS. Informal and formal consultation with other Federal agencies and affected States, and commenting opportunities for the public are implemented to assist in the development of the information and analyses in this Multisale EIS. Specifically, information requests soliciting input on the proposed lease sales were issued during scoping for this Multisale EIS (refer to **Chapter 5**).

Lease sale stipulations considered for a proposed lease sale may include the Topographic Features Stipulation; Live Bottom (Pinnacle Trend) Stipulation; Military Areas Stipulation; Evacuation Stipulation; Coordination Stipulation; Blocks South of Baldwin County, Alabama, Stipulation; Protected Species Stipulation; United Nations Convention on the Law of the Sea Royalty Payment Stipulation; Below Seabed Operations Stipulation; and the Stipulation on the Agreement between the United States of America and the United Mexican States Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico (Transboundary Stipulation). Site-specific postlease mitigations may include buffer zones and avoidance criteria to protect sensitive resources such as areas of deepwater benthic communities, topographic features, and historic shipwrecks. Mitigations may also be required by other agencies (i.e., the U.S. Army Corps of Engineers and State CZM agencies) to avoid or reduce impacts from OCS oil- and gas-related activities, e.g., boring under beach shorelines and the rerouting of pipelines to reduce or eliminate impacts from OCS pipelines that make landfall. These mitigations and their potential effect on reducing or eliminating impacts from a proposed lease sale are analyzed in this chapter.

Analytical Approach

The analyses of potential impacts to the wide variety of physical, environmental, and socioeconomic resources in the vast area of the GOM and adjacent coastal areas is very complex. Analysis of the various alternatives considers impact-producing factors (described in detail in **Chapter 3**) within a distinct framework that includes frequency, duration, and geographic extent. Frequency (whether rare, intermittent, or continuous) refers to how often the factor occurs over the entire analysis period of 50 years for routine activities and accidental events. Duration refers to how long the factor lasts from less than a year to many years. Geographic extent covers what areas are affected, and depending on the factor, how large of an area is affected.

Specialized education, experience, and technical knowledge are required of the subject-matter experts, as well as familiarity with the numerous impact-producing factors associated with OCS oil- and gas-related activities and other activities that can cause cumulative impacts in the area to conduct this analysis. Knowledge and practical working experience of major environmental laws and regulations such as NEPA, the Clean Water Act, Clean Air Act, Coastal Zone Management Act (CZMA), ESA, Marine Mammal Protection Act, Magnuson-Stevens Fishery Conservation and Management Act, and others are also required to conduct this analysis. In order to accomplish this task, BOEM has assembled an interdisciplinary team with many years of collective experience. The vast majority of this team has advanced degrees with a high level of knowledge related to the particular resources discussed in this chapter. This team prepares the input to BOEM's lease sale EISs and a variety of subsequent postlease NEPA reviews, and is also involved with ESA, EFH Assessment, and CZMA consultations. In addition, this same staff is also directly involved with the development of studies conducted by BOEM's Environmental Studies Program. The results of these studies feed directly into the Bureau of Ocean Energy Management's NEPA analyses.

For this Multisale EIS, a set of assumptions and a scenario were developed along with descriptions of impact-producing factors that could occur from routine OCS oil- and gas-related activities, including accidental events. These provide a framework for the analyses of potential impacts of the OCS oil- and gas-related activity in the GOM. This information is discussed in detail in **Chapter 3**. High-level summaries of the geographic area and level of forecasted activities for each alternative are provided below. Using this information, the interdisciplinary team applies knowledge and experience to conduct analyses of the potential effects of a proposed lease sale on assigned resources.

Alternative A could potentially result in 1.2-3.8 percent of the forecasted cumulative OCS oil and gas activity in the Gulf of Mexico and would occur in the WPA, CPA, and EPA portions of the proposed lease sale area. Most of the activity (up to 83%) of a proposed lease sale under Alternative A is expected to occur in the CPA and EPA portions of the proposed lease sale area, while up to 19 percent of the activity could occur in the WPA portion of the proposed lease sale area. Approximately 72.5 million acres (78.6%) of the regionwide lease sale area would be available for lease under this alternative.

Alternative B could potentially result in 2.0-3.6 percent of the forecasted cumulative OCS oil and gas activity in the Gulf of Mexico, or a slightly smaller amount of activity than proposed for Alternative A, and would be located geographically in the CPA and EPA portions of the proposed lease sale area. Approximately 48.9 million acres (53%) of the regionwide lease sale area would be available for lease. While all of the leases issued under this alternative would occur in the CPA and EPA portions of the proposed lease sale area, activities such as vessel support and pipeline or coastal infrastructure could occur in the WPA portion of the proposed lease sale area.

Alternative C could potentially result in 0.35-0.6 percent of the forecasted cumulative OCS oil and gas activity in the Gulf of Mexico, which is much smaller than either Alternative A or B. Approximately 23.6 million acres (25.6%) of the regionwide lease sale area would be available for lease. While all of the leases issued under this alternative would occur in the WPA portion of the proposed lease sale area, activities such as vessel support and pipeline or coastal infrastructure could occur in the CPA/EPA portion of the proposed lease sale area.

Under Alternative D, the number of available unleased blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations is small compared with the number of unleased blocks being offered under Alternatives A, B, or C. Therefore, the activity level that can be expected for Alternative D is similar to Alternative A, B, or C, as applicable.

Under Alternative E, there would be no routine activities or accidental events as part of a proposed lease sale. Therefore, there would be no associated impacts resulting from a proposed lease sale. Cancellation of a proposed lease sale, however, would not stop all OCS oil- and gas-related activities. Activities related to previously issued leases and permits (as well as those that may be issued in the future under separate decision) related to the OCS oil and gas program would continue and could have impacts similar to those described in each resource section. However, no new activities related to a proposed lease sale would proceed and, therefore, those additional impacts would be avoided.

In summary, this chapter has thoroughly examined the existing credible scientific evidence that is relevant to evaluating the reasonably foreseeable significant impacts of a proposed lease sale on the human environment. All reasonably foreseeable impacts, including beneficial ones, were considered. Impacts that could have catastrophic consequences, even if their probability of occurrence is low, not reasonably expected, and not part of a proposed action are considered in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c). Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts; if so, whether it was essential to a reasoned choice among alternatives; and, if it was essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether credible scientific information applied using generally accepted scientific methodologies can be used in its place (40 CFR § 1502.22). BOEM has made conscientious efforts to comply with the spirit and intent of NEPA and to be comprehensive in its analyses of potential environmental impacts.

4.1 AIR QUALITY

The analyses of the potential impacts of routine activities and accidental events associated with a GOM proposed lease sale and its incremental contribution to the cumulative impacts are presented in this chapter. BOEM specifically addresses the air quality impacts of OCS oil and gas exploration, development, and production, as well as the non-OCS oil- and gas-related activities sources. These OCS oil- and gas-related emissions sources are related to drilling and associated vessel support, production and the connected action of vessel support, flaring and venting, decommissioning, fugitive emissions, and oil spills, while the non-OCS oil- and gas-related emissions include State oil and gas programs, onshore industrial and transportation sources, and natural events. Since the primary National Ambient Air Quality Standards (NAAQS) are designed to protect human health, BOEM focuses on the impact of these activities on the States, where there are permanent human populations. The full analyses, including the air quality impacts to the State/seaward boundary, will be included in future EIS documents since studies examining the impact to the State/seaward boundary are currently in progress.

The approach to discuss the greatest potential impact-producing factors from OCS oil and gas exploration, development, and production (**Table 4-1**) in this Multisale EIS is based on the results found in the *Year 2011 Gulfwide Emission Inventory Study* (GWEI) (Wilson et al., 2014) and on the changes in regulations as a result of the 2010 *Deepwater Horizon* explosion, oil spill, and response. The Year 2011 GWEI study combines the activity data with the most recent emission factors published by the USEPA and estimation methods to develop the criteria pollutants and greenhouse gas emission inventories. The pollutants covered in the inventory are the criteria pollutants, i.e., carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter ($PM_{2.5}$ and PM_{10}), sulfur dioxide (SO_2), and volatile organic compounds (VOC); as well as the major greenhouse gases, i.e., carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The GWEI study groups the emissions into two very broad source categories: OCS oil/gas production sources, which includes both non-platform (drilling) and platform (production) sources; and non-OCS oil/gas production sources, which includes the sources completely unrelated to offshore oil and gas such as commercial vessel traffic. The GWEI study shows that during the exploration stage, most OCS emissions are from non-platform sources and include fuel combustion from the equipment used on a drilling rig or from fuel usage by a support vessel; during the development stage, most OCS emissions are also from non-platform emissions and include fuel usage by support or survey vessels to lay pipelines, install facilities, or map geologic formations and seismic properties; and during the production stage, most emissions are from platform emission sources.

Table 4-1. Air Quality Impact-Producing Factors.

Air Quality	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Drilling	Minor	Minor	Minor	Minor	None
Production	Minor	Minor	Minor	Minor	None
Vessel Support during Drilling and Production	Minor	Minor	Minor	Minor	None
Routine Flaring and Venting	Minor	Minor	Minor	Minor	None
Greenhouse Gases	Minor	Minor	Minor	Minor	None
Decommissioning	Minor	Minor	Minor	Minor	None
Fugitive Emissions	Minor	Minor	Minor	Minor	None

Air Quality	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Accidental Impacts					
Emergency Flaring and Venting	Minor	Minor	Minor	Minor	None
Oil Spills	Minor	Minor	Minor	Minor	None
Cumulative Impacts					
OCS Oil and Gas	Minor	Minor	Minor	Minor	Neglible
Non-OCS Oil and Gas	Minor	Minor	Minor	Minor	Neglible

In order to assess the impact-producing factors from OCS oil- and gas-related activities from routine activities and accidental events, BOEM used data from the Year 2011 GWEI study, which is the most recent detailed emissions inventory.

Impact-Level Definitions

The following impact categories and definitions are used:

- **Negligible** – No measurable impact(s).
- **Minor** – Most impacts on the affected resource could be avoided with proper mitigation; if impacts occur, the affected resource would recover completely without mitigation once the impacting stressor is eliminated.
- **Moderate** – Impacts on the affected resource are unavoidable. The viability of the affected resource is not threatened although some impacts may be irreversible, or the affected resource would recover completely if proper mitigation is applied or proper remedial action is taken once the impacting stressor is eliminated.
- **Major** – Impacts on the affected resource are unavoidable. The viability of the affected resource may be threatened although some impacts may be irreversible, and the affected resource would not fully recover even if proper mitigation is applied or remedial action is implemented once the impacting stressor is eliminated.

On August 26, 2014, BOEM contracted with Eastern Research Group, Incorporated and its team members (i.e., ENVIRON International Corporation and Alpine Geophysics, LLC) to complete an air quality modeling study in the GOM region. The "Air Quality Modeling in the Gulf of Mexico Region" study is anticipated to be available July 2016. Under this contract, photochemical and dispersion air quality modeling would be conducted in the GOM region to assess the impacts of OCS oil- and gas-related development to nearby States as required under the OCSLA. For air quality analysis purposes, the GOM region's OCS area of possible influence includes the States of Texas, Louisiana, Mississippi, Alabama, and Florida (**Figure 4-1**). In addition, the GOM region's OCS area includes the following Class I areas: the Breton National Wilderness Area in Louisiana; and the Bradwell Bay Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area in Florida. However, due to GOMESA, only the Breton National Wilderness Area is near the proposed lease sale area. The impact analysis determined by this modeling study will address current and proposed NAAQS.

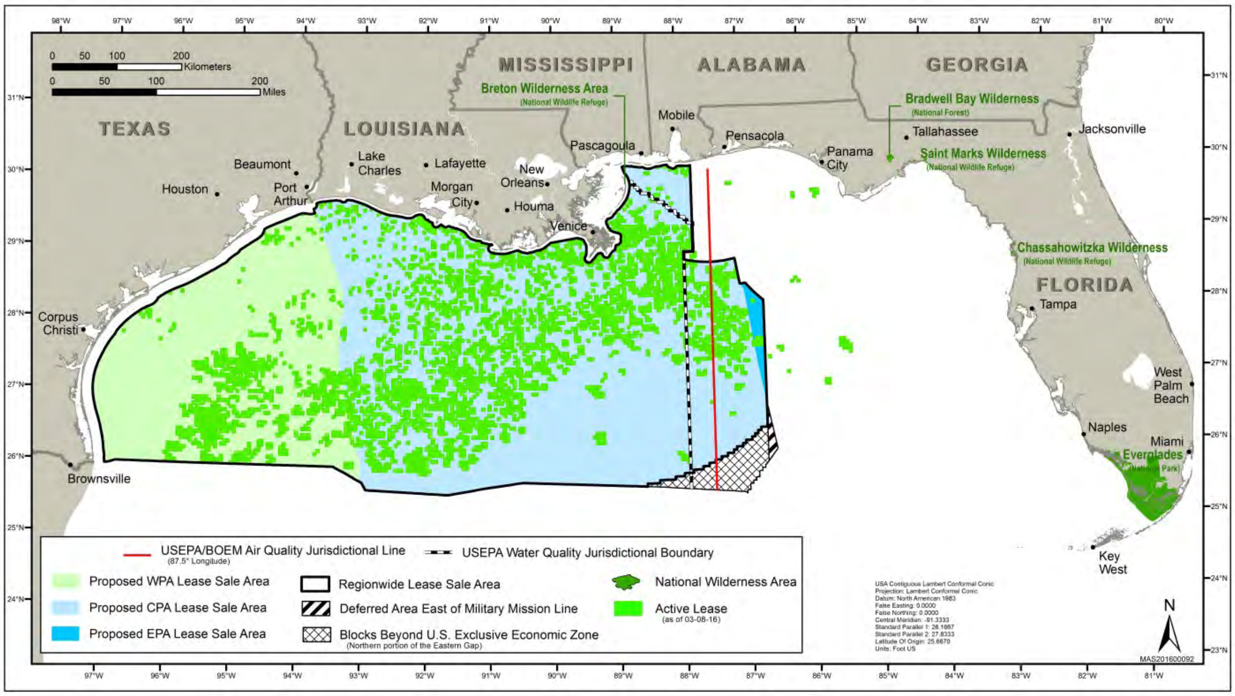

Figure 4-1. Air Quality Areas of Influence (Texas, Louisiana, Mississippi, Alabama, and Florida) in the Gulf of Mexico OCS Region with the Class I Areas, Air Quality Jurisdiction Line, and OCS Lease Blocks. (USEPA Region 6 includes Gulf Coast States Texas and Louisiana; USEPA Region 4 includes Gulf Coast States Mississippi, Alabama, and Florida.)

4.1.1 Description of the Affected Environment

For this Multisale EIS analysis, the affected environment includes the WPA, CPA, and EPA. The area also includes the federally mandated national parks and wilderness areas where visibility is protected more stringently than under the NAAQS. Air quality impact analyses were conducted to assess the impacts of offshore oil- and gas-related activity to onshore areas of the Gulf Coast States. However, the potential impacts to be modeled at the State/seaward boundary of Gulf Coast States (3-9 nmi [3.45-10.36 mi; 5.56-16.67 km] from shore, depending on the State) will also be included in the full analyses and will be included in future EIS documents.

The Clean Air Act of 1970 established the NAAQS; the NAAQS include primary standards to protect public health and secondary standards to protect public welfare, including visibility and vegetation. The current NAAQS, shown in **Table 4-2**, address seven pollutants: carbon monoxide (CO); nitrogen dioxide (NO_2); particle pollution as ($PM_{2.5}$ and PM_{10}); sulfur dioxide (SO_2); lead (Pb); and ozone (O_3). Since particle pollution is represented as particulate matter in the table, BOEM uses particulate matter to refer to particle pollution. Particulate matter is presented as two categories according to size. Fine particulate matter is less than 2.5 μm in size ($PM_{2.5}$), and coarse particulate matter is in the size range of 2.5-10 μm (PM_{10}). Under the Clean Air Act, the USEPA is periodically required to review and, as appropriate, modify the criteria based on the latest scientific knowledge. Several revisions to the NAAQS have occurred in the past few years as more is understood about the effects of the pollutants.

The Clean Air Act Amendments of 1977 specifies requirements to preserve air quality in national parks, national wilderness areas, national monuments, and national seashores. The amendments establish Class I, II, and III areas, where ambient concentrations of particulate matter, nitrogen dioxide, and sulfur dioxide are to be restricted. The restrictions are most severe in Class I areas and are progressively more lenient in Class II. All federally managed lands that are not Class I areas are Class II areas. Since Class I areas are most restrictive, Class I areas located in the GOM will be discussed in this Multisale EIS. The five Class I areas situated on the coast of the GOM are shown in **Figure 4-1**. Each of these Class I areas fall under the jurisdiction of a Federal Land Manager: the FWS has jurisdiction in the Breton National Wilderness Area, Chassahowitza National Wilderness Area, and St. Marks Wilderness Area; the NPS has jurisdiction in the Everglades National Park; and the U.S. Forest Service has jurisdiction in the Bradwell Bay Wilderness Area. These Federal Land Managers have responsibility for protecting wildlife, vegetation, visibility, and other sensitive resources that are called air-quality-related values in these areas. The Clean Air Act Amendments of 1990 gave air quality responsibility for the OCS waters in the Gulf of Mexico east of 87.5° W. longitude to the USEPA (which includes part of the CPA and all of the EPA), but BOEM retained air quality jurisdiction for OCS operations west of 87.5° W. longitude (most of the CPA and all of the WPA) in the Gulf of Mexico. This separation of authority is depicted in **Figure 4-1**. The Clean Air Act Amendments of 1990 also 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. These designations are nonattainment, attainment, and unclassifiable. Nonattainment is any area that does not meet national primary or secondary ambient air quality standard for the pollutant. When measured concentrations of these regulated pollutants exceed the standards established by the NAAQS, the number of exceedances and the concentrations determine the nonattainment classification of an area. The Clean Air Act Amendments list five classifications of nonattainment status—marginal, moderate, serious, severe, and extreme. Attainment is any area that meets the national primary or secondary ambient air quality standard for the pollutant. Unclassifiable is any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

Table 4-2. National Ambient Air Quality Standards.

Pollutant (Final Rule Citation)		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO) (*Federal Register*, 2011a)		Primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead (Pb) (*Federal Register*, 2008b)		Primary and Secondary	Rolling 3-month average	0.15 $\mu g/m^3$ (1)	Not to be exceeded
Nitrogen Dioxide (NO_2) (*Federal Register*, 2010a) (*Federal Register*, 1996)		Primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		Primary and Secondary	Annual	53 ppb(2)	Annual mean
Ozone (O_3) (*Federal Register*, 2015)		Primary and Secondary	8-hour	0.070 ppm(3)	Annual 4th-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (*Federal Register*, 2013) (*Federal Register*, 2006b)	$PM_{2.5}$	Primary	Annual	12 $\mu g/m^3$	Annual mean, averaged over 3 years
		Secondary	Annual	15 $\mu g/m^3$	Annual mean, averaged over 3 years
		Primary and Secondary	24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2) (*Federal Register*, 2010b) (*Federal Register*, 1973a)		Primary	1-hour	75 ppb(4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour 3-hour	0.5 ppm 0.5 ppm	Not to be exceeded more than once per year

(1) The Final Rule was signed on October 15, 2008. The 1978 lead standard (1.5 $\mu g/m^3$ as a quarterly average) remains in effect until 1 year after an area is designated for the 2008 standard. Areas designated nonattainment under the 1978 standard remain in effect until implementation plans are approved to attain or maintain the 2008 standard.

(2) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) The final rule was signed on October 1, 2015, and became effective on December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The Final Rule was signed on June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until 1 year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Notes: PM – particulate matter; ppb – parts per billion; ppm – parts per million.

Source: USEPA, 2015d.

Clean Air Act Amendments' Classification Designation in the Gulf of Mexico Region

The Federal OCS waters are unclassifiable. The OCS areas are not classified because there is no regulatory 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 as either attainment or nonattainment. In this Multisale EIS analysis, attainment and nonattainment status for the criteria pollutants (i.e., CO, NO_2, $PM_{2.5}$, PM_{10}, SO_2, O_3, and Pb) include the coastal counties/parishes of Alabama, Florida, Louisiana, Mississippi, and Texas. The ozone nonattainment status discussed in this chapter represents the 2008 O_3 standard since the USEPA has not designated nonattainment status for the 2015 O_3 standard.

Attainment status for counties/parishes in the States of the GOM region is as follows: Alabama is attainment for all criteria pollutants except Pb; Florida is in attainment for all criteria pollutants except Pb and SO_2; Louisiana is in attainment for all criteria pollutants except O_3 and SO_2; Mississippi is attainment for all criteria pollutants; and Texas is in attainment for all criteria pollutants except O_3 and Pb.

Nonattainment status for counties/parishes in the States of the GOM region includes Alabama, Florida, Louisiana and Texas. In Alabama, the 2008 Pb standard has been exceeded, but a nonattainment status subclassification (i.e., marginal, moderate, serious, severe, and extreme) has yet to be assigned to this area in Pike County (USEPA, 2015a). In Florida, the 2008 Pb standard and the 2010 SO_2 standard have been exceeded in Hillsboro County, but a nonattainment status subclassification has yet to be assigned to this area (USEPA, 2015b). **Figure 4-2** shows the nonattainment status for the 2008 O_3 standard in both Louisiana and Texas. Louisiana is in nonattainment for criteria pollutants O_3 and SO_2. In Louisiana, the 2008 8-hour O_3 standard is classified as marginal in the following parishes: Ascension, East Baton Rouge, Iberville, Livingston, and West Baton Rouge; but the 2010 SO_2 standard exceedance has yet to be subclassified in St. Bernard Parish (USEPA, 2015c). In Texas, the 2008 8-hour O_3 standard is classified as marginal in the following coastal counties: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller; but the 2008 Pb standard has yet to be subclassified in Collin County (USEPA, 2015d).

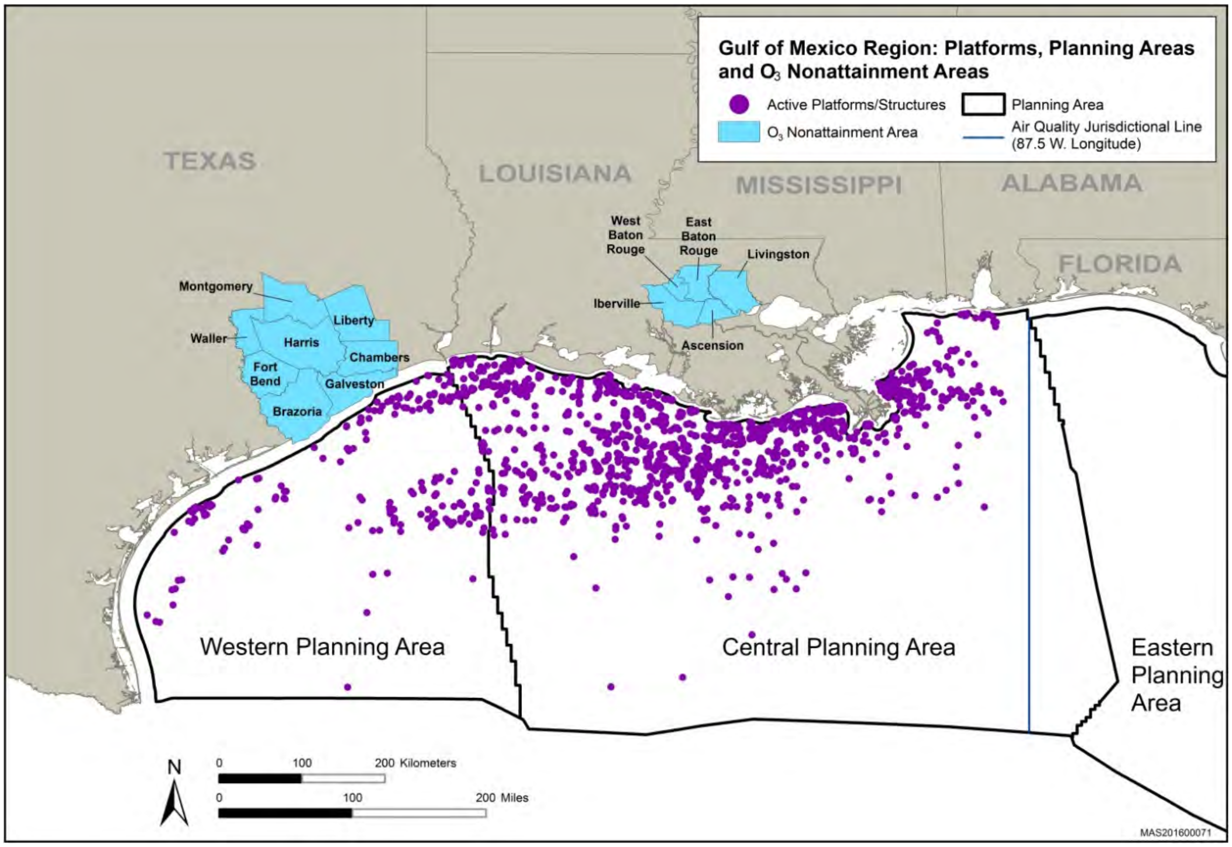

Figure 4-2. Ozone Nonattainment Status in the Gulf of Mexico Region in Louisiana and Texas. (Note: This figure does not indicate the platform count, location, or emissions at the time of publication of this Multisale EIS.)

Emission Inventories

The Year 2011 GWEI study was completed with a goal to develop criteria pollutant and greenhouse gas emission inventories for all oil and gas production-related sources on the Gulf of Mexico OCS, including platform and non-platform sources as well as non-OCS oil- and gas-related emissions. This inventory includes all major oil and gas production platforms and non-platform sources under BOEM's air quality jurisdiction on the Gulf of Mexico OCS. Platform sources include the following: amine units; boilers/heaters/burners; diesel engines; drilling equipment; combustion flares; fugitive sources; glycol dehydrators; losses from flashing; minor sources; mud degassing; natural gas engines; natural gas, diesel, and dual-fueled turbines; pneumatic pumps; pressure/level controllers; storage tanks; and cold vents. Non-platform sources, sources related to OCS oil and gas that do not occur from a stationary platform location, include the following: drilling rigs; pipelaying operations; support helicopters; support vessels; and survey vessels. Non-platform non-oil/gas production sources are unrelated to the OCS oil and gas industry and include the following: biogenic and geogenic sources; commercial fishing vessels; commercial marine vessels; LOOP; military vessels (Coast Guard/Navy); vessel lightering; and recreational vessels. Pollutants covered in the inventory are the criteria pollutants (i.e., CO, NO_x, $PM_{2.5}$, PM_{10}, SO_2, and VOC), as well as the major greenhouse gases (i.e., CO_2, CH_4, and N_2O). The particulate matter emission estimates of $PM_{2.5}$ and PM_{10} are similar; PM_{10} values being slightly higher. Therefore, PM_{10} values have been used in figures in this chapter to represent particulate matter. Nitrogen dioxide, a NAAQS criteria pollutant, is one of a group of highly reactive gases known as NO_x. In this inventory, nitrogen oxides (NO_x) are stated as an equivalent mass of NO_2; consequently, NO_x is used instead of NO_2. The VOCs are not a NAAQS criteria pollutant but are precursors to ozone formation. Lead (Pb), a NAAQS criteria pollutant, is not covered in this inventory due to the lack of credible emission factors available at the time this inventory was developed. However, Pb will be analyzed in the air quality modeling study.

Ozone (O_3) is a NAAQS criteria pollutant but is not covered in this inventory. This inventory provides emission estimates for directly emitted pollutants. Ozone is not directly emitted into the air from OCS oil- and gas-related activities. Therefore, NO_x and VOCs, which are precursors to ozone, are analyzed. Since ozone is formed by photochemical reactions of NO_x and VOCs in the atmosphere, photochemical modeling would need to be conducted to determine ozone impacts. The air quality modeling study includes both photochemical and dispersion modeling, and it uses the 2011 emission inventory to assess ozone impacts.

As previously stated, these emissions inventories are used in air quality modeling to determine the potential impacts of offshore sources to onshore areas. However, potential impacts modeled at the State/seaward boundary will be included in future EIS documents.

The figures below illustrate the NO_x and VOC emissions from platform and non-platform sources. The emissions are shown across the CPA and WPA, where BOEM has air quality jurisdiction. **Figure 4-3** shows the NO_x emissions from platform sources. **Figure 4-4** shows the NO_x emissions from non-platform sources. **Figure 4-5** shows VOC emissions from platform sources, and **Figure 4-6** shows VOC emissions from non-platform sources.

The Year 2011 GWEI total platform and non-platform criteria pollutants emissions and the total platform and non-platform greenhouse gas emissions results are depicted in **Figures 4-7 and 4-8**, respectively. In both figures, the total emissions sources include three main categories: total non-OCS oil/gas production source emissions; total OCS oil/gas non-platform emissions; and total OCS oil/gas platform emissions. The results indicate that the total OCS oil and gas non-platform sources emit the majority of criteria pollutants and greenhouse gases. However, the total non-OCS oil/gas production sources emit the majority of SO_2, which is primarily released from commercial marine vessels; and the majority of CH_4 and N_2O, which are primarily released from biological sources. The total OCS oil/gas platform sources emit the majority of VOCs, which are primarily released by natural gas venting; the majority of CO, which is primarily released from natural gas engines; and the majority of CO_2, which is primarily released from natural gas, diesel, and dual-fuel turbines.

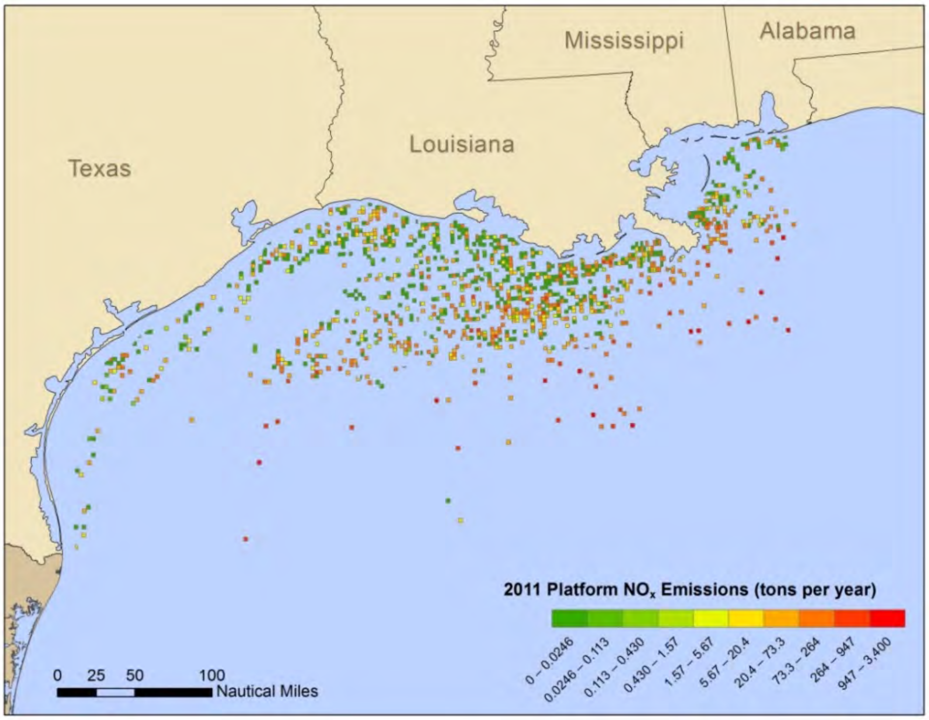

Figure 4-3. 2011 Platform NO_x Emissions (Wilson et al., 2014). (Note: This figure does not indicate the platform source count, location, or emissions at the time of publication of this Multisale EIS.)

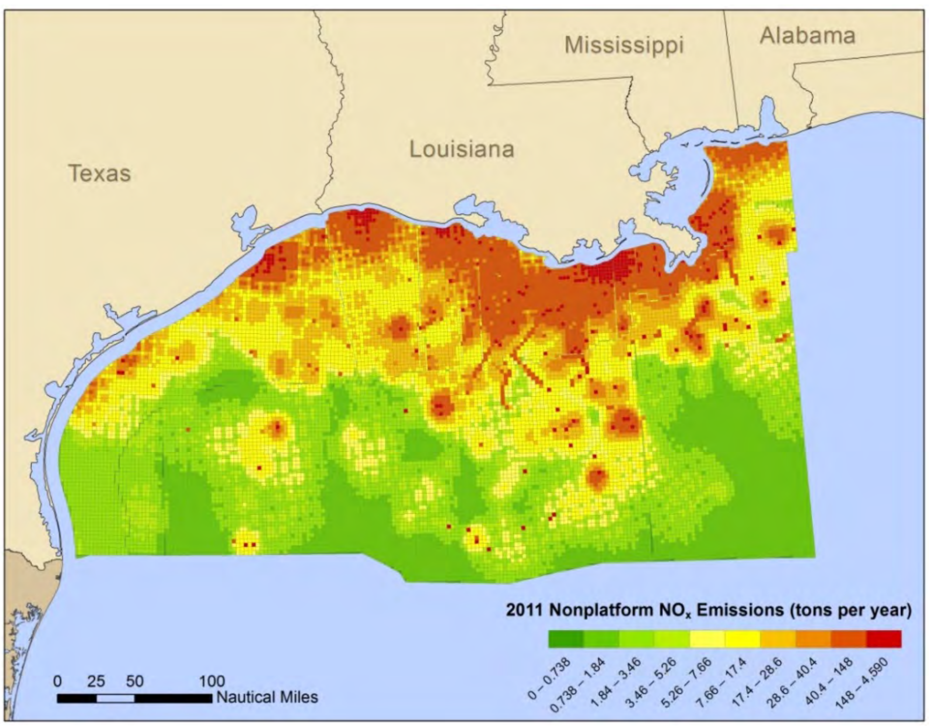

Figure 4-4. 2011 Non-Platform NO_x Emissions (Wilson et al., 2014). (Note: This figure does not indicate the non-platform source count, location, or emissions at the time of publication of this Multisale EIS.)

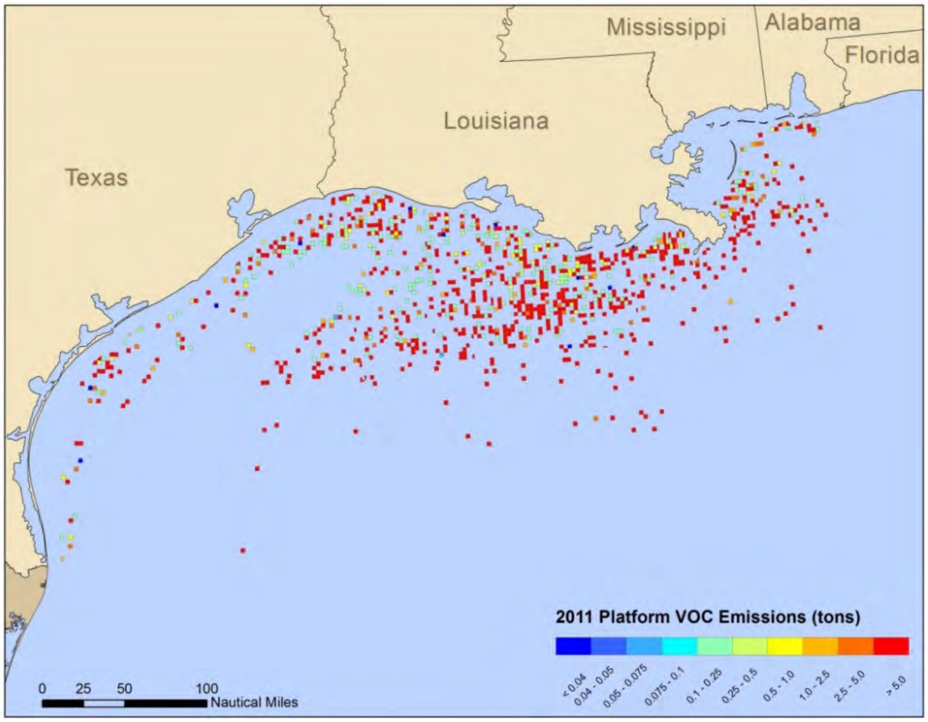

Figure 4-5. 2011 Platform VOC Emissions (Wilson et al., 2014). (Note: This figure does not indicate the platform source count, location, or emissions at the time of publication of this Multisale EIS.)

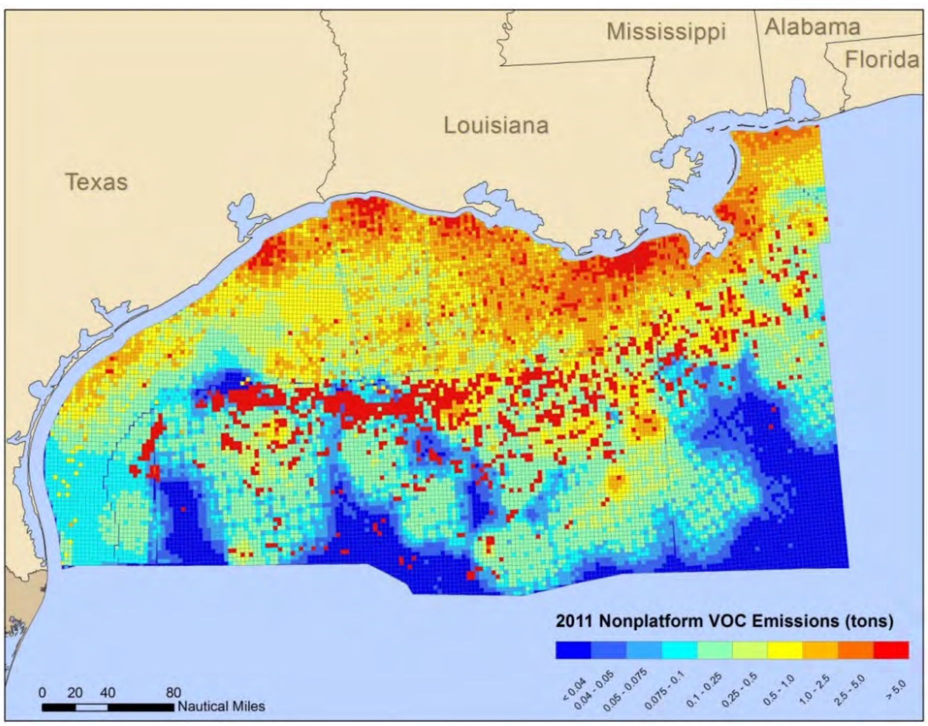

Figure 4-6. 2011 Non-Platform VOC Emissions (Wilson et al., 2014). (Note: This figure does not indicate the non-platform source count, location, or emissions at the time of publication of this Multisale EIS.)

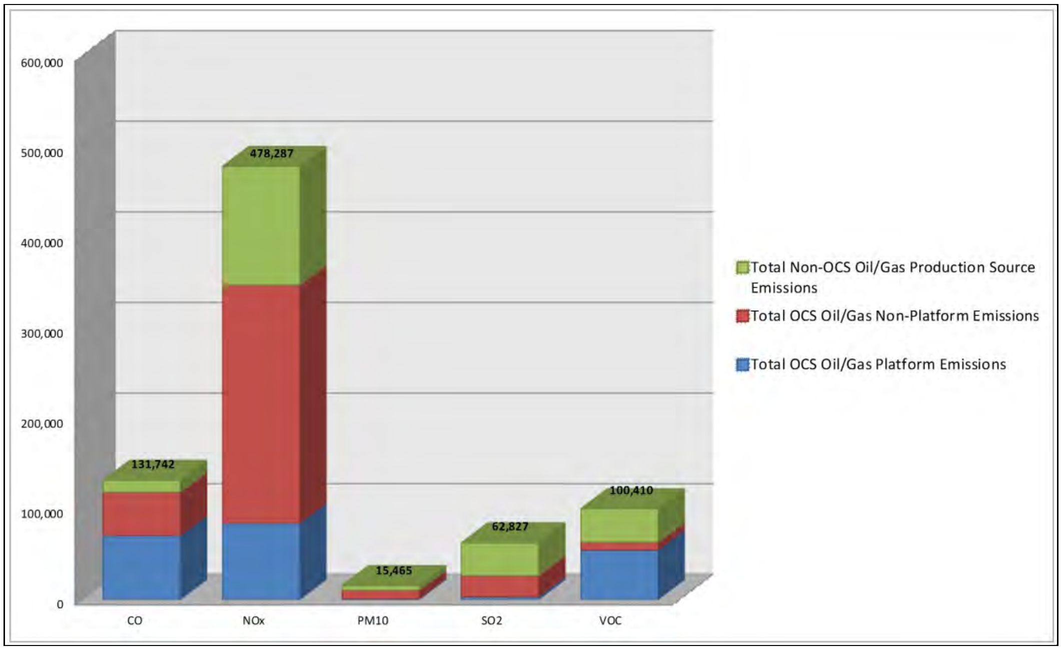

Figure 4-7. Year 2011 Gulfwide Emission Inventory Results for Total Platform and Non-Platform Criteria Pollutant Emissions (TPY).

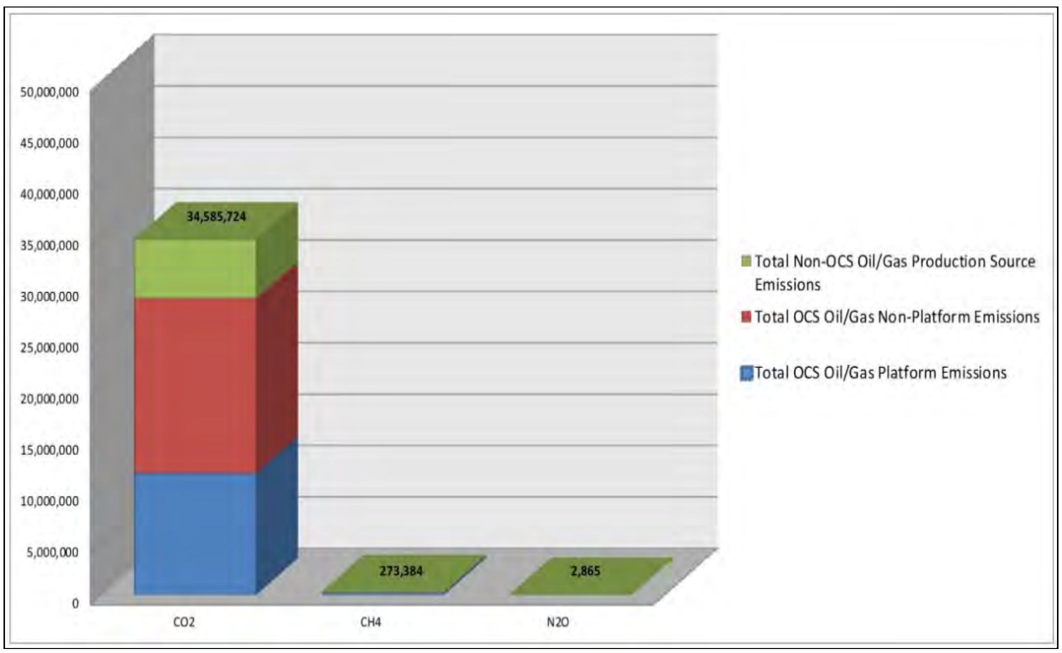

Figure 4-8. Year 2011 Gulfwide Emission Inventory Results for Total Platform and Non-Platform Greenhouse Gas Emissions (TPY).

4.1.2 Environmental Consequences

The impact-producing factors and their potential impacts identified for routine activities, accidental events, cumulative impacts, and incomplete or available information would apply, in general, to Alternatives A-D. This analysis is then applied to each alternative based on the varying degrees of forecasted levels of activities by geographical area and water depth.

Routine Activities

The following routine activities associated with a proposed lease sale would potentially affect air quality: drilling and production with associated vessel support; flaring and venting; fugitive emissions; greenhouse gases; and decommissioning (refer to **Chapter 3.1.8** for a description of these routine activities). These routine activities result in pollutant emissions. Emissions of air pollutants from these activities would occur during exploration, development, production, and decommissioning activities. These activities may potentially affect the air quality at Bradwell Bay Wilderness Area, Breton National Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area during a 50-year analysis period.

Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper wellbore hole. During drilling, diesel engines are used to power the drilling (top drive) assembly, draw works, electrical generators, mud pumps, vessel propulsion (drillships and support vessels) and dynamic positioning (DP) systems of the drilling rig (if DP semisubmersible or DP drillship is used). Combustion of fuel to run the engines generates NAAQS criteria pollutants, VOCs, and greenhouse gases. More information about the pollutants that are generated by specific equipment and activities is available in the *Year 2011 Gulfwide Emission Inventory Study* (Wilson et al., 2014). As illustrated in **Figure 3-2**), during a 50-year analysis period, exploratory drilling mainly occurs during the first decade and development drilling extends throughout the first and second decade.

During production, pollutants emitted during routine activities may be combustion products of burning fuel to power pumps, compressors, or generators, or they may consist of fugitive VOCs, which escape from the uncombusted hydrocarbons. The platform emission sources include boilers, turbines, pneumatic pumps, diesel engines, combustion flares, fugitives, glycol dehydrators, natural gas engines, pressure/level controllers, storage tanks, cold vents, and others. As illustrated in **Figure 3-2**, during a 50-year analysis, most production occurs during the second and third decade.

During a 50-year analysis period, most decommissioning occurs during years 20-40. Decommissioning emissions are due mainly to engines on vessels used in the decommissioning process for propulsion, electrical power, and ancillary mechanical equipment and activities. These emissions include the following pollutants: CO, NO_2, PM, SO_2, CO_2, CH_4, N_2O, and VOCs.

During a 50-year analysis, greenhouse gas emissions would occur during the exploration, development, and production stages. The major greenhouse gases emitted from these activities include CO_2, CH_4, and N_2O. Greenhouse gases are not NAAQS criteria pollutants and there is currently no ambient concentration standard for greenhouse gases. However, owners or operators of petroleum and natural gas facilities that emit 25,000 metric tons of carbon dioxide equivalent (CO_2e) or more from process operations and stationary fuel combustion must report greenhouse gas emissions to the USEPA as required under the Greenhouse Gas Program. This reporting requirement includes platforms that fall under both BOEM's air quality jurisdiction as well as USEPA's air quality jurisdiction. The reporting requirement does not include emissions from offshore drilling and exploration that is not conducted on production platforms. Since the GWEI studies include greenhouse gas emissions, calculated via the Gulfwide Offshore Activities Database System (GOADS), OCS operators can use the data to report their greenhouse gas emissions to the USEPA.

Routine flaring and venting emissions operations occur intermittently for short periods of time over the life of the lease. Flaring is the controlled burning of natural gas and is a common practice in oil and gas exploration, production, and processing operations. Flaring systems are also used to vent natural gas during well testing or during repair/installation of production equipment. The BSEE operating regulations at 30 CFR § 250.1160 provide for some limited volume, short-duration flaring, or venting of some natural gas volumes upon approval by BSEE. These operations may occur for short periods of time (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the wellbore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. The potential impacts from these emergency operations are described in the "Accidental Events" section below and in **Chapter 3.2.3**.

Most of the hydrogen sulfide released to the air comes from natural sources such as swamps, bogs, and volcanoes. Hydrogen sulfide can also be released from industrial sources such as petroleum refineries, natural gas plants, kraft paper mills, manure treatment facilities, waste water treatment facilities, and tanneries. The concentration of hydrogen sulfide (H_2S) occurring naturally in crude oil varies from formation to formation and even varies to some degree within the same reservoir. 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 (93 mi) of the Breton National Wilderness Area Class I area. The BSEE regulations at 30 CFR § 250.490(f) describe safety precautions for employees operating in an H_2S area. Hydrogen sulfide is a naturally occurring compound that is formed from the breakdown of organic matter in low oxygen environments. The effects of H_2S depend on the magnitude, duration, and frequency of exposure, as well as susceptibility of the individual organism or environment. The human nose is very sensitive and can detect extremely low levels of H_2S. A rotten egg odor characterizes H_2S at very low concentrations. However, prolonged exposure to low levels of H_2S can cause skin irritation and olfactory paralysis. Therefore, relying on odor or sense of smell would not be a reliable warning signal to detect H_2S presence. Short-term exposure to high concentrations of H_2S can cause death. Portable monitors worn by workers, as well as visual and audible alarms and H_2S sensors on platforms to activate when the presence of H_2S is detected, can help to prevent loss of life. According to the NPS, Gulf Islands National Seashore visitors have complained about H_2S odors. BOEM expects that concentrations at the park, resulting from OCS sources of H_2S, to be at very low nuisance levels. The source of odors in the park may include releases from the local marsh muds or nearby State oil and gas activity. Therefore, several contributing factors could be responsible for the odors at Gulf Islands National Seashore.

During the flaring of gas containing H_2S, the gas entering the flare would largely combust to SO_2. The contribution of flaring sour gas to SO_2 is regulated in 30 CFR part 250 subpart K. The SO_2 levels from routine flaring are evaluated as a part of the postlease plans review process.

Venting is the intentional release of unburned gases into the atmosphere in the course of oil and gas production operations. The primary sources of VOCs result from venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOCs is the vents on glycol dehydrator units.

Fugitive emissions are gases that are not emitted through a stack or vent but instead leak or intermittently escape from pressurized equipment and sealed surfaces in various components of the facility. Fugitive emission sources include valves, flanges, connectors, pump seals, compressor seals, and pneumatic controllers. During a 50-year analysis period, fugitive emissions can occur during all phases of OCS oil- and gas-related activity. Fugitive emissions are mainly comprised of VOCs and methane (CH_4).

Analysis of Routine Activities

The impacts on air quality from routine activities over the OCS and adjacent onshore areas would be **minor**. The impacts would vary in intensity based on the type and location of the activity. As a result of a proposed lease sale, more NAAQS criteria pollutants would be emitted to the affected environment, as described in **Chapter 4.1.1**. The OCS emissions in tons per year for the criteria pollutants and for the greenhouse gases from platform sources would resemble past emissions inventories and are indicated in **Figures 4-9 and 4-10**. The annual OCS emissions are based on the *Year 2011 Gulfwide Emission Inventory Study* (Wilson et al., 2014). Of the criteria pollutants, the major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant. Of the greenhouse gases, the major pollutant emitted is CO_2, while N_2O is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x and CO_2; platform operations are also the major contributors of VOC emissions. As a result of a lease sale, multiple platforms would be installed on the leases, and platform construction emissions contribute appreciable amounts of all pollutants over the resulting lease sale's 50-year analysis period. Emissions from a singular platform construction 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 90-day per well drilling period. Support vessels for OCS oil- and gas-related activities, as described in **Chapter 3.1.4.4**, include emissions from NO_x, CO, and CO_2. 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.

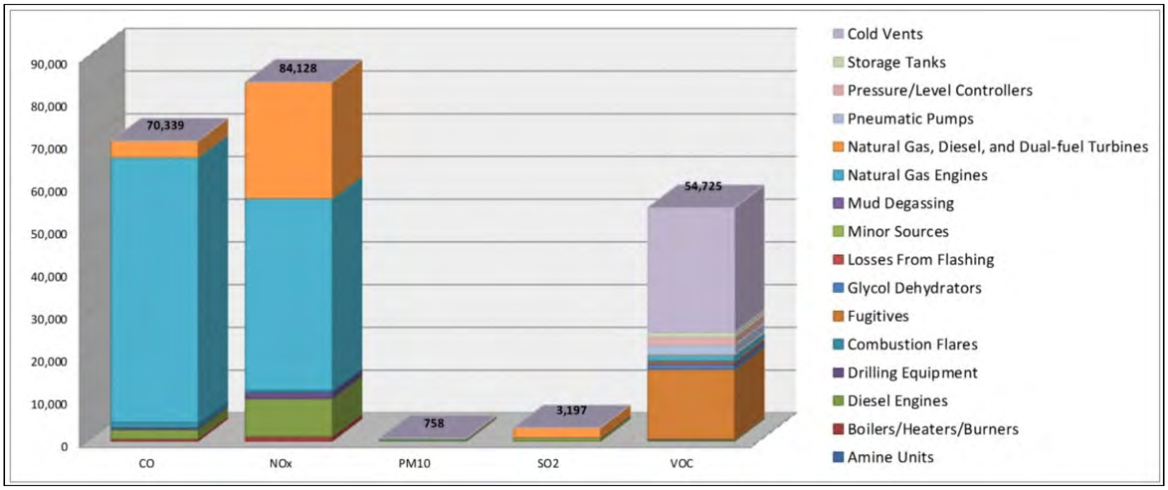

Figure 4-9. 2011 Criteria Pollutant Emissions (TPY) from Platform Sources.

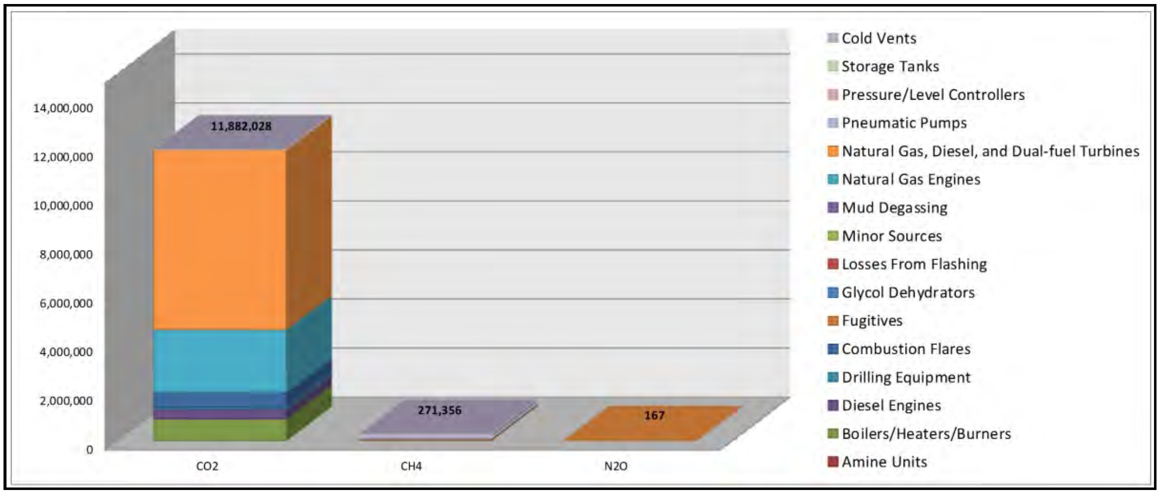

Figure 4-10. 2011 Greenhouse Gases (TPY) from Platform Sources.

The total pollutant emissions per year from activities on a lease are not uniform. After a lease is obtained, various activities to utilize the lease ramp up. Non-platform emissions (drilling and associated vessel support) occur during the first decade and then taper down. After economically recoverable resources have been located, industry efforts turn to platform installation followed by production (platform emissions) and associated vessel support (non-platform emissions), with periodic maintenance episodes and additional side-track wells during roughly the second and third decade. After reaching a maximum, emissions would decrease during the third through fifth decade as wells are depleted and abandoned, platforms are removed, and service-vessel trips and other related activities are no longer needed.

Previous Modeling of Routine Activities

For past lease sale EIS analyses, BOEM used data from the *Year 2008 Gulfwide Emission Inventory Study* (Wilson et al., 2010) and the scenario from Chapter 3 of the 2012-2017 WPA/CPA Multisale EIS (USDOI, BOEM, 2012) to predict a range of impacts. The 2012-2017 WPA/CPA

Multisale EIS relied on modeling from the 2007-2012 WPA/CPA Multisale EIS (USDOI, BOEM, 2007) because the scenarios projecting activity levels generating air emissions were similar.

Previous ozone modeling studies focused on the coastal areas of Louisiana extending eastward to Florida (Haney et al., 2008) and ozone levels in southeast Texas (Yarwood et al., 2004). These studies showed that the impacts of OCS emissions on onshore O_3 levels were very small, with the maximum contribution of 1 ppb or less at Louisiana coastal locations when the standard was exceeded and with a maximum contribution of 0.2 ppb or less to Texas coastal areas exceeding the ozone NAAQS standard. Previous SO_2 and NO_2 annual modeling with the CALPUFF model revealed that none of the allowable SO_2 or NO_2 increments had been fully consumed, as shown in the table below (Wheeler et al., 2008).

Comparison of the Allowable SO_2 or NO_2 Increment
in the Breton National Wilderness Area with the NAAQS

Increment	Class I Area ($\mu g/m^3$)	Allowable Increment ($\mu g/m^3$)
3-hour SO_2	1.7	25
24-hour SO_2	1.18	5
Maximum Annual SO_2	1.07	2
Maximum Annual NO_2	0.1	2.5

The 1-hour NO_x modeling performed by operators as part of the postlease approval process indicates concentrations less than the maximum increase allowed. Regulations, activity data reporting via the GOADS reporting requirement, and mitigation such as monitoring the performance of the sulfur recovery unit or the catalytic converter would ensure these levels stay within the NAAQS.

Based on past studies (Wheeler et al., 2008), emissions of pollutants into the atmosphere from the activities associated with the OCS Program are not projected to have substantial effects on onshore air quality. Additionally, reductions in emissions have been achieved through the use of low sulfur fuels, catalytic reduction, and other efforts.

BOEM used data gathered during the Year 2008 and Year 2011 OCS emission inventories, along with a scenario or estimates of future production, to evaluate the potential effects of emissions. The scenario provided (1) the set of assumptions for and estimates of future activities, (2) the rationale for the scenario assumptions and estimates, and (3) the type, frequency, and quantity of emissions from offshore sources associated with a proposed lease sale. BOEM estimates the projected emissions that result from the activities on the lease from estimated emissions of equipment, such as diesel engines and generators, and the level of offshore activity projected in **Chapter 3.1.8**. Potential impacts resulting from all of the above routine activities based on Year 2008 and Year 2011 OCS emission inventories, postlease 1-hour NOx modeling, and past studies are projected to be minor. Emissions of pollutants from activities associated with a regionwide proposed lease sale are not projected to have major effects on onshore air quality due to dilution and diffusion of the pollutants over time and distance. The emission sources would not produce enough emissions to overcome the effects of wind and transport in a single area to cause deterioration of onshore air quality. The overall analysis of air quality demonstrates a minor impact on coastal areas. To develop a more robust analysis of emissions from OCS oil- and gas-related activities, as w ell as non-OCS oil- and gas-related activities, BOEM secured $2.5 million to fund a special study to obtain dispersion and photochemical modeling results (USDOI, BOEM, 2015). Since previous model runs, there have been new meteorological data and new NAAQS standards. The new study will compare previously used models as well as the new data and standards.

Accidental Events

BOEM determined the greatest impact factors from a reasonably foreseeable accidental event to be emergency flaring or venting, and oil spills. Accidental air emissions are described in **Chapter 3.2.3**.

The accidental release of hydrocarbons related to a proposed lease sale would result in the emission of air pollutants. The OCS accidents would include the release of oil, condensate, or natural gas or chemicals used offshore or pollutants from the burning of these products. The air pollutants include criteria NAAQS pollutants, volatile and semi-volatile organic compounds, hydrogen sulfide, and methane. These pollutants are discussed in **Chapter 4.1.2** above. These accidental events may potentially affect the air quality at Bradwell Bay Wilderness Area, Breton National Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area during a 50-year analysis period.

Emergency Flaring

Emergency flaring may be conducted to manage excess natural gas during an accidental event such as damage to a pipeline that transports the gas to shore or a process upset. In the absence of safety flares, plants would be at a higher risk for fires and explosions. The flare is operated temporarily until the emergency situation is resolved. Flaring would result in the release of NO_x emissions from the flare; SO_2 emissions would be dependent on the sulfur content of the crude oil; and particulate matter from the flare would affect visibility.

The presence of H_2S (**Chapter 3.1.10.1**) within formation fluids occurs sporadically throughout the Gulf of Mexico OCS and may be released during an accident. The BSEE regulations at 30 CFR part 250 subpart E and NTL 2009-G31 require health and safety precautions such as a Contingency Plan for special training, practice drills, strategically placed H_2S sensors, alarms and flashing lights to indicate a release, and accessible protective-breathing equipment. Regulations also require equipment to have metallurgical properties to protect from cracking and corrosion and a flare system with a backup ignition source. While regulations are in place to reduce the risk of impacts from H_2S and while no H_2S-related deaths have occurred on the OCS, accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. The natural gas H_2S concentrations in the Gulf of Mexico OCS are generally low; however, there are areas such as the Norphlet formation in the northeastern Gulf of Mexico, for example, that contain levels of H_2S up to 9 percent. Ignition of the blowout gas and subsequent fire would result in emissions of NO_x, SO_x, CO, VOCs, PM_{10}, and $PM_{2.5}$. The fire could also produce polycyclic aromatic hydrocarbons (PAHs), which are known to be hazardous to human health. The pollutant concentrations would decrease with downwind distance. A large plume of black smoke would be visible at the source and may extend a considerable distance downwind. However, with increasing distance from the fire, the gaseous pollutants would undergo chemical reactions, resulting in the formation of fine particulate matter ($PM_{2.5}$) that includes nitrates, sulfates, and organic matter. The $PM_{2.5}$ concentrations in the plume would have the potential to temporarily degrade visibility in any affected Class I areas (i.e., National Wilderness Areas and National Parks) and other areas where visibility is of significant value.

Venting

Emergency venting may be necessary where flaring of the gas is not possible or in situations precluding the use of a flare gas system, such as insufficient hydrocarbon content in the gas stream to support combustion or a lack of sufficient gas pressure to allow it to enter the flare system. Venting produces mainly CH_4 emissions.

Oil Spills

In the Gulf of Mexico, evaporation from an oil spill would result in concentrations of VOCs in the atmosphere, including chemicals that are classified as being hazardous. Benzene, toluene, ethylbenzene and xylene (BTEX) are a category of VOCs that occur naturally in crude oil, as well as during the process of making of gasoline and other fuels from crude oil. The VOC concentrations would occur anywhere where there is an oil slick, but they would be highest at the source of the spill because the rate of evaporation depends on the volume of oil present at the surface. The VOC concentrations would decrease with distance as the layer of oil gets thinner. The lighter compounds of VOCs, such as BTEX, would be most abundant in the immediate vicinity of the spill site. The heavier compounds would be emitted over a longer period of time and over a larger area. Some of the compounds emitted could be hazardous to workers in close vicinity of the spill site. In hazardous conditions, the Occupational Safety and Health Administration and USCG regulations require workers to use breathing protection. The hazard to workers can also be reduced by limiting exposure through limited work shifts, rotating workers in close vicinity of the spill site, and pointing vessels into the wind. While the spills analyzed as part of this Multisale EIS are significantly smaller than the catastrophic *Deepwater Horizon* explosion and oil spill, air samples collected during that event by individual offshore workers of British Petroleum (BP), the Occupational Safety and Health Administration (OSHA), and the USCG showed levels of BTEX that were mostly under detection levels. All samples had concentrations below the OSHA permissible exposure limits and the more stringent American Conference of Governmental Industrial Hygienists threshold limit values (U.S. Dept. of Labor, OSHA, 2010).

The VOC emissions that result from the evaporation of oil contribute to the formation of particulate matter ($PM_{2.5}$) in the atmosphere (Brock et al., 2012). In addition, VOCs could cause an increase in ozone levels, especially if the release were to occur on a hot, sunny day with sufficient concentrations of NO_x present in the lower atmosphere. Effects to ozone concentrations would depend on distance of the proposed lease sale area from shore and the accidental spill size. If there were any effects to onshore ozone concentrations, they would likely be temporary in nature and last, at most, the length of time of the spill's duration.

Removal and containment efforts to respond to an ongoing offshore spill would likely require multiple technologies, including source containment, mechanical cleanup, in-situ burning of the slick, and chemical dispersants (Chapter 3.2.7). In-situ burning would result in ambient concentrations of CO, CO_2, NO_x, PM_{10}, $PM_{2.5}$, and SO_2 very near the site of the burn and would generate a plume of black smoke. The levels of $PM_{2.5}$ could be a hazard to personnel working in the area, but this could be effectively mitigated through monitoring and relocating vessels to avoid areas of highest concentrations.

Analysis of Accidental Events

Emergency flaring is distinguished from routine flaring by the magnitude, frequency, and duration of flaring events. Emergency flaring events are the result of operating conditions that are outside normal process and equipment operations. Emergency flaring is generally characterized by infrequent occurrence, high-emission rates, and short durations. Potential impacts to air quality are not expected to be significant, except in the rare case of a catastrophic event, which is not part of a proposed lease sale and not likely expected to occur. Therefore, the potential impacts of a reasonably foreseeable accidental gas release analyzed in this Multisale EIS would be localized and short term, and would have no impact to coastal areas, including the Bradwell Bay Wilderness Area, Breton National Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area. The accidental event impacts on air quality over the OCS and adjacent onshore areas on accidental gas releases is **minor**.

Accidental oil spills, though not considered a routine oil and gas activity, have the potential to occur during each phase of oil and gas operations. In April 2010, the *Deepwater Horizon* explosion and oil spill was a catastrophic event that occurred on the Gulf of Mexico OCS. The impacts on air quality from *Deepwater Horizon* explosion and oil spill have been well documented. BOEM does not expect accidental events to resemble the *Deepwater Horizon* explosion and oil spill. BOEM is not analyzing the rare, catastrophic *Deepwater Horizon* explosion and oil spill as an accidental event in this chapter but rather is using the information to describe the potential impacts common to spills and accidental events regardless of size. To date, air monitoring conducted following the *Macondo* loss of well control and spill has not found any pollutants at levels expected to cause long-term harm (USEPA, 2010). The loss of well control and blowouts are rare events and of a short duration. Potential impacts to air quality are not expected to be significant, except in the rare case of a catastrophic event, which is not reasonably expected and not part of a proposed action. Therefore, potential impacts as a result of the much smaller reasonably foreseeable accidental spills analyzed in this Multisale EIS would be localized and short term, and would have no impact to coastal areas, including the Bradwell Bay Wilderness Area, Breton National Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area. The accidental event impact on air quality over the OCS and adjacent onshore areas on oil spills is **minor**.

Cumulative Impacts

An analysis of the cumulative impacts in the GOM region is described in this section. This cumulative analysis considers OCS oil- and gas-related and non-OCS oil- and gas-related activities that could occur and adversely affect onshore air quality during the 50-year analysis period. This cumulative analysis also considers these activities' effects on the Bradwell Bay Wilderness Area, Breton National Wilderness Area, Chassahowitza National Wilderness Area, Everglades National Park, and St. Marks Wilderness Area during a 50-year analysis period. These Class I areas are protected against excessive increases in air quality-related values—resources sensitive to air quality. These air quality-related values include visibility impairment, acid (sulfur and nitrogen) deposition, and nitrogen eutrophication. Therefore, one of the tasks of the "Air Quality Modeling in the Gulf of Mexico Region" study is to develop a comprehensive emissions inventory of all sources in the GOM region and to conduct air quality modeling for cumulative/visibility assessment.

The activities in the cumulative scenario that could potentially impact onshore air quality include a regionwide proposed lease sale and the ongoing and future OCS Program, accidental releases from oil spills, accidental releases from hydrogen sulfide, and a catastrophic oil spill, as well as non-OCS oil- and gas-related activities, State oil and gas programs, and natural events (e.g., hurricanes).

OCS Oil- and Gas-Related Impacts

Emissions contributing to air quality degradation come from many sources. Air pollutants on the NAAQS list are commonly referred to as criteria pollutants because they are ubiquitous. Although these pollutants occur naturally, elevated levels are usually the result of anthropogenic activities. The OCS oil- and gas-related activities that could impact air quality include the following: platform construction and emplacement; platform operations; drilling activities; flaring; service-vessel trips; fugitive emissions; the release of oil, condensate, natural gas, and chemicals used offshore, or pollutants from the burning of these products; and a low-probability catastrophic spill, which is not part of the proposed action and not likely expected to occur. Emissions of pollutants into the atmosphere from the activities associated with the OCS Program are not projected to have substantial effects on onshore air quality based on results of past GWEI studies, past ozone studies, and modeling results of the 2012-2017 WPA/CPA Multisale EIS.

In the past, BOEM has prepared Gulfwide emissions inventories in 2000, 2005, 2008, and 2011. In all of the inventories conducted, the largest sources of NO_x and VOCs are the OCS non-platform sources and OCS platform source categories, respectively. Support vessels generate about 67 percent of OCS non-platform sources of NO_x emissions, whereas within the OCS platform source category, cold vents and fugitive emissions comprise more than 83 percent of the total VOCs. Previous ozone modeling studies (Yarwood, 2004; Haney, 2008) suggest that the dominant cause of onshore ozone exceedances are onshore emission sources but that offshore oil and gas activity do cause offshore ozone peaks to occur. Additionally, the *Cumulative Increment Analysis for the Breton National Wilderness Area* study indicated that the cumulative impacts to the Breton Wilderness Class I Area are well within the Prevention to Significant Deterioration Class I allowable increment (Wheeler et al., 2008).

In the 2012-2017 WPA/CPA Multisale EIS, BOEM used data gathered during the recent OCS emission inventories (Year 2008 GWEI), along with a scenario or estimates of future production, to evaluate the potential effects of emissions. The affected environment included the CPA and WPA; however, BOEM also examined impacts in the EPA. In the CPA, the impacts of the OCS oil-and gas related emissions on the onshore air quality were annual NO_2 (0.4 μ/m^3) and 24-hour $PM_{2.5}$ (0.3 μ/m^3) in the Class I area, which exceed the USEPA's Significant Impact Levels for annual NO_2 (0.1 μ/m^3) and 24-hour $PM_{2.5}$ (0.07 μ/m^3) in the Class I area. However, onshore impacts on air quality from emissions from OCS oil- and gas- related activities are estimated to be within the Prevention of Significant Deterioration Class II allowable increments. In the WPA, the impacts of the OCS emissions on the onshore air quality were below the USEPA's Significant Impact Levels. Additionally, BOEM examined impacts to air quality in the EPA using the same approach for the CPA and WPA. In the EPA, the impacts of the OCS emissions on the onshore air quality were below the USEPA's Significant Impact Levels. The background concentration and impact concentration for the CPA, WPA, and EPA were below the NAAQS. The only potential exception is for ozone, where there may be some minimal contribution to the ozone at the shoreline.

For this Multisale EIS analysis, BOEM used data gathered during the recent OCS emission inventory (Year 2011 GWEI), along with a scenario or estimates of future production, to evaluate the potential effects of emissions. The affected environment includes the WPA, CPA, and EPA, which comprise the Gulf of Mexico OCS region. The area also includes the federally mandated national parks and wilderness areas where visibility is protected more stringently than under the NAAQS. As a result of a proposed lease sale, more NAAQS criteria pollutants would be emitted to the affected environment. The scenario for this Multisale EIS analysis includes the WPA, CPA, and EPA; the Year 2011 GWEI study data were used in this analysis. In the 2012-2017 WPA/CPA Multisale EIS, the scenario included the WPA and CPA, but the EPA was analyzed as a supplement to that Multisale EIS; the Year 2008 GWEI study data were used in this analysis. Since the Year 2008 and Year 2011 GWEI study results are similar and the scenario analyzed includes the WPA, CPA, and EPA, BOEM concludes that the impacts of cumulative activities on air quality over the OCS and adjacent onshore areas would be moderate; however, the incremental impacts as a result of a proposed lease sale would be **minor**.

Non-OCS Oil- and Gas-Related Impacts

Onshore emission sources from non-OCS oil- and gas-related activities include power generation, industrial processing, manufacturing, refineries, commercial and home heating, and motor vehicles (**Chapter 3.3.2.6**). The total impact from the combined onshore and offshore emissions would have an effect on the ozone nonattainment areas in southeast Texas and the parishes near Baton Rouge, Louisiana.

State oil and gas programs (**Chapter 3.3.2.1**) onshore, in territorial seas, and in coastal waters also generate emissions that affect onshore air quality. These emissions are regulated by State agencies and/or the USEPA. Reductions in emissions have been achieved through the use of low sulfur fuels, catalytic reduction, and other efforts and, as a result, constitute minor impacts to onshore air quality.

Other major factors influencing offshore environments, such as sand borrowing (**Chapter 3.3.2.7.6**), commercial transportation (**Chapter 3.3.2.3**), military vessels, and recreational vessels also generate emissions that can affect air quality. These emissions are regulated by State agencies and/or the USEPA. Reductions have been achieved through the use of low sulfur fuels and catalytic reduction and, as a result, constitute slight impacts to onshore air quality.

Hurricanes (**Chapter 3.3.2.10.2**) mainly cause damage to offshore infrastructures and pipelines, which may result in an oil spill. A hurricane would cause minor effects on the onshore air quality since air emissions in the event of a hurricane are temporary sources. For the cumulative scenario, the emissions from oil spill and the associated response activities and infrastructure repair activities are expected to be the same as a proposed lease sale and to have lesser effects on the onshore air quality.

Additionally, recent information shows that intercontinental dust transport may have impacts on the GOM's air quality. For example, dust from Central America and North Africa has been found in the Texas atmosphere. Fine particulates ($PM_{2.5}$), such as ammonium sulfate, can be suspended in the atmosphere and can impair visibility and adversely affect human health. Once in the atmosphere, these fine particulates can be transported for long distances. It has been observed that a substantial amount of the fine particulates observed in Texas comes from Mexico and Central America, and enters into the United States across Texas' southern border. As a result, it reduces the visibility at Big Bend and Guadalupe Mountains National Parks, both Class I (pristine with respect to visibility) areas. The results of air dispersion modeling indicate that as much as half of the visibility impairment (occurring on 20% of the most visibility impaired days) at Big Bend comes from international transport (State of Texas, Commission on Environmental Quality, 2014). The trans-Atlantic transport of North African dust by summertime trade winds occasionally increases ambient particulate matter (PM) concentrations in Texas above air quality standards (Bozlaker et al., 2013). These results indicate that an increase in visibility impairment in Texas is likely due to transport of dust rather than OCS oil- and gas-related emission sources.

The incremental contribution of a proposed lease sale to the cumulative impacts would most likely have a slight effect on coastal nonattainment areas. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a proposed lease sale would be very small. The cumulative contribution to visibility impairment from a proposed lease sale is also expected to be very small. The cumulative impacts on air quality over the OCS and adjacent onshore areas would be moderate, but the incremental impacts as a result of a proposed lease sale would be **minor**.

Incomplete or Unavailable Information

This section discusses the incomplete or unavailable information needed to assess the impacts from OCS oil and gas-related activities. The air modeling study results that are necessary to determine if lease sale emissions adversely impact the State/seaward boundary or the shoreline are unavailable. A contract exists to obtain this information and the results should be available in future EIS documents.

In order to accurately assess the impacts of a proposed lease sale, BOEM uses data gathered from recent Gulf of Mexico OCS emission inventories, along with scenarios or estimates of future production. The scenarios provide (1) the assumptions for and estimates of future activities, (2) the rationale for the scenario assumptions and estimates, and (3) the type, frequency, and quantity of emissions from offshore sources associated with a proposed lease sale.

BOEM determines the projected total emissions that would result from the activities on a lease based on estimated emissions from various OCS non-platform and OCS platform equipment types, such as diesel engines and generators, and the level of offshore activity projected in **Chapter 3.1**. These same emissions estimates are used as inputs for modeling scenarios to predict future impacts. The study results are not available in time for this Draft Multisale EIS, but BOEM expects that they would be included in future EIS documents. To address data gaps and current impacts, BOEM used emissions inventory data, available studies, postlease plan information, and current proposed lease sale scenario data, as well as previous proposed action scenario data, to reach our impact conclusions.

Air Quality Models

In 2014, BOEM awarded a contract to complete an air quality modeling study in the GOM region. The "Air Quality in the Gulf of Mexico Region" study (GM-14-01) will use photochemical and dispersion air quality modeling in the GOM region to assess the impacts of OCS oil and gas development to nearby States, as required under the OCSLA. The pollutants covered in this study are the criteria pollutants (i.e., CO, NO_x, PM_2, PM_{10}, SO_2, Pb, and O_3), volatile organic compounds (VOCs), hydrogen sulfide (H_2S), and ammonia (NH_3).

Inputs to the model include the locations of the emission sources and the receptors, the aforementioned emissions, source parameters such as source height and source stack gas temperature, and a 5-year history of meteorological conditions. The latter two parameters influence the dispersion of the pollutant as it is transported from the source to the receptor. The model output is the concentration of the pollutant at the onshore receptor location at specified time intervals. The proposed lease sales would have reasonably foreseeable adverse effects to air quality, but at the time of this Draft Multisale EIS, results from the "Air Quality Modeling in the Gulf of Mexico Region" study are not available to evaluate the impacts of a proposed lease sale. However, this impact analysis will be updated in future EIS documents to include the results of this model.

The results of photochemical and dispersion modeling would be used to predict the impact of emissions from both current and proposed OCS oil- and gas-related activities. The accuracy of the modeling predictions depends on several factors, including the representative meteorological dataset and rate of emissions. Thus, the air quality impact analyses are only as accurate as the meteorological dataset applied to disperse and transport the pollutants, and only as comprehensive as the emissions inventory on which the analyses are based. While the USEPA, State agencies, and Regional Planning Organizations have conducted air quality modeling studies that include the GOM region, efforts are needed to bring together data from these resources that would contribute to BOEM's comprehensive understanding of how GOM region OCS oil and gas production activities affect the air quality of any state, particularly with regard to annual and short-term NAAQS. The results of photochemical and dispersion modeling would be used to estimate pre- and postlease impacts of offshore oil and gas.

Air quality modeling requires several input datasets, i.e., meteorology, emissions inventories, and ambient pollutant concentrations. Meteorological information is needed for air quality modeling because parameters such as wind speed, wind direction, air temperature, and humidity are required by models to determine the rate that pollutants disperse and react in the atmosphere. Sources of meteorological information include datasets of measurements gathered at various locations within the GOM region domain. However, the spatial coverage of measurements is insufficient to describe the three-dimensional structure of the atmosphere away from measurement locations. Using measurement data as inputs, gridded meteorological models are able to estimate meteorological conditions in regions far from measurement sites. The results of these models are often used to establish conditions near remote pollutant sources or remote locations downwind of pollutant sources.

In past EIS assessments, BOEM used the Offshore and Coastal Dispersion model version 5 (OCD 5 model) to assess offshore impacts. One of the limitations of the OCD model is that it is unable to directly model contributions to ambient ozone (O_3), as ozone is formed in the ambient atmosphere through chemical reactions from precursor pollutants and energy from sunlight. To address this limitation, BOEM examined available studies on OCS oil- and gas-related activities' contribution to onshore ozone levels. The findings of these prior studies suggest that the dominant cause of onshore ozone exceedances are onshore emissions in urban and industrial areas but that offshore oil- and gas-related activity do cause offshore ozone peaks to occur. However, these studies need to be updated and made more comprehensive to determine the potential impacts of oil- and gas-related activities from a proposed lease sale.

Assumptions

The air quality in the GOM can be affected by the pollution emitted from OCS oil- and gas-related sources as well as non-OCS oil- and gas-related sources. These pollution sources can also emit a wide variety of pollutants. To improve air quality and reduce air pollution, the Clean Air Act Amendments set regulatory limits on pollutants that help to ensure basic health and environmental protection from air pollution. To assess the amount of pollution being emitted, pollutants have to be measured. To determine impacts from these pollutants, emission-related conditions (e.g., rate of emission, height, and distance of sources from coastline) and environmental conditions (e.g., wind speed and direction, humidity, temperature, and height of the atmospheric surface layer where pollutants are transported) are calculated.

Emissions from activities related to prior lease sales are represented by the GOAD 2011 database. Emissions from BOEM's proposed lease sales are estimated from the exploration and development scenario and have been included in the emission inventory that will be used in the model to determine routine impacts. The "Air Quality in the Gulf of Mexico Region" modeling study includes development of meteorological datasets appropriate for air quality modeling of the study area (which includes a proposed lease sale), comprehensive emissions inventory of all sources in the GOM region, and air quality modeling for the cumulative impacts and visibility assessment. Given that BOEM does not have the results from the ongoing air quality modeling study yet, for this Draft Multisale EIS, BOEM has had to rely on emissions inventory data, available studies on OCS oil- and gas-related activities, and postlease exploration and development plan information, as well as previous proposed action scenario data and impacts analysis to fill data gaps. Since BOEM has not had the resources to conduct such a robust analysis in previous Multisale EISs, BOEM used past studies, emission inventories, and postlease plan information to assess impacts. This approach was adequate because it assessed a combination of pollutants from OCS oil- and gas-related activities, non-OCS oil- and gas-related activities, and non-oil and gas activities.

4.1.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

As mentioned in **Chapter 3**, for a proposed lease sale under **Alternative A**, BOEM projects that no more activity would occur than has resulted in the past from the highest CPA lease sale combined with the highest WPA lease sale. Each stage of operation within each phase of a proposed lease sale results in a **minor** air quality impact when considering the countervailing effects of actual operations together with dilution and diffusion of the pollutants over time and distance. The emission sources would not produce emissions sufficient to overwhelm the effects of wind and transport in a single area, causing deterioration of air quality over the regionwide OCS. The incremental contribution of a single regionwide proposed lease sale would likely have a **minor** impact on coastal areas. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a regionwide proposed lease sale would be very small.

4.1.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Since this Alternative excludes the available unleased blocks in the WPA, it would result in activity concentrated in the CPA/EPA. As mentioned in **Chapter 3**, for a proposed lease sale under **Alternative A**, BOEM projects that no more activity would occur than has resulted in the past from the highest CPA lease sale combined with the highest WPA lease sale. Therefore, the impacts to Alternative B would be very similarly to Alternative A. The incremental contribution of a single CPA/EPA proposed lease sale would likely have a **minor** impact on coastal nonattainment areas.

Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a proposed lease sale would be very small.

4.1.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Since this Alternative excludes the available unleased blocks in the CPA/EPA, it would result in activity concentrated in the WPA. As mentioned in **Chapter 3**, a maximum of 13 percent of the oil production and associated activity and 19 percent of the gas production and associated activity would occur in the WPA. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA under Alterative B, the smaller area could decrease impacts to communities from production platforms and also increase total emissions due to travel distances for marine vessels; the potential impacts would remain **minor**. The incremental contribution of a single WPA proposed lease sale would likely have a **minor** impact on coastal areas. Portions of the Gulf Coast onshore areas have ozone levels that exceed the Federal air quality standard, but the incremental contribution from a proposed lease sale would be very small.

4.1.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D would have the same analysis and potential impacts as Alternative A, B, or C because there are so few unleased blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations. The difference between Alternatives A, B, and C with and without any combination of these stipulations is **negligible** for air quality. The impacts under Alternative D would not be much different and likely not even measurable when compared with the other alternatives.

4.1.2.5 Alternative E—No Action

BOEM has concluded in **Chapter 2.3** that the selection of Alternative E would result in no additional discernible impacts to the resources analyzed. Cumulative impacts of current and past activities, however, would continue to occur under this alternative.

4.2 WATER QUALITY

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

Coastal water impacts associated with routine activities include increases in turbidity resulting from pipeline installation and navigational canal maintenance, discharges of bilge and ballast water from support vessels, and runoff from shore-based facilities. Offshore water impacts associated with routine activities result from discharge of drilling muds and cuttings, produced water, and residual chemicals used during workovers. The discharge of drilling muds and cuttings causes temporary increased turbidity and changes in sediment composition. The discharge of produced water results in increased concentrations of some metals, hydrocarbons, and dissolved solids. Structure installation and removal and pipeline placement disturb the sediments and cause increased turbidity. In addition, offshore water impacts result from supply and service-vessel bilge and ballast water discharges.

The activity associated with a proposed lease sale could contribute a small percentage of the existing and future OCS oil- and gas-related activities. The specific discharges, drill muds, cuttings and produced water, and accidents resulting in spills would occur in proportion to production and, therefore, would add a small increase to the anticipated impacts. Furthermore, the vessel traffic and related discharges associated with a proposed lease sale are a fraction of the ongoing commercial shipping and military activity in the Gulf of Mexico. The impact of discharges, sediment disturbances, and accidental releases are a small percentage of the overall activity and the overall impacts to coastal and offshore waters.

The USEPA (Regions 4 and 6) regulates all waste streams generated from offshore oil- and gas-related activities. Section 403 of the Clean Water Act requires that National Pollutant Discharge Elimination System (NPDES) permits be issued for discharges to the territorial seas (baseline to 3 mi [5 km]), the contiguous zone, and the ocean in compliance with USEPA's regulations for preventing unreasonable degradation of the receiving waters.

The authority for the NPDES program is given at 40 CFR part 125 subpart M, "Ocean Discharge Criteria." The purpose of the NPDES program is to prevent the unreasonable degradation of the marine environment as described in 40 CFR § 125.122. In accordance with definitions stated at 40 CFR § 125.121, "unreasonable degradation of the marine environment" means (1) significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities; (2) threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or (3) loss of aesthetic, recreational, scientific, or economic values, which is unreasonable in relation to the benefit derived from the discharge.

Regulated wastes include drilling fluids, drill cuttings, deck drainage, produced water, produced sand, well treatment fluids, well completion fluids, well workover fluids, sanitary wastes, domestic wastes, and miscellaneous wastes. The bulk of waste materials produced by offshore oil- and gas-related activities are produced water (formation water) and drilling muds and cuttings (USEPA, 2009b). There are two general NPDES permits that cover the Gulf of Mexico. Permit GMG290000, issued by USEPA Region 6, covers the WPA and CPA, and Permit GEG460000, issued by USEPA Region 4, covers the EPA. The USEPA Regions' jurisdictional areas are shown in **Figure 3-9** (USEPA, 2009b).

To meet the goal of preventing unreasonable degradation of the marine environment, Section B of the NPDES permits specifies effluent limitations and monitoring requirements for offshore oil and gas facilities. Discharged regulated wastes may not contain free oil or cause an oil sheen on the water surface, and the oil/grease concentration may not exceed 42 milligrams per liter (mg/L) daily maximum or 29 mg/L monthly average. Discharge of drilling fluids containing oil additive or formation oil is prohibited, except that which adheres to cuttings and certain small volume discharges. Barite used in drilling fluids may not contain mercury or cadmium at levels exceeding certain concentrations (1.0 mg/kg mercury and 3.0 mg/kg cadmium). Some discharged regulated wastes (e.g., produced waters and miscellaneous wastewaters) must also be characterized using a whole effluent toxicity test, where a population of mysid shrimp or inland silverside minnows are exposed to a certain concentration of the waste stream, and mortality of the population must not exceed 50 percent. The NPDES permits allow a mixing zone for some regulated discharges as defined at 40 CFR § 125.121 to meet compliance using an approved plume model. The NPDES permits require no discharge within 1,000 m (3,281 ft) of an area of biological concern. Region 4 also requires no discharge within 1,000 m (3,281 ft) of any federally designated dredged material ocean disposal site.

Impacts on water quality from operational discharges related to a proposed lease sale are expected to be minimal because of the following: (1) USEPA regulations to prevent unreasonable degradation of the marine environment; (2) prohibitions on discharge of some waste types; (3) prohibitions on discharge near sensitive biological communities; (4) monitoring requirements and toxicity testing; (5) mixing zone and dilution factors; (6) operational discharges are temporary in nature; and (7) any effects from elevated turbidity would be short term, localized, and reversible. As such, assuming compliance with applicable regulations, the impacts from the discharge of regulated wastes from routine operations would require no additional mitigation.

These OCS oil- and gas-related sources are related to the activities listed in **Table 4-3** below. This table also illustrates the impact level conclusions for each impact-producing factor reached in this chapter's impact analysis.

Table 4-3. Water Quality Impact-Producing Factors.

Water Quality	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Geological Sampling	Negligible	Negligible	Negligible	Negligible	None
Bottom Area Disturbance	Negligible	Negligible	Negligible	Negligible	None
Operational Discharges and Wastes	Negligible	Negligible	Negligible	Negligible	None
Pipeline Installation	Negligible	Negligible	Negligible	Negligible	None
Decommissioning and Removal Operations	Negligible	Negligible	Negligible	Negligible	None

Water Quality	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Accidental Impacts					
Drilling Fluid Spills	Minor	Minor	Minor	Minor	None
Chemical and Waste Spills	Minor	Minor	Minor	Minor	None
Oil Spills					
Without Mitigation	Moderate	Moderate	Moderate	Moderate	None
With Mitigation	Minor	Minor	Minor	Minor	None
Cumulative Impacts					
OCS Oil and Gas	Negligible	Negligible	Negligible	Negligible	Negligible
Non-OCS Oil and Gas	Negligible	Negligible	Negligible	Negligible	Negligible

Impact-Level Definitions

For the purpose of the following discussion, the significance of impact-producing factors on water quality is discussed below. The criteria for significance reflect consideration of the context and intensity of impact (40 CFR § 1508.27), based on four parameters: detectability (i.e., measurable or detectable impact); duration (i.e., short term, long term); spatial extent (i.e., localized, extensive); and severity (i.e., severe, less than severe). For water quality, the significance criteria have been broadly defined as follows:

- **Negligible** – Impacts are defined as short-term (less than 1 year), localized contaminants and turbidity that present little to no detectable impact.
- **Minor** – Impacts are defined as detectable, short-term, localized, or extensive but less than severe; however, detectable contaminant concentrations may exceed regulatory levels. Minor impacts may have little to no effect on marine life.
- **Moderate** – Impacts are defined as detectable, short term, extensive, and severe; or impacts are detectable, short term or long term, localized and severe; or impacts are detectable, long term, extensive, or localized but less than severe. Moderate impacts may result in acute or chronic effects to marine life.
- **Major** – Impacts are defined as detectable, short term or long term, extensive, and severe; however, major impacts may result in acute or chronic effects to marine life and may potentially cause human health effects.

4.2.1 Description of the Affected Environment

For the purposes of this analysis, the GOM is divided into coastal and offshore waters. Coastal waters are defined to include all bays and estuaries from the Rio Grande River to the Florida Bay. Offshore waters are defined to include those waters extending from outside the barrier islands to the Exclusive Economic Zone, located within State waters and the Federal OCS. The inland extent is defined by the Coastal Zone Management Act. Offshore waters are divided into three regions: the continental shelf west of the Mississippi River; the continental shelf east of the Mississippi River; and deep water (>1,000 ft; 305 m).

The U.S. portion of the GOM follows the coastline of five states, from the southern tip of Texas moving eastward through Louisiana, Mississippi, Alabama, and ending in the Florida Keys. Including the shorelines of all barrier islands, wetlands, inland bays, and inland bodies of water, the combined coastlines of these states total over 75,639 km (47,000 mi) (USDOC, NOAA, 2008a). The GOM coastal areas comprise over 750 bays, estuaries, and sub-estuary systems that are associated with larger estuaries (USEPA, 2012b). More than 60 percent of U.S. drainage, including outlets from 33 major river systems and 207 estuaries, flows into the GOM (USEPA, 2014c) and has a large influence on water quality. The largest contributing inputs from the U.S coast are from the Mississippi and Atchafalaya Rivers in Louisiana. Additional freshwater inputs into the GOM originate in Mexico, the Yucatán Peninsula, and Cuba.

The physical oceanography of the deep Gulf can be approximated as a two-layer system with an upper layer about 800- to 1,000-m (2,625- to 3,281-ft) deep that is dominated by the Loop Current and associated clockwise (anticyclonic) eddies (Welsh et al., 2009; Inoue et al., 2008); and the lower layer below ~1,000 m (3,281 ft) that has near uniform currents (Welsh et al., 2009; Inoue et al., 2008). Deep waters east of the Mississippi River are affected by the Loop Current and associated warm-core anticyclonic eddies, which consist of clear, low-nutrient water (Muller-Karger et al., 2001). Cold-core cyclonic eddies also form at the edge of the Loop Current and are associated with upwelling and nutrient-rich, high-productivity waters. More details on the physical oceanography of the Gulf of Mexico are available in **Chapter 3.3.2.9.1**.

The primary factors influencing coastal and offshore environments are temperature, salinity, dissolved oxygen, chlorophyll content, nutrients, potential of hydrogen (pH), oxidation reduction potential (Eh), pathogens, transparency (i.e., water clarity, turbidity, or suspended matter), and contaminant concentrations (e.g., heavy metals, hydrocarbons, and other organic compounds).

Surface water temperatures in the Gulf of Mexico vary seasonally from about 29 ºC (84 ºF) in the summer to about 19 ºC (65 ºF) in the winter (Gore, 1992). In the summer, warm water may be found from the surface down to a thermocline at depths to about 160 ft (50 m). Minimum water temperatures below the 5,000-ft (1,524-m) water depth approach 4º C (39 ºF) (Forrest et al., 2007).

The salinity at the sea surface in the offshore Gulf of Mexico is generally 36 parts per thousand (ppt) (Gore, 1992). Lower salinities are characteristic nearshore where fresh water from the rivers mixes with shallow Gulf waters. For example, salinity in open water near the coast may vary between 29 and 32 ppt during fall and winter, but it may decline to 20 ppt during spring and summer due to increased runoff (USDOI, MMS, 2000b).

There is a surface turbidity layer associated with the freshwater plumes from the Mississippi and Atchafalaya Rivers due to suspended sediment in river discharge, especially during seasonal periods of heavy precipitation. High turbidity may extend up to 50 mi (80 km) offshore the Mississippi River and lesser distances to the east and west along the coast. Outside of these areas, water clarity in the Gulf of Mexico improves, with low levels of suspended sediment.

During summer months, shelf stratification results in a large hypoxic zone on the Louisiana-Texas shelf in bottom waters (Turner et al., 2005). Hypoxia, the condition of having low dissolved oxygen concentration in the water (below 2 mg/L), is caused by excessive nutrients and other oxygen-demanding contaminants (refer to **Chapter 3.3.2.12**). Hypoxia often forms when the water column becomes vertically stratified and mixing between oxygenated surface waters and bottom waters cannot occur. Hypoxia is a widespread phenomenon on the continental shelf of the northern GOM and is the largest hypoxic zone in the western Atlantic Ocean (Rabalais and Turner, 2001). The hypoxic zone in the GOM occurs seasonally and is influenced by the timing of the Mississippi and Atchafalaya River discharge. Formation of the zone is attributed to nutrient influxes and shelf stratification, and the zone persists until wind-driven circulation mixes the water column. Recent estimates of the area of low oxygen by NOAA (USDOC, NOAA, 2015h) as of August 3, 2015, measured 6,474 mi^2 (16,760 km^2) (**Figure 3-15**), an increase from the size measured in 2014 (5,052 mi^2; 13,085 km^2) and larger than the estimated size (5,838 mi^2; 15,120 km^2) forecast by LUMCON (2015) in June 2015. The size of the hypoxic zone has been shown to be directly correlated with the flux of nitrogen from the Mississippi River (Turner et al., 2012).

Anthropogenic factors that affect coastal water quality include urban runoff and eroded soil carrying oil and trace metals, agricultural runoff carrying fertilizer (e.g., nutrients including nitrogen and phosphorus), pesticides, fungicides, and herbicides; upstream withdrawals of water for agricultural, industrial, and domestic purposes; contamination by industrial and sewage discharges, dumping, atmospheric fallout, and spills of oil, chemicals, and hazardous materials (refer to **Chapter 3.3.2.3**). Mixing or circulation of coastal water can either improve water quality through flushing or be the source of factors contributing to its decline.

Oil/grease and other contaminants associated with the suspended load may ultimately reside in the sediments rather than in the water column. For example, a contaminant may react with the mineral particles in the sediment and be removed from the water column (e.g., sorption). Thus, under appropriate conditions, sediments can serve as sinks for contaminants such as metals, nutrients, or organic compounds. However, if sediments are (re)suspended (e.g., due to dredging, a storm event, or in conjunction with seasonal mixing and circulation patterns), the resuspension can lead to a temporary redox flux, including a localized and temporal release of any formerly sorbed metals or nutrients (Caetano et al., 2003; Fanning et al., 1982).

Offshore waters, especially deeper waters, are more directly affected by natural seeps (refer to **Chapter 3.3.2.9.2**). Hydrocarbons enter the Gulf of Mexico through natural seeps at a rate of approximately 980,392 bbl per year (a range of approximately 560,224-1,400,560 bbl per year) (NRC, 2003). Pelagic tar is a common form of hydrocarbon contamination present in the offshore environment of the GOM (U.S. Dept. of Homeland Security, CG, 2015b). Higher tar concentrations were closely correlated with proximity to the Loop Current. Van Vleet et al. (1983) estimated that that approximately 7,000 tons (7,112,323 kg) of pelagic tar are discharged annually from the GOM into the North Atlantic Ocean and that roughly half of the oil may be brought into the Gulf from the Caribbean Sea via the Loop Current, while the remainder appears to originate in the GOM.

The USEPA's *National Coastal Condition Report IV* categorizes coastal waters of the United States based on an evaluation of five indices including water and sediment quality. The water quality index for the GOM's coastal waters was rated fair, and the sediment quality index was rated poor (USEPA, 2012b). Sediment quality poses an impact risk to coastal water quality as contaminants in sediments may be resuspended into the water by anthropogenic activities, storms, or other natural events. Sediments in the GOM coastal region have been found to contain pesticides, metals, polychlorinated biphenyls (PCBs), and occasionally polycyclic aromatic hydrocarbons (PAHs) (USEPA, 2012b). These contaminants are not likely OCS industry-related but are more likely from onshore industries and upland practices.

4.2.2 Environmental Consequences

Routine Activities

Impact-producing factors from routine activities identified in **Chapter 3.1** include geological sampling, bottom area disturbance, operational discharges and wastes, pipeline installation, and decommissioning and removal operations. Geological sampling is performed for geological and geotechnical evaluation, using grab samples, box cores, and gravity, rotary, and piston core methods. Each of these sample techniques disturbs a small area of the seafloor (typically less than 1 ac [0.4 ha]), creating turbidity. Bottom area disturbances create turbidity and occur during emplacement and removal of jack-up drill rigs, anchored semisubmersible drill rigs and drillships, platforms, pipelines, and subsea production systems. The emplacement or removal of these structures disturbs areas of the seafloor beneath or adjacent to the structure. Anchored catenary systems may disturb an area of seafloor up to about 5-7 ac (2-3 ha). Trenching for emplacement of pipelines disturbs an area of seafloor up to 2.5 ac (1.0 ha) per kilometer of pipeline (Cranswick, 2001). These bottom-disturbing activities impact water quality when sediments are resuspended, creating turbidity and resulting in a temporary redox flux, including a localized and temporal release of components such as metals or nutrients that were associated with the sediment, as described in **Chapter 4.2.1**. Because these areas of disturbance are localized and short term, impacts from turbidity due to bottom-disturbing activities are considered **negligible**.

Operational wastes and discharges are discussed in detail in **Chapter 3.1.5.1**. These wastes include drilling fluids (also known as muds) and cuttings, which are discussed in detail in **Chapter 3.1.5.1.1**. Water-based muds and cuttings are discharged at the seafloor during drilling of the shallow portion of the well, prior to installation of surface riser. The resulting splay (pattern of mud distribution) on the seafloor may be up to 2,000 ft (610 m) in radius (British Petroleum, 2015), indicating that turbidity resulting from riserless drilling settles out relatively quickly. After the riser is installed, drilling muds and cuttings are generally discharged from the drilling unit at or near the water surface. The heavier mud and cuttings fall close to the drilling unit; however, the resulting turbidity plume may extend more than a mile from the drilling unit, depending on currents. Similar to bottom-disturbing activities, turbidity generated from drilling muds and cuttings is temporary and would settle out quickly. Unlike bottom-disturbing activities, turbidity from drilling muds and cuttings is less likely to result in a redox flux.

The discharge of water-based drilling muds and cuttings is allowed under the USEPA Region 4 and Region 6 NPDES general permits (except in biologically sensitive areas). Under the guidance of the NPDES permit, drilling muds can be discharged into the ocean only if they meet USEPA requirements, which include testing for toxicity prior to discharge. If they fail the toxicity tests, the materials cannot be discharged to the ocean. Therefore, the impact from drilling muds and cuttings is considered **negligible**.

Other than turbidity, the potential toxic effects of drilling muds are discussed in **Chapter 3.1.5.1.1**. Drilling muds may contain synthetic-based fluid (SBF), which is nonpetroleum manufactured hydrocarbons incorporated into the barite mud matrix. The SBF is well-characterized, has low toxicity and bioaccumulation potentials, and is biodegradable. Also, SBF is not soluble in water and is therefore not expected to adversely affect water quality. A previous study of an SBF spill (USDOI, MMS, 2004a) concluded that the released SBF dispersed into the water, settled to the seafloor, and biodegraded. The SBF would cause a temporary decrease in dissolved oxygen at the sediment/water interface. The discharge of SBF-wetted cuttings is allowed under the USEPA Region 4 and Region 6 NPDES general permits. Discharge of muds containing SBF is prohibited. However, synthetic-based mud (SBM)-wetted cuttings may be discharged after the majority of the SBM has been removed (up to 9.4% of SBM may be retained on cuttings for ocean discharge). Under the guidance of the NPDES permit, drilling muds can be discharged into the ocean only if they meet USEPA requirements, which include testing for toxicity prior to discharge. If they fail the toxicity test, the materials cannot be discharged into the ocean. The discharge of drilling muds that meet the required regulatory criteria but include very low quantities of SBMs appear to have minimal and brief impacts to the ocean environment. As such, the impact from discharging SBF-wetted drill cuttings is considered **negligible**.

Produced water is discussed in **Chapters 3.1.5.1.2**. This waste stream may include well treatment chemicals, dissolved solids from the geological formation, inorganic and organic chemicals, and radionuclides. The discharge of produced water is allowed under the USEPA Region 4 and Region 6 NPDES general permits with requirements for the treatment method and prior analytical and toxicity testing. When discharge into the ocean is permitted, the discharge cannot exceed set discharge rates. As with drilling muds, following treatment, produced water must be tested for toxicity according to USEPA requirements. If it fails the toxicity test, it cannot be discharged into the ocean. Therefore, the potential impact from discharge of produced water is considered negligible. Furthermore, the produced-water discharge loadings estimated for the entire hypoxic zone are several orders of magnitude smaller than those entering the Gulf of Mexico from rivers. The total nitrogen loading is about 0.16 percent and the total phosphorus loading is about 0.013 percent of the nutrient loading coming from the Mississippi and Atchafalaya Rivers (Argonne National Laboratory et al., 2005). As such, the incremental effect of produced water contributing to the effects of the hypoxic zone is considered **negligible**.

Other operational waste streams identified in **Chapter 3.1.5** include well treatment, workover, and completion fluids; bilge, ballast, and fire water; cooling water; deck drainage; and treated domestic and sanitary wastes. These waste streams are also discharged in accordance with the USEPA Region 4 and Region 6 NPDES general permits with requirements for the treatment method and prior analytical testing. Wastes that do not meet regulatory requirements for offshore discharge into the ocean must be properly disposed of or recycled onshore according to State and Federal regulations. Assuming compliance with these requirements and since the discharge of these waste streams is regulated under the general NPDES permit, the impact of the discharge on water quality is considered **negligible**.

Discharges from supply/service vessels that support oil and gas operations are discussed in **Chapter 3.1.5.2**. These discharges typically include ballast water, trash and debris, and sanitary and domestic wastes, and they are regulated under the NPDES Vessel General Permit (VGP), Small Vessel General Permit (sVGP), and MARPOL 73/78. All discharges of ballast water must comply with applicable U.S. Coast Guard regulations (33 CFR part 151). The NPDES permit defines mandatory ballast water practices required of all vessels. All discharges of oil, including oily mixtures, must not contain oil in quantities that may violate applicable water quality standards pursuant to 40 CFR part 110. Assuming compliance with these regulations, the impact of these discharges is considered **negligible**.

Discharges related to the onshore disposal of OCS oil- and gas-related wastes (**Chapter 3.1.5.3**) are limited to potential point-source runoff from the disposal facilities, which is regulated by the facility NPDES permit. Facility NPDES permits set discharge limits for each characterized waste stream to protect water quality standards of the receiving waters and require routine discharge monitoring to ensure compliance. As such, the impact of regulated point-source runoff on water quality is considered **negligible**.

Potential impacts to water quality related to decommissioning and removal operations are discussed in **Chapter 3.1.6**. Decommissioning activities may use both explosive and nonexplosive technologies to remove structures to a depth of at least 15 ft (5 m) below the mudline. Prior to decommissioning, all tanks formerly containing oil or hazardous materials are removed, such that the decommissioning may only result in turbidity from the associated bottom-disturbing activity and temporary redox flux that could cause a release of formerly-sorbed components. As stated in **Chapter 3.1.6**, it is anticipated that the majority of decommissioning activities would take place landward of the 800-m (2,625-ft) isobath, where naturally occurring turbidity and impacted sediments are more likely to exist. Because these areas of decommissioning are localized and short term, impacts from turbidity due to the associated bottom-disturbing activities are considered **negligible**.

In summary, as OCS oil- and gas-related routine events are highly regulated, such that effects on water quality are short term, localized, and reversible, and therefore, they would be expected to have a **negligible** impact.

Accidental Events

Impact-producing factors related to OCS oil- and gas-related accidental events are discussed in **Chapter 3.2**. These events primarily involve drilling fluid spills, chemical and waste spills, and oil spills.

Water-based fluid (WBF) and SBF spills may result in elevated turbidity, which would be short term, localized, and reversible. The WBF is normally discharged to the seafloor during riserless drilling, which is allowable due to its low toxicity. For the same reasons, a spill of WBF would have **negligible** impacts. The SBF has low toxicity, and the discharge of SBF is allowed to the extent that it adheres onto drill cuttings. A spill of SBF may cause a temporary increase in biological oxygen demand and locally result in lowered dissolved oxygen in the water column. Also, a spill of SBF may release an oil sheen if formation oil is present in the fluid. Therefore, impacts from a release of SBF are considered to be **minor**. Spills of SBF typically do not require mitigation because SBF sinks in water and naturally biodegrades, seafloor cleanup is technically difficult, and SBF has low toxicity.

Accidental chemical spills could result in temporary localized impacts on water quality, primarily due to changing pH. Chemicals spills are generally small volume compared with spills of oil and drilling fluids. As stated in **Chapter 3.2.6**, during the period of 2007 to 2014, small chemical spills occurred at an average annual volume of 28 bbl, while large chemical spills occurred at an average annual volume of 758 bbl. These chemical spills normally dissolve in water and dissipate quickly through dilution with no observable effects. Also, many of these chemicals are approved to be commingled in produced water for discharge to the ocean, which is a permitted activity. Therefore, impacts from chemical spills are considered to be **minor** and do not typically require mitigation because of technical feasibility and low toxicity after dilution.

Oil spills have the greatest potential of all OCS oil- and gas-related activities to affect water quality. Small spills (<1,000 bbl) are not expected to substantially impact water quality in coastal or offshore waters because the oil dissipates quickly through dispersion and weathering while still at sea. Reasonably foreseeable larger spills (≥1,000 bbl), however, could impact water quality in coastal and offshore waters. Oil spills, regardless of size, may allow hydrocarbons to partition into the water column in a dissolved, emulsion, and/or particulate phase. Therefore, impacts from reasonably foreseeable oil spills are considered **moderate**. Mitigation efforts for oil spills may include booming, burning, and the use of dispersants (**Chapter 3.2.7.2**). These methods may cause secondary impacts to water quality, such as the introduction of additional hydrocarbon into the dissolved phase through the use of dispersants and the sinking of hydrocarbon residuals from burning. As such, impacts to water quality after mitigation efforts are considered to be **minor**.

Cumulative Impacts

OCS Oil- and Gas-Related Impacts

Routine OCS oil- and gas-related impacts are considered to be a small contribution to cumulative impacts because they are considered to be **negligible** (refer to **Chapter 3.3.1**). Accidental OCS Program spills of drilling fluids, chemicals, and oil are considered to have **moderate** impacts prior to mitigation (with **minor** impacts where certain mitigations are implemented). However, other contaminant sources unrelated to the OCS Oil and Gas Program contribute significant impacts to water quality in the GOM, as discussed below.

Non-OCS Oil- and Gas-Related Impacts

Impact-producing factors related to non-OCS oil- and gas-related anthropogenic events and natural processes discussed below are described in **Chapter 3.3.2**. These cumulative effects are important for comparison with OCS oil- and gas-related effects relative to their potential impacts on water quality.

Non-OCS oil-and gas-related anthropogenic impacts that are regulated include non-OCS oil- and gas-related activities in State waters, marine vessel activity, LNG ports and terminals, land-based point-source discharges, aquaculture, OCS sand borrowing, maintenance dredging and dredged material disposal. Discharges as a result of these activities require NDPES permits. Discharges in compliance with regulations, including the NPDES permit and other provisions of the Clean Water Act, are considered negligible because the regulations are risk-based to assure little to no effect on marine life, and monitoring is required to demonstrate compliance. Therefore, the impacts on water quality from these activities are considered **negligible**.

Unregulated anthropogenic activities often have associated impacts on water quality of greater magnitude than regulated activities. Non-OCS oil- and gas-related oil spills present the same impacts as described above. Land-based nonpoint-source discharges from uncontained runoff and groundwater discharge are a source of suspended solids, organic matter, nutrients, and other pollutants in river outflow. Nutrients in river outflow cause eutrophication and hypoxia, which can cause unreasonable degradation of the marine environment. Therefore, impacts to water quality from hypoxia are considered major. Pollutants in nonpoint-source discharges are incorporated into bottom sediments within the coastal zone and have the potential to cause impacts to water quality. Therefore, impacts to sediments from nonpoint-source discharges are considered moderate. Because marine trash and debris in the water column has the potential to cause health effects in marine life due to entanglement or ingestion, the impacts to water quality are considered **moderate**.

Discharges associated with military activities (**Chapter 3.3.2.3.2**) were evaluated for their potential impacts to water quality. The floating portion of debris that may be released into the GOM as a result of military activities presents the same risks to water quality as marine trash and debris, and the associated impacts are considered moderate. The sinking portion of military debris is largely inert, and the associated impacts to water and sediment quality are considered **minor**. In-flight jettisoning of fuel is short term and likely volatilizes into the atmosphere quickly after release. Therefore, the associated impact of released fuel to water quality is considered **minor**.

Potentially polluting shipwrecks (e.g., bulk cargo and fuel leakage from the wreck), chemical weapon disposal areas, and industrial waste disposal areas, which may cause potential impacts to water quality, are discussed in **Chapter 3.3.2.4**. The potential impacts to water quality from shipwrecks are dependent on the type of fuel and cargo present on the wreck and the flow rate of contaminants into the water column. Light oils released from wrecks are localized and generally degrade in the short term, and may present only minor impacts to water quality. Chemical weapons were known to contain extremely toxic substances that, if leaked into the water column, could impact water quality over the long term. Some of the known disposal areas are in shallow waters, and there have been occurrences where trawlers have inadvertently raised 55-gallon drums suspected of containing chemical weapons. Since potential exposures of humans to these substances may occur via the water column, the impacts to water quality are considered moderate. Wastes disposed of in historical industrial waste dumpsites areas were known to contain toxic substances that, if leaked, could impact water quality over the long term. As such, the impacts to water quality are considered **moderate**.

Natural events also contribute to cumulative impacts on water quality resulting from oil seeps and turbidity caused by suspended sediment load from rivers and erosion from currents, storms, and downslope sediment transport. Hurricanes may increase the potential for spills and cause short-term turbidity. Oil seeps (**Chapter 3.3.2.9.2**) present the same potential impacts as an accidental oil spill, except that the seeps may persist over the long term. As such, the impacts to water quality are considered moderate. Natural turbidity persists in coastal waters due to river outflow and may be intermittent in response to currents, storms, and downslope sediment transport. The effects from the elevated turbidity on water quality would be short term, localized, and reversible, and are considered **minor**.

The impacts of routine operational discharges from the OCS oil and gas program on water quality are short term and localized, and are considered negligible. The potential impacts from reasonably foreseeable oil spills as a result of the proposed action on water quality after mitigation are also short term and are considered minor. The impacts from a proposed lease are a small addition to the cumulative impacts on water quality when compared with inputs from hypoxia, potentially leaking shipwrecks, chemical weapon and industrial waste dumpsites, natural oil seeps, and natural turbidity. The incremental contribution of the routine activities and accidental discharges associated with a proposed lease sale to the cumulative impacts on water quality would be **negligible**.

Incomplete or Unavailable Information

In preparation for this Multisale EIS, BOEM has reviewed the latest information available relative to potential impacts on water quality, which is presented in **Chapter 3.1**. BOEM has identified incomplete or unavailable information that may be relevant to reasonably foreseeable impacts on water quality. Much of this information relates to the *Deepwater Horizon* explosion, oil spill, and response and is continuing to be collected and developed through the NRDA process. These research projects may be years from completion. It is not foreseen that all related information would be publicly available to include in this NEPA analysis regardless of the costs or resources needed. BOEM has used the best available scientific information to date and believes that any additional information would not likely change the ranking of impacts and is not essential to a reasoned choice among alternatives.

4.2.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Under Alternative A, BOEM estimates that a total of 53-984 exploration and delineation wells and 61-767 development and production wells would be drilled and that 221-1,332 mi (355-2,144 km) of pipeline would be installed over a 50-year period. The projected number of wells and miles of pipeline are used as an indicator of total activity, which correlates to the volume of routine operational waste discharged, amount of bottom disturbance and drill cuttings causing turbidity, and the potential for drilling fluid and chemical and oil spills. Some localized and short-term moderate impacts could occur for site-specific actions; however, these activities would be reviewed on a case-by-case basis and applicable commonly applied mitigating measures (refer to **Appendix B**) would be identified during postlease reviews of plans and permits. Based on the previously discussed impact-producing factors for routine activities and accidental events, their estimated level of activity, commonly applied mitigating measures, and occurring across the entire proposed lease sale area, Alternative A is expected to have **minor** impacts overall.

4.2.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Under Alternative B. BOEM estimates that a total of 33-893 exploration and delineation wells and 46-671 development and production wells would be drilled and that 158-1,-020 mi (254-1,641 km) of pipeline would be installed over a 50-year period. The projected number of wells and miles of pipeline are used as an indicator of total activity, which correlates to the volume of routine operational waste discharged, amount of bottom disturbance and drill cuttings causing turbidity, and the potential for drilling fluid and chemical and oil spills. Based on the previously discussed impact-producing factors for routine activities and accidental events, their estimated level of activity, commonly applied mitigating measures, and occurring mostly in the CPA/EPA portion of the proposed lease sale area, Alternative B is expected to result in **minor** impacts to water quality. As under Alternative A, some localized and short-term moderate impacts could occur for site-specific actions; however, these activities would be reviewed on a case-by-case basis and applicable commonly applied mitigating measures (refer to **Appendix B**) would be identified during postlease reviews of plans and permits. The environmental consequences of a proposed lease sale under

Alternative B and the inherent resulting activities to water quality would be slightly smaller than under Alternative A and would be more restricted to the CPA/EPA portion of the proposed lease sale area.

4.2.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Under Alternative C, BOEM estimates that a total of 17-91 exploration and delineation wells and 22-96 development and production wells would be drilled and that 65-314 mi (105-505 km) of pipeline would be installed over a 50-year period. The projected number of wells and miles of pipeline are used as an indicator of total activity, which correlates to the volume of routine operational waste discharged, amount of bottom disturbance and drill cuttings causing turbidity, and the potential for drilling fluid and chemical and oil spills. While all of the leases issued under this alternative would occur in the WPA portion of the proposed lease sale area, activities such as vessel support and pipeline or coastal infrastructure could occur in the CPA portion of the proposed lease sale area. As under Alternatives A and B, postlease activities would be reviewed on a case-by-case basis and applicable commonly applied mitigating measures (refer to **Appendix B**) would be identified during site–specific or postlease reviews of plans and permits. Based on the estimated level of activity and much smaller geographic area, Alternative C is expected to result in **minor** impacts, though fewer impacts than Alternative A or B.

4.2.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

The number of available unleased blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations is small compared with the number of unleased blocks being offered under Alternatives A, B, or C. Therefore, the activity level (and water quality impacts) that can be expected for Alternative D is similar to Alternative A, B, or C, as applicable, which would be **minor** under all action alternatives.

4.2.2.5 Alternative E—No Action

Under Alternative E, there would be no new activities related to a proposed action (no wells drilled and no pipelines installed). Therefore, there would be no associated impacts to water quality resulting from a proposed lease sale and, therefore, those additional impacts would be avoided. However, cumulative impacts related to past, present, and reasonably foreseeable future activities would continue.

4.3 Coastal Habitats

4.3.1 Estuarine Systems (Wetlands and Seagrass/Submerged Vegetation)

The estuarine system is the transition zone between freshwater and marine environments. It can consist of many habitats, including wetlands and submerged vegetation. While some seagrass species can be found farther offshore, the majority is within the coastal area of the GOM and will be covered in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from routine OCS oil- and gas-related activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts (**Table 4-4**).

Table 4-4. Estuarine Systems Impact-Producing Factors.

Impact-Producing Factors	Magnitude of Potential Impact				
	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Pipeline Construction and Maintenance	Negligible	Negligible	Negligible	Negligible	None
Navigation Channel Maintenance Dredging	Negligible	Negligible	Negligible	Negligible	None
Vessel Operation (support use of navigation channels)	Negligible	Negligible	Negligible	Negligible	None
Disposal of OCS Oil- and Gas-Related Wastes	Negligible	Negligible	Negligible	Negligible	None
Construction and Use of Coastal Support Infrastructure	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Oil Spills	Minor	Minor	Minor	Minor	None
Cumulative Impacts					
OCS Oil and Gas	Moderate	Moderate	Moderate	Moderate	Moderate
Non-OCS Oil and Gas	Major	Major	Major	Major	Major

In this chapter, BOEM reviewed and analyzed routine OCS oil- and gas-related activities and reasonably foreseeable accidental events. Routine activities associated with a proposed lease sale that takes place on the OCS, where wells are drilled and platforms and pipelines are installed, would not impact the wetlands or submerged vegetation that is located miles away. Other routine activities that support offshore oil and gas exploration, such as increased vessel traffic (**Chapter 3.1.4.4**), maintenance dredging of navigation canals (**Chapter 3.1.4.6**), pipeline installation (**Chapter 3.1.3.3**), disposal of OCS oil- and gas-related wastes (**Chapter 3.1.5**), and construction and maintenance of support infrastructure in the coastal areas (**Chapter 3.1.7**), could potentially impact wetlands. Of these impact-producing factors, vessel traffic was not analyzed with respect to seagrass and submerged vegetation because OCS vessels (due to their size and use of commercial ports) are generally not in areas shallow enough to have large submerged vegetation beds. An analysis of the potential impacts from accidental events, primarily oil spills, associated with a proposed lease sale is presented in this chapter, as is the incremental contribution of a proposed action to the cumulative impacts to wetlands and submerged vegetation. Cumulative impacts were analyzed for OCS oil-and gas-related activities and for other sources that could affect wetlands and submerged vegetation communities (i.e., human impacts, storms, and vessel traffic). Additional factors that could affect estuarine systems include subsidence and sea-level rise.

Impact-Level Definitions

For this analysis, the following definitions were used to categorize impacts to wetlands and submerged vegetation:

- **Negligible** – Little to no measurable impacts in the surrounding habitat (i.e., wetland segment and seagrass bed).
- **Minor** – Noticeable but short-term and localized impacts.
- **Moderate** – Damage to coastal habitats that is detectable, spatially extensive, but temporary and not severe.
- **Major** – Detectable changes in species composition and abundance and/or altered ecological function well beyond that of normal variability. Changes would likely be both long-lasting and spatially extensive for such an effect.

4.3.1.1 Description of the Affected Environment

Wetlands

A recent evaluation of wetland trends in the U.S. covering the period from 2004 to 2009 indicated that in 2009 there were 15.4 million ac (6.2 million ha) of coastal wetlands (including saltwater and freshwater wetlands) in the GOM region, a downward trend of 257,150 ac (104,065 ha) (Dahl and Stedman, 2013). In 2009, there were approximately 3.35 million ac (1.35 million ha) of intertidal wetlands in the GOM coastal region, which was a decline of approximately 2.8 percent since 2004 and represents 99 percent of all intertidal wetland losses across the three coastal regions of the conterminous U.S. These losses have been attributed to the effects of severe coastal storms, land subsidence, sea-level rise, and the construction of levees along the Mississippi River. In coastal Louisiana and Texas, oil, gas, and groundwater extractions have contributed to subsidence and relative sea-level rise (Dahl, 2011). A small percentage is attributed to discrete anthropogenic actions (Dahl and Stedman, 2013).

An estimated 3.9 million ac (1.6 ha) of wetlands existed on the Texas coast in 1992. Approximately 210,600 ac (85,227 ha) had been lost since 1955. Approximately 1.7 million ac (687,966 ha) or 52 percent of the freshwater wetlands were classified as farmed wetlands. The greatest losses were of freshwater emergent and forested wetlands (Moulton et al., 1997). The major cause was faulting and land subsidence due to the withdrawal of underground water and oil and gas (onshore), which has resulted in the submergence of marshes (Moulton et al., 1997).

Coastal Louisiana, which contains about 37 percent of the estuarine herbaceous marshes in the conterminous U.S. and which supports the largest commercial fishery in the lower 48 States

(**Chapter 4.10**), currently accounts for about 90 percent of the total coastal wetland loss in the continental U.S. (Couvillion et al., 2011). Coastal Louisiana has undergone a net change in land area of about -1,883 mi^2 (-4,877 km^2) from 1932 to 2010. Ninety-five percent of this loss is due to continual loss of land through subsidence, saltwater intrusion, and other factors. The wetland loss rate for Louisiana has slowed from 42 mi^2/yr (27,000 ac/yr) during the late 1960's to a rate of 16.57 mi^2 (43 km^2) per year from 1985 to 2010 (Couvillion et al., 2011).

In 1999, Mississippi had approximately 64,000 ac (25,900 ha) of vegetated coastal wetlands (Mississippi Department of Marine Resources, 1999). Estuarine wetlands are common in Mississippi and include marshes, mud flats, and forested wetlands. The estuarine marshes around Mississippi Sound and associated bays occur in discontinuous bands. The most extensive coastal wetland areas in Mississippi occur in the eastern Pearl River delta near the Louisiana/Mississippi border and in the Pascagoula River delta area near the Mississippi/Alabama border. Mississippi's wetlands seem to be more stable than those in Louisiana and Alabama (Mississippi Department of Marine Resources, 1999; Wallace, 1996; Couvillion et al., 2011). Urban and suburban growth are suggested as the greatest contributors to direct coastal wetland loss in Mississippi and Alabama.

Alabama has approximately 118,000 ac (47,753 ha) of coastal wetlands. Between 1955 and 1979, 69 percent of the freshwater marsh and 29 percent of the estuarine marsh were lost (Wallace, 1996). Most coastal wetlands in Alabama occur on the Mobile River Delta or along the northern Mississippi Sound. Both Mississippi and Alabama have estuarine intertidal emergent habitats that include salt marsh, as well as intertidal forested/shrub that can include mangroves and other salt-tolerant shrubs. Urban and suburban growths are suggested as the greatest contributors to direct coastal wetland loss in Mississippi and Alabama.

Florida wetlands, at one time estimated to encompass over 20 million ac (8.1 million ha), have been converted through draining, dredging, filling, and flooding, until by 1996, approximately 11.4 million ac (4.6 million ha) remained (Dahl, 2005). Wetland loss rates in Florida, as high as 72,000 ac (29,137 ha) per year from the mid-1950's to the mid-1970's, declined by nearly 80 percent to 5,000 ac (2,023 ha) per year between 1985 and 1996. This decline was due largely to increased regulation and elimination of incentives for wetland drainage. Public education, protection programs, and policies that promoted wetland restoration and creation also contributed (Dahl, 2005).

Florida's salt marshes are most abundant on its central and northern coastlines (Mitsch and Gosselink, 2000). They are dominant along the Big Bend area of the Gulf Coast in low-energy shorelines, sands, lagoons, and bays. Florida's coastal zone contained approximately 21 percent of the estuarine and marine wetlands of the conterminous U.S. and 92 percent of estuarine shrub wetlands in 1996.

Coastal wetlands and barrier islands are complex systems that provide many important functions. One of these functions is as a front line of defense against storm surge. High organic productivity and efficient nutrient recycling are characteristic of coastal wetlands. These wetland corridors 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.

The intensity and frequency of hurricanes in the GOM in recent years has greatly impacted the system of protective barrier islands, beaches, and dunes and associated wetlands along the Gulf Coast. Gulf shorelines have lost existing beach dunes and have experienced a decrease in beach ridge elevations, and barrier islands and wetlands have lost acreage to wave erosion due to hurricanes. As a result of decreased dune and barrier island elevations, as well as associated marshes and backshore and foreshore wetlands, the inland coasts and wetlands are more vulnerable to future hurricanes and wind-driven tidal or storm events.

The *Deepwater Horizon* oil spill was the largest spill ever recorded in the GOM and resulted in the oiling of an extensive portion of the northern Gulf Coast shoreline from the Texas/Louisiana State line to northwest Florida (Florida Panhandle) (OSAT-2, 2011). Oil from the *Deepwater Horizon* explosion and oil spill was documented to have stranded on approximately 495 mi (796 km) of marsh shoreline. In most areas, the oil stranded along the marsh edge, usually spreading into the marsh no more than about 33-49 ft (10-15 m) perpendicular to the shoreline. Cleanup activities were conducted on 8.9 percent of the affected marsh (Michel et al., 2013). Various cleanup techniques were employed, but as of 2012, recovery was not complete and negative effects were ongoing (Zengel et al., 2015).

Submerged Aquatic Vegetation

Submerged aquatic vegetation can be defined as the collection of benthic plants that settle and grow in the marine and estuarine waters but that do not emerge from it. Distribution and composition of the species present depend on an interrelationship among a number of environmental factors, including water temperature, depth, turbidity, salinity, turbulence, and substrate suitability (Kemp, 1989; Onuf, 1996; Short et al., 2001). In high salinity waters, submerged aquatic vegetation are marine seagrasses that generally occur in relatively shallow and clear protected waters with substrates firm enough to enable colonization (Short et al., 2001). For estuarine waters with low salinity, submerged aquatic vegetation may include several species of vegetation typically considered to be freshwater species but are tolerant of low levels of salinity (Castellanos and Rozas, 2001). In the higher salinity waters of the GOM, there are five true seagrass species and one similar species, although not technically a true seagrass (Zieman, 1982; Short et al., 2001; Berns, 2003; Handley et al., 2007; Cho and May, 2008). Where salinity is lower, there are four genera that routinely comprise the community (Castellanos and Rozas, 2001; Cho and May, 2008). Submerged vegetative habitats are important in carbon sequestration, nutrient cycling, and sediment stabilization (Heck et al., 2003; Duarte et al., 2005; Orth et al., 2006; Frankovich et al., 2011). Submerged vegetation functions as an important habitat for many species by providing protection from predation. It also provides food resources for associated infaunal species, nekton, and other megaherbivores and over wintering waterfowl (Rozas and Odum, 1988; Rooker et al., 1998; Castellanos and Rozas, 2001; Heck et al., 2003; Orth et al., 2006; Maiaro, 2007). One of the more important functions of submerged aquatic vegetation systems is the transfer of primary production from epiphytic algae into the ecosystem via grazing of those epiphytes by secondary consumers; however, without grazers, excessive epiphyte growth can become a hindrance to growth (Howard and Short, 1986; Bologna and Heck, 1999; Heck et al., 2006).

According to the most recent and comprehensive data available, approximately 1.25 million ac (500,000 ha) of seagrass beds are estimated to exist in exposed, shallow coastal/nearshore waters and embayments of the GOM; over 80 percent of these beds are in Florida Bay and Florida coastal waters (calculated from Handley et al., 2007). In the northern GOM from south Texas to Mobile Bay, seagrasses occur in relatively small beds behind barrier islands in bays, lagoons, and coastal waters (**Figure 4-11**), while freshwater submerged aquatic vegetation occurs in the upper regions of estuaries and rivers (Onuf, 1996; Castellanos and Rozas, 2001; Handley et al., 2007). Increased nutrients and sediments from natural (e.g., tropical cyclones) or anthropogenic events (e.g. nutrient loading, sedimentation, and declining water quality) are common and are a significant cause of seagrass declines worldwide (Orth et al., 2006; Carlson and Madley, 2007; Waycott et al., 2009). The USGS's *Seagrass Status and Trends in the Northern Gulf of Mexico: 1940-2002* demonstrated a decrease of seagrass coverage across the northern Gulf of Mexico from the bays of Texas to the Gulf shores of Florida; this loss was from approximately 1.02 million ha (2.52 million ac) estimated in 1992 to approximately 500,000 ha (1.25 million ac) calculated in the 2002 report (Handley et al., 2007). While declines have been documented for different species in different areas, it is difficult to estimate rates of decrease because of the fluctuation of biomass among the different species seasonally and yearly.

Figure 4-11. Seagrass Locations of the Northern Gulf of Mexico.

These coastal habitats also play an important role to ESA-listed species; BOEM consults on these species with the FWS and NMFS. These species include nearshore fishes, sea turtles, beach mice, and birds; to read about the protected species that use these habitats, refer to **Chapters 4.7** (Fish and Invertebrate Resources), **4.9.2** (Sea Turtles), **4.9.3** (Beach Mice), and **4.9.4** (Protected Birds).

4.3.1.2 Environmental Consequences

Routine Activities

Impact-producing factors and scenarios for routine operations can be found in **Chapter 3.1**. In this chapter, consideration is given to impacts to coastal wetlands and marshes from routine activities associated with a proposed lease sale. The primary impact-producing factors associated with a proposed lease sale that could affect wetlands and marshes include pipeline emplacement, construction, and maintenance; navigation channel use (vessel traffic) and maintenance dredging; disposal of OCS oil- and gas-related wastes; and use and construction of support infrastructure in these coastal areas.

Pipeline Emplacement

Many existing OCS pipelines make landfall on barrier island and wetland shorelines (**Chapter 3.1.3.3**). Approximately 4,971 mi (8,000 km) of OCS oil- and gas-related pipelines cross marsh and upland habitat in Louisiana (USDOI, MMS, 2007). Wetlands protect pipelines from waves and help to keep the lines buried and in place. At least two studies have shown a connection between land loss and existing pipelines. One study indicated that existing pipelines have caused direct land loss averaging 6 ac (2.43 ha) per linear km of pipeline for the 1955-1978 time period (Bauman and Turner, 1990). Bauman and Turner (1990) also indicated that the widening of OCS pipeline canals does not appear to be an important factor for total net wetland loss in the coastal zone because few pipeline canals are open to navigation. In contrast, Johnston et al. (2009) found that land loss was consistently higher in the vicinity of pipelines compared with more general, regional trends of land loss, suggesting that they contributed to the loss.

Modern pipeline construction typically employs horizontal, directional (trenchless) drilling techniques and open-water routes to the extent possible to avoid damages to estuarine systems (i.e., emergent wetlands and submerged vegetation beds) and beaches. Similar features are now commonly required to minimize any impacts from pipeline landfalls. Currently, no new construction of flotation canals (the most harmful construction technique) is being allowed in vegetated areas (Johnston et al., 2009). There is only 0-1 pipeline landfalls projected to result from a proposed action. About 12-20 ac (5-8 ha) of land loss for the projected 1.2 mi (2 km) of pipeline (based on historic loss rates) are expected from a proposed action. This represents approximately 0.19 percent of the total land loss estimated to occur along the Louisiana coast in 1 year (Couvillion et al., 2011). This estimate does not take into account mitigating measures from the present regulatory programs of Federal or State agencies, modern installation techniques, and the Federal “no net loss” policy. These programs and techniques include compensatory mitigations and less destructive construction methods among others. Because of the regulations and new construction methods, and the limited projection for, at most, one new pipeline landfall, pipeline emplacement would be expected to result in zero to negligible impacts to estuarine habitats.

Five pipeline installation techniques are used throughout the coastal zone of the Gulf of Mexico: upland trenching; jetting; building flotation canals; push-pull ditching; and directional drilling. Of these, flotation canals have the most harmful effects. Push-pull ditching can also be used to effectively minimize wetland impacts when postconstruction mitigation methods such as backfilling are used (Johnston et al., 2009). Trenchless, or directional drilling, is the newest and favored technique in sensitive habitats. This technique is considered to be extremely protective of sensitive habitats. At present, directional drilling is required almost without exception for crossing barrier island and shore faces. Impacts are limited to the access and staging sites for the equipment. By using directional drilling, pipeline installation can occur without having to cut through shore facings, minimizing any erosion and surface habitat disturbance.

Because of the modern installation techniques and mitigations, the small number of projected pipeline landfalls, and the present regulatory programs of the COE and the Gulf Coast States, impacts to wetlands and other estuarine areas from pipeline emplacement associated with a proposed lease sale are expected to be **negligible**.

Dredging

Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts to wetlands. It is assumed that the need for maintenance dredging is proportional to the percentage of the vessel traffic; therefore, a proposed lease sale is expected to only contribute minimally to the need for this dredging, accounting for less than 2 percent, of all traffic using navigation channels in the GOM (**Chapter 3.1.4.6**; **Tables 3-2 and 3-6**). Thus, vessel traffic related to a proposed action is only a small portion of the traffic that would require maintenance dredging of channels. However, occasionally a channel would be dredged ahead of its normal maintenance schedule in order to accommodate the transport of large OCS platforms. Beneficial use of dredged material can be used to enhance and create coastal wetlands after material has been tested for the presence of contaminants. The COE's New Orleans District annually removes approximately 46-53 million m^3 (60-70 million yd^3) of dredged material from 10 Federal navigation channels throughout coastal Louisiana, and approximately 26 percent of this material is used for coastal wetland restoration projects (Creef, official communication, 2011). As a result of the tremendous wetlands land loss in the Louisiana coastal region, the beneficial use of dredged material is expected to increase. Executive Order 11990 (1977) requires that, where appropriate, material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage. Given the COE's policy of beneficial use of dredged material, increased emphasis has been placed on the use of dredged material for marsh creation.

Despite the beneficial uses described above, dredging and dredged-material disposal can also be detrimental to coastal environments and associated fish and wildlife that use the affected areas for nursery grounds and protection. These impacts may include increased erosion rates, removal of sediments, increased turbidity, and changes in salinity (Onuf, 1996; Kenworthy and Fonseca, 1996; Erftemeijer and Lewis, 2006). Many of these impacts are reduced through the use of modern disposal practices.

Because of the mitigations and regulations connected with coastal dredging operations, the impacts outlined above are expected to only occur in localized areas over a short amount of time; therefore, the overall level of impact to coastal communities is minor. Therefore, due to the small contribution of a proposed action to the need for dredging, impacts to coastal habitats from a proposed action are expected to be **negligible**.

Navigation Channels and Vessel Traffic

Most navigation channels projected to be used to support a proposed action are currently used by vessels that support the OCS Program (**Chapter 3.1.4.6**; **Table 3-6**). Approximately 1,988 mi (3,200 km) of OCS oil- and gas-related navigation canals, bayous, and rivers are found in the coastal regions around the GOM. This is exclusive of channels through large bays, sounds, and lagoons. No new navigation channels are expected as a result of a proposed action, although channels within ports may be created or enlarged. Ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand their infrastructure to accommodate 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 the expansion. Port Fourchon currently services approximately 90 percent of all deepwater rigs and platforms in the GOM (Loren C. Scott and Associates, 2008), and approximately half of all offshore service vessel trips from 2012 through 2017 are expected to emanate from there (Kaiser, 2015b).

Vessel traffic that may support a proposed action is discussed in **Chapter 3.1.4.4**. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion processes. Much of the service-vessel traffic that is a necessary component of OCS oil- and gas-related activities uses the channels and canals along the Louisiana coast. The most heavily used OCS navigation channel is the channel from Port Fourchon to the GOM, which is heavily armored and is less erodible. Recent studies have found that armored canals have reduced loss rates compared with unarmored canals (Johnston et al., 2009; Thatcher et al., 2011) and that widening rates have slowed based on maintenance techniques. A recent BOEM and USGS-funded study (Thatcher et al., 2011) examined the susceptibility to erosion of navigation channels based on cover and substrate. They found that canal erosion rates have slowed in recent years. Indirect impacts from wake erosion and saltwater intrusion are expected to result in **minor** impacts, which are indistinguishable from direct impacts from inshore activities.

A proposed action is estimated to contribute <2 percent of the total OCS traffic from 2017 through 2066 (**Tables 3-2 and 3-6**). Further details concerning vessel traffic can be found in **Chapter 3.1.4.4**. Navigation channels projected to be used in support of a proposed action are discussed in **Chapter 3.1.4.6**. According to BOEM's calculations, all estimated navigational use (both OCS and other) is expected to contribute approximately 336 ha/yr (831 ac/yr) of land loss per year. However, given the relatively small percentage of vessel traffic from OCS oil- and gas-related activities, in combination with ongoing armoring and regular maintenance along the waterways, only **negligible** impacts related to the vessel traffic would result from a proposed action.

Disposal of OCS-Related Wastes, Trash, and Debris

Produced sands, oil-based or synthetic-based drilling muds and cuttings, along with fluids from well treatment, workover, and completion activities, would be transported to shore for disposal (**Chapter 3.1.5**). Sufficient disposal capacity is expected to be available in support of a proposed action (**Chapter 3.1.7.2.7**). Produced-water discharges from OCS wells would be too distant from coastal habitats to have anything more than negligible impacts. Because of wetland-protection regulations, no new waste disposal sites are expected to be developed in wetlands. Some seepage or discharges from existing waste sites into adjacent wetland areas may occur and toxic wastes could kill wetland plants, but such seepage is not expected to be widespread.

Trash and debris can be an issue for estuarine communities in that the fauna in these areas could ingest or become entangled in the trash and debris. BOEM and BSEE have addressed the marine debris issue by imposing marine debris awareness and prevention measures on the oil and gas industry through NTL 2015-BSEE-G03, which provides guidance to the industry operators regarding dumping trash and debris into the marine environment and informs operators of regulations set by other regulatory agencies (i.e., the USEPA and USCG). Because of the mitigations and awareness, OCS oil- and gas-related trash and debris from a proposed action would result in **negligible** impacts to estuarine habitat.

Onshore Facilities

Various kinds of onshore facilities service OCS development. All projected new facilities that are attributed to the OCS Program and a proposed action are described in **Chapter 3.1.7**. State and Federal permitting agencies discourage the placement of new facilities and the expansion of existing facilities in wetlands. However, any large construction project in the coastal zone is likely to impact some wetland acreage. Any impacts upon wetlands are mitigated in accordance with the Clean Water Act requirements and the COE's 404 permit and State permitting programs. The high cost of wetland mitigation discourages industry from causing damage to wetlands when building onshore facilities. Since no new facilities are estimated with a proposed action and any possible impacts would be mitigated, the impact level from the associated factors discussed above would be **negligible**.

Accidental Events

A detailed description of the impact-producing factors and scenario for accidental events from a proposed action are given in **Chapter 3.2**. There is also a risk analysis of accidental events in **Chapters 3.2.1**. The main impact-producing factors that would affect wetlands are oil spills. Chemical spills could also potentially affect wetlands, but they are rare (**Table 3-21**).

Both coastal and offshore oil spills can be caused by large tropical storm events, faulty equipment, or human error. The degree of coastal impact is a function of the source oil type, volume, and condition of the oil as it reaches shore, along with the season of the spill and the composition of the wetland plant community affected. Barrier island loss due to hurricanes and anthropogenic factors has reduced protection of wetlands from offshore oil spills, and thus, there is a greater potential for the oiling of coastal wetlands during an accidental event. Refer to the *Catastrophic Spill Event Analysis* white paper for an analysis of impacts from a low-probability catastrophic spill event (USDOI, BOEM, 2016c).

Primary Impacts of Oil Spills

The widespread distribution of OCS oil- and gas-related activity reduces the probability of toxic oil reaching coastal wetlands. The OCS production facilities are located at least 3 nmi (3.5 mi; 5.6 km) from coastal wetlands, and much of the OCS oil- and gas-related activity is much farther. Recent trends towards drilling in deeper water have increased the proportion of OCS oil- and gas-related activity in distant locations, many of which are well over 100 nmi (115 mi; 185 km) offshore. This allows for the toxicity of spilled oil from offshore to be greatly reduced or eliminated by weathering and biodegradation (OSAT-2, 2011).

Coastal Spills

The greatest threat to estuarine habitat with regards to an oil spill is from a coastal spill resulting from a vessel accident or pipeline rupture. These spills are a concern since they would be much closer to the estuarine resources. Resulting contact would likely be greater, and toxicity would tend to be greater due to reduced weathering of the oil. While a resulting slick may cause impacts to estuarine habitat, the cleanup effort (i.e., equipment, chemicals, and personnel) can generate additional impacts to the area. Associated foot and vehicular traffic may work oil farther into the sediment than would otherwise occur. Further, physical prevention methods such as booms, barrier berms, and diversions can alter hydrology, specifically changing salinity and water clarity. These changes could cause mortality or reduced productivity in certain species of submerged vegetation because they are only tolerant to certain salinities and light levels (Zieman et al., 1984; Kenworthy and Fonesca, 1996; Frazer et al., 2006). Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

Numerous investigators have studied the immediate impacts of oil spills on GOM coastal habitats and elsewhere. Often, seemingly contradictory conclusions are generated from these impact assessments. These contradictions can be explained by differences in parameters, including oil concentrations and chemical composition, season or weather, vegetation type and density, whether the area is in a low- or high-energy environment, preexisting stress level on the vegetation, soil types, anoxic condition of the soil, and water levels. Data indicate that vegetation that is lightly oiled would experience plant die-back, followed by recovery without replanting; therefore, most impacts from light oiling to vegetation are considered to be short term and reversible (Lytle, 1975; DeLaune et al., 1979; Webb et al., 1985). However, Alexander and Webb (1987) noted erosion of the shoreline in areas affected with high oil content and Fischel et al. (1989) found that, while some oiled marsh areas showed recovery of vegetation a year after a spill, other areas had converted to mud flats or open water.

Oil has been found or estimated to persist for at least 17-20 years in low-energy environments like salt marshes (Teal et al., 1992; Baker et al., 1993; Burns et al., 1993; Irvine, 2000). If thick oil is deposited on marsh in low-energy environments, effects on marsh vegetation can be severe and recovery can take decades (Baca et al., 1987; Baker et al., 1993). The sediment type, the anoxic condition of the soils, and whether the area is in a low- or high-energy environment all play a part in the persistence of oil in marsh sediment (Teal and Howarth, 1984), so different shorelines exhibit varying levels of oil persistence (Hayes et al., 1980; Irvine, 2000). Oil is more persistent in anoxic sediments and, as a result of this longer residence time, has the potential to do damage to both marsh vegetation and associated benthic species. Batubara et al. (2014) found that PAH degradation is higher in intertidal than in subtidal wetland soils. For submerged vegetation the same is true, and oil can cause decreased water clarity from coating and shading could cause reduced chlorophyll production and could lead to a decrease in vegetation (Erftemeijer and Lewis, 2006).

Cleanup activities in marshes that can last years to decades following a spill may accelerate erosion rates and retard recovery rates. While oil can completely foul wetland plants, it is the amount and type of oil, as well as the particular plant that determines recovery. Pezeshki et al. (2000) found that Louisiana crude oil was less damaging and fatal to *Spartina alterniflora* marsh grass than the heavier crudes. Heavy oiling can stop photosynthetic activity, but the *S. alterniflora* produced additional leaves and was able to recover without shoreline cleanup. Except in areas of heavy oiling, it is better to let wetland areas recover naturally (Zengel et al., 2014).

Numerous studies have demonstrated that different species of plants respond differently to oiling. Lin and Mendelssohn (1996) found that Louisiana crude oil applied to three species of marsh plants resulted in no regrowth after 1 year in applications for *Spartina alterniflora* and *S. patens*, but resulted in increased regrowth with increased oil application for *Sagittaria lancifolia*. Kokaly et al. (2011) found that, where the predominant marsh grass is tall (*Phragmites australis)* and less susceptible to being completely oiled, damage is minimized. Judy et al. (2014) also found high tolerance of *P. australis* to weathered and emulsified oil. Coastal marshes impacted by crude oil were observed to show evidence of recovery within 1 year after oil was stranded and covered vegetation, with shoot production observed in heavily oiled areas, although depending on vegetation type, the amount of recovery varied (Delaune and Wright, 2011). When a spill contacts wetlands, an impact from the resulting depletion of marsh vegetation is increased and accelerated erosion, and resulting land loss (Alexander and Webb, 1987). Another study documented increased erosion at highly oiled sites 26 months after a spill (McClenachan et al., 2013).

Some OCS oil- and gas-related pipelines traverse wetland areas, and pipeline accidents could result in high concentrations of oil directly contacting localized areas of wetland habitats (Fischel et al., 1989). In a study of a coastal pipeline break by Mendelssohn et al. (1993), a 300-bbl spill of Louisiana crude oil impacted 49 ac (20 ha) of wetlands, resulting in considerable short-term effects on the brackish marsh community. While considerable die out of the marsh was noted, recovery of the marsh was complete within 5 years despite the residual hydrocarbons that were found in the marsh sediment. The study also noted that the health of the recolonizing vegetation was not significantly different from the health of vegetation found in the areas that were not oiled. Patterns of land loss were spatially variable, but the rate of loss in the oiled areas was similar to that of the unaffected areas (Mendelssohn et al., 1993).

BOEM's analysis shows that 96 percent of reasonably foreseeable spills from OCS oil-and gas-related activity are <1 bbl, with an average size of <0.05 bbl (Anderson et al., 2012). Because of the small contribution to all such spills from the proposed action, the small size of most spills, and with current safety measures and cleanup guidance in place, the impacts from the impact-producing factors of a coastal spill are expected to be **minor** for estuarine communities.

Offshore Spills

The probabilities of an offshore spill ≥1,000 bbl occurring and contacting environmental features are described in **Chapter 3.2.5.8**. In addition, the results of a risk analysis estimating the likelihood of a spill <1,000 bbl occurring and contacting environmental resources (including wetlands) can be found in **Chapter 3.2.1.6.4**. Most spills from the OCS are likely to be distant enough that, should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small. This is because the distance of the spill to the coast allows oil to evaporate, break down, and disperse. Also, due to the tidal flushing on the coast, a slick would be broken down further. However, should spills from the OCS occur proximate to State waters, they could reach shore before much weathering, evaporation, or dispersal had occurred. The probabilities of oil spills ≥1,000 bbl occurring and contacting coastal shorelines varies by location, with the highest probability as a result of a proposed action estimated at 8 percent for one location; for most locations, it was <0.5-1 percent (**Figure E-20**).

Because of the small contribution to all such spills from the proposed action, the distance from coastal communities, improved technologies, and the dynamic nature of the coastal environment, offshore spills are expected to have a **minor** impact on the estuarine community.

Spills that occur in or near Chandeleur Sound or Mississippi Sound could affect estuarine habitat in the Gulf Islands National Seashore (135,458 ac; 545,818 ha), including its Wilderness Area (4,080 ac; 1,651 ha), and the Breton National Wildlife Refuge (18,273 ac; 7,395 ha) with its Wilderness Area (5,000 ac; 2,023 ha). Although the wetland acreage on these islands is small, the wetlands and associated communities make up an important element in the habitat of the islands. The inlets that connect Mississippi Sound with the marsh-fringed estuaries and lagoons within the islands are narrow; therefore, a small percentage of the oil that contacts the Sound side of the islands would be carried by the tides into interior lagoons.

Secondary Impacts of Oil Spills

The short-term effects of oil on wetland plants range from reduction in transpiration and carbon fixation to plant mortality. Depending on the type and quantity of oil in the sediment, mineralization of nutrients can be blocked so that there is less nutrient uptake from the soils. The potential impact of the oiling on the wetland habitats is dependent on several factors, including season. In general, most wetland plants are more susceptible to impacts from oiling during the growing season. Heavy oil causes mortality by coating gas exchange surfaces on the plants and by sealing sediment, which limits nutrient exchange to below-ground tissue. Light weight oils have been found to be more toxic to various marsh plants and associated organisms because the oil alters membrane permeability and disrupts metabolism (Pezeshki et al., 2000). Due to the difference in oil tolerances of various wetland plants, changes in species composition may be evident as a secondary impact of the spill (Pezeshki et al., 2000). Studies indicated that some dominant freshwater marsh species (*Sagittaria lancifolia*) are tolerant to oil fouling and may recover without being cleaned (Lin and Mendelssohn, 1996). Secondary impacts can also include impacts caused by cleanup activities, as discussed below. Because these secondary impacts would not noticeably affect GOM coastal plant communities as a whole, impacts are expected to be **minor**.

Cleanup Activities

Current methods to clean up oil spills include mechanical removal, *in-situ* burning, and bioremediation (refer to **Chapter 3.2.7** for more information). Generally speaking, unless the oiling is extremely heavy, the best approach has been to avoid measures that would further drive oil into the sediment (e.g., vessel and foot traffic) or damage vegetation. Often that means it is best to do nothing and let nature take its course. Oil spill cleanup in coastal marshes remains a problematic issue because wetlands and submerged vegetation 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 clean up 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, such as trampling vegetation, accelerating erosion, and burying oil (Long and Vandermeulen, 1983: Getter et al., 1984; Mendelssohn et al., 1993). In areas of thick oil deposits, however, a cleanup effort would result in greater recovery (Baker et al., 1993). Because oil spills that require cleanup can have noticeable but localized impacts, cleanup activities are expected to have a **minor** effect on the estuarine community.

Cumulative Impacts

Estuarine habitats are vulnerable to many impact-producing factors from OCS oil- and gas-related and non-OCS oil- and gas-related impacts. Specific OCS oil- and gas-related, impact-producing factors considered in this cumulative analysis include the following: (1) oil spills; (2) OCS oil- and gas-related vessel traffic and navigation canals; (3) construction of OCS oil- and gas-related infrastructure and support structure (including pipelines); and (4) waste disposal. Non-OCS oil and gas-related, impact-producing factors would potentially impact wetland resources, including the following: (1) State oil and gas activities; (2) non-OCS oil- and gas-related vessel traffic and navigation canals; (3) coastal infrastructure and development; (4) natural processes (including hurricanes and subsidence); and (5) sea-level rise (natural causes of subsidence are combined with subsidence caused by extraction and other man made alterations). While each of these factors can cause negative impacts to wetlands, a proposed action would not greatly increase the overall impacts.

OCS Oil- and Gas-Related Impacts

Oil Spills

The potential for coastal oil spills poses a threat for coastal habitats due to the proximity of the spills to these vegetated areas. Aging infrastructure including refineries, onshore production facilities, platforms, and pipelines would continue to be an increasing source of potential spills, but future spills from these types of facilities would be less likely because these older facilities are gradually either structurally updated or replaced by the owner/operator. The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past (not including catastrophic spills), as long as the level of energy-related commercial and recreational activities remains the same.

The *Deepwater Horizon* oil spill was the largest spill recorded in the GOM and resulted in the oiling of an extensive portion of the northern Gulf Coast shoreline from the Texas/Louisiana border to northwest Florida (Florida Panhandle) (OSAT-2, 2011). This event must be considered in the cumulative baseline due to the volume of oil released and the geographic area affected. In Michel et al. (2013), oil from the *Deepwater Horizon* explosion and oil spill was documented by shoreline assessment teams to have stranded on approximately 495 mi (796 km) of marsh shoreline. In most areas, the oil stranded along the marsh edge usually spreads into the marsh no more than about 33-49 ft (10-15 m) perpendicular to the shoreline. Cleanup activities were conducted on 8.9 percent of the affected marsh. The most heavily oiled marshes in Barataria Bay, Louisiana, were cleaned using intensive manual and mechanical raking and cutting methods (Michel et al., 2013). This oil and the associated cleanup activities have impacted wetlands in Louisiana, Mississippi, Alabama, and the panhandle of Florida. While there were localized severe impacts to wetlands, many of the areas affected have recovered or show a moderate level of impact. The oil was released and treated in deep water nearly 48 mi (77 km) from shore. This contributed to the weathering and detoxification of the oil that reached the shoreline. It is too early to determine the cumulative long-term effect of this spill and its contribution to the ongoing marsh loss or the acceleration of that loss. New regulations focusing on improved safety, more regulatory checks, and inspections should decrease the already small likelihood of the occurrence of such spills, which are not part of a proposed action and not reasonably expected to occur. Potential impacts as a result of a low-probability catastrophic event are discussed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

Oil from offshore spills is less likely to reach the estuarine habitat in the same condition it was released due to weathering, potential dispersant treatment, and blockage by barrier islands and shorelines. However, erosion of these barriers by hurricanes and tropical storms has decreased the level of protection afforded the mainland, so flood tides could bring oil through tidal inlets (USDOC, NMFS, 2007a). For many spills, light oiling of vegetated wetlands may occur. Adverse impacts from light oiling that may occur to wetland plants are expected to be short lived, with possible plant die-back, followed by recovery without replanting (Lytle, 1975; DeLaune et al., 1979; Webb et al., 1985). However, spill data from the OCS show that, over decades of activity, tens of thousands of barrels of oil have been spilled (**Chapter 3.2.1.1.3**). Cumulative OCS oil- and-gas-related spills resulting from all past and present leasing activities are expected to have a **moderate** impact on the estuarine community. The incremental contribution to cumulative OCS oil- and gas-related spills as a result of a proposed action, however, are expected to be **minor**; due the small size of most spills, the distance from estuarine communities, improved technologies, and the dynamic nature of the coastal environment.

Vessel Traffic

Navigation channels in the coastal areas of the GOM support both OCS oil- and gas-related and non-OCS oil- and gas-related vessel traffic. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process. BOEM conservatively estimates that there are approximately 3,013 mi (4,850 km) of Federal navigation channels, bayous, and rivers potentially exposed to OCS oil- and gas-related traffic (**Table 3-6**) in the GOM. Conservative show that land loss in Federal navigation channels from various activities could total approximately 58,137 ac (23,527 ha) and from cumulative OCS oil- and gas-related activities land loss could total approximately 4,480-13,606 ac (1,813-5,506 ha). This number is considered conservative because open waterways were included in the total length of Federal navigation channels, vessel size was not taken into consideration, and there are sources of erosion to navigation canals other than vessel traffic alone. In addition, approximately half of all offshore service vessel trips from 2017 through 2022 are expected to originate from Port Fourchon, Louisiana (Kaiser, 2015b), and the channel from the Gulf to Port Fourchon is mostly armored, reducing channel widening. If this reliance on Port Fourchon continues, the land loss related to OCS channel use would be less than that estimated above.

Coastal wetland loss is greatest in Louisiana. In the Louisiana Coastal Master Plan (State of Louisiana, Coastal Protection and Restoration Authority, 2012), it is estimated that up to 1,750 mi^2 (4,500 km^2) of land would be lost in the next 50 years. Using BOEM's conservative estimates of waterways exposed to OCS traffic in the Louisiana Coastal Area (LCA) and the average canal widening rate, and comparing those data to estimated land loss in Louisiana over the next 50 years, BOEM estimates that approximately 3.7 percent of the total land loss in Louisiana would occur due to saltwater intrusion, hurricanes, and vessel traffic (OCS oil- and gas-related and non-OCS oil- and gas-related) in navigation canals. Because OCS oil- and gas-related vessel traffic constitutes only 9-27 percent of the total vessel traffic in the GOM, BOEM conservatively estimates that OCS oil- and gas-related vessel traffic would contribute approximately 1 percent or less of the land loss in coastal Louisiana in the next 70 years.

The OCS oil- and gas-related vessel traffic associated with the increased number of offshore platforms is expected to contribute minimally to the need for maintenance dredging activity of navigation canals. The primary support, transfer, and production facilities used for OCS oil- and gas-related activities are located along armored canals and waterways, thus minimizing marsh loss. If new onshore transfer or production facilities would be constructed, access channels may have to be dredged. In the foreseeable future, there would be a continuing need for dredged material for coastal restoration, wetland creation, and to some extent, offshore sediments (e.g., sand, etc.) needed for beach restoration and hurricane protection. Alternative dredged-material disposal methods can be beneficially used for wetland creation or restoration as required by the COE's permitting program.

Because of the small incremental increase in cumulative impacts to coastal wetlands associated with OCS oil- and gas-related vessel traffic and the offsetting benefits of wetland creation using dredged material from navigation channels, impacts are expected to be **minor**.

Coastal Infrastructure and Pipelines

Projected new facilities that are attributed to the OCS Program and a proposed lease sale would not be primarily in wetland areas, and no additional service bases, heliports, platform fabrication yards, shipyards, pipe-coating facilities, or refineries are expected (**Chapter 3.3.1.10**). State and Federal permitting agencies discourage the placement of new facilities or expansion of existing facilities in wetlands. However, any sizable coastal facility may have construction impacts in wetlands. Any localized impacts upon wetlands from existing facilities are expected to be mitigated because of the Clean Water Act permitting requirements.

Activities that would further contribute to wetland loss include additional construction of access channels to shoreline staging areas and expansion of onshore and offshore facilities (receiving and transferring facilities or fabrication of production platforms). BOEM projects 0-1 new gas processing facilities and 0-1 new pipeline landfalls for a proposed action. A more detailed description of coastal infrastructure is provided in **Chapter 4.14.1**. If a new facility is constructed and a pipeline makes landfall, any impacts upon wetlands would be mitigated in accordance with the Clean Water Act requirements and the COE's 404 permit and State permitting programs. These mitigations and regulatory requirements, such as avoidance and compensatory wetland mitigation, would result in **negligible** impacts to coastal habitats.

Several methods exist to further reduce the number of new pipeline landfalls and their cumulative impact, e.g., the addition of corrosion preventatives to the pipeline itself (reducing the probability of accidental leakage from aging pipelines), in combination with "tie ins" to existing

Federal or State pipelines with shore connections. While impacts are greatly reduced by mitigation techniques, existing pipelines were placed using older techniques and have caused, and would continue to cause, impacts to adjacent wetlands. Remaining impacts may include expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment transport, and habitat conversion (Cox et al., 1997; Morton, 2003; Ko and Day, 2004b). Pipeline maintenance activities that disturb wetlands are very infrequent and are mitigated through regulatory programs, including review by the State of Louisiana through its coastal use permit requirements and through the Clean Water Act Section 404 and Rivers and Harbors Act Section 10 permits.

The continued widening of OCS pipeline canals from erosion does not appear to be an important factor contributing to OCS oil- and gas-related direct land loss. This is because few pipelines are open to navigation and the impact width of these pipelines does not appear to be significantly different from that for pipelines closed to navigation. Based on the projected coastal Louisiana wetlands over 50 years (Couvillion et al., 2013), land loss resulting from new OCS pipeline construction represents <1 percent of the total expected loss. This estimate does not take into account the present regulatory programs and modern installation techniques that would be expected to further mitigate this potential impact. Throughout the 50-year life of a proposed lease sale, a majority of the already old pipeline distribution and production systems would continue to age. This could result in an increasingly large inventory of pipelines and support structures that would need to be replaced or repaired. The replacement and repair of the pipeline system may temporarily impact wetlands in the pipeline corridors, as crews could trample wetland plants or access would have to be dredged; however, if proper mitigation is implemented and maintained, impacts should be minimal and temporary. In the absence of the replacement of these aging pipelines, the potential risk for spills and leaks would increase in coastal and offshore waters. Because of the mitigations and regulations connected with coastal operations, the impacts outlined above are expected to only occur in localized areas over a short amount of time and, therefore, the overall level of impact to estuarine communities is **minor**.

Waste Disposal

Discharge of OCS oil- and gas-related produced water is generally into offshore Gulf waters in accordance with NPDES permits or injected back down into wells; therefore, produced waters from the OCS are not expected to affect coastal wetlands (**Chapter 3.3.1.8**). Produced sands, oil-based or synthetic-based drilling muds and cuttings, along with fluids from well treatment, workover, and completion activities from OCS wells, would be transported to shore for disposal in existing disposal facilities approved by the USEPA for handling these materials. Because of wetland-protection regulations, no new waste disposal site would be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation ranging from sublethal effects to mortality, depending on the toxicity of the waste.

Trash and debris can potentially impact coastal estuarine communities in that the fauna in these areas could ingest or become entangled in the trash and debris. BOEM and BSEE have addressed the marine debris issue by imposing marine debris awareness and prevention measures on the oil and gas industry through NTL 2015-BSEE-G03, which provides a guidance to industry operators regarding dumping trash and debris into the marine environment and informs operators of regulations set by other regulatory agencies (i.e., the USEPA, USCG, and others; refer to **Chapter 4.12**). Because of the distance of the sources of trash on the OCS from wetlands, mitigations, and awareness, OCS oil- and gas-related trash and debris would result in **negligible** impacts to estuarine habitat.

Non-OCS Oil- and Gas-Related Impacts

State Oil and Gas

Impacts are expected to occur as a result of oil spills, dredging for new pipeline canals, maintenance, and usage of existing rig access canals and drill slips, and for the preparation of new well sites related to State oil and gas activities (**Chapter 3.3.2.1**). Such activity has taken a tremendous toll on coastal wetlands, particularly in Louisiana (Turner et al., 1994). Many pipelines carry product from both OCS oil- and gas-related and non-OCS oil- and gas-related sources. The impacts from these activities are generally the same as those described in the “Routine Activities,” “Accidental Events,” and “OCS Oil- and Gas-Related Impacts” sections above, although these impacts may be more pronounced due to the proximity of oil and gas activities on State lands to wetlands. Another impact from State oil and gas activity is local subsidence. This subsidence may be due to the extraction of large volumes of oil and gas, sulfur, and salt from subsurface reservoirs (Morton, 2003; Morton et al., 2002 and 2005), but subsidence associated with this factor seems to have slowed greatly over the last three decades as the reservoirs are depleted. Subsidence leads to the drowning of marsh plants and conversion to open water. Because of the continued effects of the extensive dredging of canals through coastal wetlands, impacts from State oil and gas activities are expected to be **major**.

Vessel Traffic and Navigation Canals

Non-OCS oil- and gas-related vessel traffic in the GOM includes commercial shipping, support for State oil and gas activities, commercial and recreational fishing vessels, pleasure boating, and other types of traffic (**Chapter 3.3.2.2**). Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process. In many cases, this erosion results in wetland loss. Submerged vegetation communities can be damaged by boat anchors, keels, and propellers, and by activities such as trampling, trawling, and State oil- and gas-related or scientific seismic surveys (Sargent et al., 1995; Dunton et al., 1998). Navigation channels require routine maintenance dredging. Minor adverse impacts on wetlands from maintenance dredging are expected because the large majority of the material would be either used to enhance or create marsh, or disposed upon existing disposal areas.

Net land loss due to navigation canals alone can be calculated by comparing erosion rates with beneficial activities such as land gained through the use of dredged sands; refer to the estimates in “OCS Oil- and Gas-Related Impacts” section above.

Wetland losses may be generated by the secondary impacts of saltwater intrusion, flank subsidence, freshwater-reservoir reduction, and deeper tidal penetration. Navigation channels contribute to the negative impacts from saltwater intrusion (Gosselink et al., 1979; Wang, 1987). Wang (1987) developed a model demonstrating that, under certain environmental conditions, saltwater penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as “salt pumps.” This change in salinity results in a substantial habitat transition from freshwater to brackish water, then to saltwater, and ultimately to open-water systems. An example is the construction of the Mississippi River Gulf Outlet, which transformed many of the cypress swamps east of the Mississippi River below New Orleans into open water or areas largely composed of marsh vegetation (*Spartina* spp.) among dead cypress tree trunks. This channel was closed in 2009, and further saltwater intrusion through it has been curtailed.

Onshore activity that would contribute to wetland loss includes additional construction of access channels (for instance at fabrication yards) and onshore construction of new well sites and the expansion or construction of onshore production facilities or receiving and transferring facilities. Most of these facilities would be located in Louisiana. Management activities, including erosion protection and restoration along the edges of these canals, can significantly reduce canal-widening impacts on wetland loss (Johnston et al., 2009; Thatcher et al., 2011). Because of the large contribution to total vessel traffic from non-OCS oil- and gas-related sources, the secondary impacts of navigation canals, such as saltwater intrusion, and the continuing impacts of existing access channels, the impacts from non-OCS oil- and gas-related vessel traffic and related activities are expected to be **moderate**.

Coastal Infrastructure and Development

The development of estuarine habitat for agricultural, residential, industrial, commercial, and silvicultural (forest expansion) uses (**Chapter 4.14.1**) would continue but with more regulatory and planning constraints required under the Clean Water Act and other regulations. Impacts from these developments, such as alteration to habitat or hydrology, are expected to continue as development in coastal regions around the GOM continues.

Urban and rural development was an important factor in wetland loss in coastal watersheds from 1998 through 2004 (Stedman and Dahl, 2008; Dahl and Stedman, 2013). Agricultural, residential, industrial, and commercial developments, including recreational and tourist developments, have been particularly destructive to coastal wetlands in the GOM by altering habitat and hydrology, which can contribute to the loss of wetland ecosystems through mechanisms such as the addition of pollutants, creating or widening channels, or physical removal of habitat. Indirect effects of such development can include expansion of supporting infrastructure, including roads, bridges, and utilities, with related impacts similar to those mentioned above.

Infrastructure that serves the transportation of foreign oil, such as oil ports, can have wetland impacts to the extent that it is constructed on or adjacent to wetlands. The current regulatory programs, modern construction techniques, and mitigations have reduced recent impacts to wetlands from pipeline installation. The continued presence of existing pipelines can contribute to wetland loss (Johnston et al., 2009). Oil spills caused by leaking or broken pipelines can also impact wetlands.

Existing regulations and development permitting procedures indicate that development-related wetland loss may be slowed. Between 2004 and 2009, there were very few (<1%) estuarine emergent losses attributed to discrete anthropogenic actions that fill or otherwise convert salt marsh areas to uplands. This suggests that marine and estuarine vegetated wetlands (tidal salt marsh and shrubs) have been afforded protection by various State and Federal coastal regulatory measures (Dahl, 2011). Impacts are to some extent offset by coastal restoration programs. Examples of these programs are the Coastal Impact Assistance Program (CIAP), the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), and the Resources and Ecosystems Sustainability, Tourist Opportunities and Revived Economies of the Gulf Coast States Act (RESTORE Act) (refer to **Chapter 3.3.2.8.4**). Although development-related wetland loss may be slowed, cumulative impacts of past development and related infrastructure are expected to be **moderate**.

Sea-Level Rise

There is increasing new evidence of the importance of the effect of sea-level rise (and marsh subsidence) as it relates to the loss of marsh or changes in marshes, marsh types, and plant diversity (**Chapter 3.3.2.8.1**; Spalding and Hester, 2007). Spalding and Hester (2007) show that the very structure of coastal vegetative communities would likely be altered by sea-level rise because community shifts would be governed by the responses of individual species to new environmental conditions. This could change the vegetative make up of different estuarine habitats and, in turn, could change faunal species presence.

Gulf Coast wetlands tend to occur at low elevations, often between 1 and 2 ft (0.3 and 0.6 m) above sea level. For example, if current projections are realized and sea level increases by 3.5 ft (1.1 m) in Galveston, Texas, by the year 2100 (USEPA, 2013b), most of Texas' coastal wetlands would be under water well before 2100. A more conservative estimate of sea-level rise, known as the AR4 scenario, calls for an increase (globally) of 16 in (41 cm) by 2100 (NRC, 2010). Even this rate of increase would be likely to drown large areas of Gulf Coast wetlands, especially when local, relative sea-level rise is considered. Since 1870, global sea level has risen by about 8 in (20 cm) (USEPA, 2013b). Even at current measured rates of relative sea-level rise, vast areas of Gulf coastal wetlands can be expected to convert to open water as low-lying coastal marshes are inundated (refer to **Chapter 3.3.2.8.1**). Impacts to coastal habitats are expected to be **major** due to the large scale of wetland loss from sea-level rise.

Natural Processes

Along with increased human activities, hurricanes and tropical storms in the GOM have greatly impacted coastal habitats (**Chapter 3.3.2.9**). Intense storms can erode all of the vegetation and soil from some areas of marsh, leaving behind a body of water. An extreme example occurred when hurricanes in 2005 resulted in land loss in Louisiana equivalent to approximately 42 percent of the projected total land loss over the next 50 years (Barras et al., 2003; Barras, 2006). These storms can also remove or bury submerged beds and the barriers that protect these beds from storm surges. This could weaken the existing populations of local submerged vegetation. Seagrass beds have been repeatedly damaged from hurricane overwash of barrier islands onto the beds. The presence of strong tropical storms is a routine background condition in the GOM that contributes to cumulative impacts to wetlands. Natural subsidence has caused wetland loss through compaction of Holocene strata (the rocks and deposits from 10,000 years ago to present). Stephens (2010) has identified faulting mechanisms in coastal Louisiana that actually may be causing what appears as subsidence. Refer to **Chapter 3.3.2.8** for more information.

Whether it is from anthropogenic activities or a natural cycle, increased surface water temperature, sea levels, and storm events have impacts on seagrass beds by adding stress (e.g., burial, salinity changes, turbidity changes etc.) to this sensitive and already stressed ecosystem (Orth et al., 2006). Impacts to estuarine habitats are expected to be **major** because of the large scale of wetland loss from hurricanes and subsidence added to the ongoing stress these communities endure.

Mississippi River Hydromodification

With the construction of levees, dams, and other flood control structures along the Mississippi River, some of the natural processes that built the coastal Louisiana delta have been prevented, which has had serious impacts (**Chapter 3.3.2.10**). Beneficially, the hydromodification has allowed human settlement and development in coastal areas of Louisiana while also providing a stable navigation channel. However, by channelizing the river, it is prevented from flooding and distributing sediments that can build wetlands and counteract the effects of sea-level rise (Yuill et al., 2009). When the Mississippi River floods, it brings nutrient-rich water and alluvial sediments to the wetlands. The water would provide nutrients for wetland vegetation, thereby encouraging plant growth. This growth can stabilize wetland sediments, which makes them less susceptible to erosion. The water also prevents the sediments from drying out and compacting due to loss of pore water and oxidation of organic material (Yuill et al., 2009). Sediment deposition in wetlands is vital for the area to stave off sea-level rise. Without new sediments coming into the marsh, a major contributor to vertical building processes is removed, and the wetlands become more at risk to being inundated by rising sea levels (Yuill et al., 2009). The hydromodification of the Mississippi River has exacerbated these issues by preventing the flooding of coastal wetlands in Louisiana, and as a result, those areas are experiencing some of the highest land-loss rates in the world; therefore, the impact has been **major**. While the cumulative impacts to coastal habitats from the factors described above range from negligible to major, the incremental impact to those habitats from a proposed lease sale would be **negligible**. The relatively small contribution of a proposed lease sale to OCS oil- and gas-related activity would have impacts that are much less than those attributed to several sources, as noted above.

Incomplete or Unavailable Information

BOEM has identified incomplete or unavailable information regarding estuarine habitat. There is incomplete information about routine impacts, as the scenario forecast is only an estimate, and many global factors can affect OCS oil- and gas-related activity. There also remains unavailable information about the future rates of oil spills, as well as spill locations and volumes of oil.

There are unknowns regarding the future restoration efforts that are being planned, such as what projects would ultimately be constructed and how successful they may be. In addition, the future rates of relative sea-level rise are not known with certainty, and thus, resulting impacts to wetlands are unknown. Future rates of coastal development are unknown, as is the extent of impacts to estuarine systems thereof.

BOEM acknowledges that there remains incomplete or unavailable information that may be relevant to reasonably foreseeable significant impacts on estuarine systems. This incomplete or unavailable information includes potential data on the *Deepwater Horizon*, explosion, oil spill, and response that may be forthcoming. As there is substantial information available since the *Deepwater Horizon* explosion, oil spill, and response, which is included in this Multisale EIS, BOEM believes that the incomplete or unavailable information regarding the effects of the *Deepwater Horizon* explosion, oil spill, and response on estuarine systems would likely not be essential to a reasoned choice among alternatives. Regardless of the costs involved, it is not within BOEM's ability to obtain this information from the NRDA process within the timeline contemplated in the NEPA analysis for this Multisale EIS. BOEM's subject-matter experts have used what scientifically credible information is available in their analyses, and applied it using accepted scientific methodology. Compared with the historic and ongoing threats to wetlands, such as sea-level rise, natural factors such as hurricanes, and channelization, the remaining effects of the *Deepwater Horizon* explosion, oil spill, and response on wetlands are expected to be small.

BOEM has determined that the information is not essential to a reasoned choice among alternatives. Many studies have been produced that demonstrate the effects of exposure of wetland plants to crude oil, covering a wide range of exposure intensity, longevity, and oil characteristics. Much has been learned about the different survival and recovery rates of various plant species. In addition, studies have been produced regarding the long-term impacts of canal dredging and pipeline installation on wetlands. A proposed lease sale would result in a relatively minor addition to existing routine activities and accidental events, and therefore, the incremental contribution to wetland impacts from a proposed lease sale would be **minor** given what is currently known.

The potential for impacts from changes to the affected environment (post-*Deepwater Horizon*) and cumulative impacts remains whether or not the No Action or an action alternative is chosen, and therefore, the incremental contribution from a proposed action would be **minor** relative to cumulative impacts. BOEM used reasonably accepted scientific methodologies to extrapolate from existing information in completing this analysis and formulating the conclusions presented here.

4.3.1.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

BOEM reviewed and analyzed the impacts to coastal habitats from routine OCS oil- and gas-activities, reasonably foreseeable accidental events, and the incremental contribution of a proposed action to the cumulative impacts to wetlands. It is expected that impacts from pipeline emplacement would be negligible with only 0-1 pipeline landfalls projected, and any impacts would be reduced or eliminated through mitigation (e.g., avoidance of impacts by use of modern techniques such as directional drilling). Although maintenance dredging of navigation channels and canals is expected to occur, a proposed action is expected to contribute only minimally to the need for this dredging. Secondary impacts to estuarine systems from a proposed action would result from OCS oil- and gas-related vessel traffic contributing to the erosion and widening of navigation channels and canals. Overall, the impacts to these habitats from routine activities associated with a proposed action are expected to be negligible due to the small length of projected onshore pipelines, the minimal contribution to the need for maintenance dredging, and the mitigating measures that would be used to further reduce these impacts.

The greater threat from an oil spill to coastal habitat is from a coastal spill as a result of a nearshore vessel accident or pipeline rupture. While a resulting slick may cause impacts to wetland habitat and surrounding seagrass communities, the equipment, vessel traffic, and personnel used to clean it up can also generate impacts to the area. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts. In addition, an assessment of the area covered, oil type, and plant composition of the wetland oiled should be made prior to choosing remediation treatment. Offshore oil spills resulting from a proposed action would have a low probability of contacting and damaging large areas of the coast, except in the case of a catastrophic event, which is not reasonably foreseeable and not expected to occur as a result of a proposed lease sale (*Catastrophic Spill Event Analysis* white paper, USDOI, BOEM, 2016c). This is because of the distance of the projected OCS oil- and gas-related activity to the coast, the likely weathered and therefore less toxic condition of oil (through evaporation, dilution, and biodegradation) should it reach the coast, and because wetlands are somewhat protected by barrier islands, peninsulas, sand spits, and currents. Overall, impacts to estuarine habitats from oil spills associated with activities related to a proposed action would be expected to be minor because of the distance of most of the resulting activities from the coast, expected weathering of spilled oil, projected low probability of large spills near the coast, resiliency of wetland vegetation, and availability cleanup techniques.

Cumulative impacts to wetlands are caused by a variety of factors, including the OCS oil- and gas-related and non-OCS oil- and gas-related activities discussed above. Development pressures in the coastal regions of the GOM have been largely the result of tourism and residential beach side development, and this trend is expected to continue. The cumulative effects of human and natural activities in the coastal area have severely degraded the deltaic processes and have shifted the coastal area from a condition of net land building to one of net land loss. Deltaic Louisiana is expected to continue to experience the greatest loss of wetland habitat in the GOM. Wetland loss is also expected to continue in coastal Texas, Mississippi, Alabama, and Florida, but at slower rates. A proposed action represents a small (>4.5%) portion of the cumulative OCS Program that would occur over the 50-year analysis period. Impacts associated with a proposed action are a minimal part of the overall OCS oil- and gas-related impacts. The incremental contribution of a proposed action to the cumulative impacts on coastal wetlands is expected to be **minor**.

4.3.1.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

The impacts of this alternative would be similar to those of Alternative A, except that there would be **negligible** impacts to coastal wetlands and submerged vegetation in Texas because no new OCS oil- and gas-related activity is forecasted in the WPA along the Texas coast with this alternative. Under Alternative B, the resulting OCS oil- and gas-related activity would be located off the coasts of Louisiana, Mississippi, and western Florida. The greater distance between these activities and the coastal habitats of Texas would reduce the impacts along the Texas coast, whether from routine activities or accidental events. Less use of service bases in Texas is likely, and the distance between oil spills associated with this alternative and the Texas coast is expected to be greater.

4.3.1.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

The impacts of this alternative would be less than those of Alternative A, as only a fraction of the resulting activity forecast for Alternative A is projected under Alternative C. For this alternative, there would be **negligible** impacts to coastal wetlands and submerged vegetation in Louisiana; **negligible** impacts to Mississippi, Alabama, and the panhandle of western Florida; and incrementally more impacts to the wetlands and submerged vegetation of Texas, compared with Alternative A. However, Alternative C would have less potential for impact than Alternative A or B as the level of projected OCS oil- and gas-related activities and impact-producing factors are much less in the WPA. For example, a range of 22-96 production wells are projected to be drilled and developed under Alternative C, whereas 46-671 production wells are projected to occur under Alternative B. The significance of impact-producing factors on estuarine habitats would be less for Alternative C as for Alternative A, as discussed in **Chapter 2.2.2**.

4.3.1.2.4 Alternative D—Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama Stipulations

The impacts of this alternative would be nearly identical to those of Alternative A because the available unleased blocks with topographic features do not contain wetlands or submerged vegetation and are too distant (over 25 km; 16 mi) from the coast to have indirect impacts either. In addition, there are only 367 blocks subject to the Topographic Features Stipulation, 74 blocks subject to the Live Bottom (Pinnacle Trend) Stipulation, and 32 blocks subject to the Blocks South of Baldwin County, Alabama Stipulation. This relatively small percentage of the total number of unleased blocks would not be expected to generate a great contribution to OCS oil- and gas-related activity if leased.

4.3.1.2.5 Alternative E—No Action

If a proposed action does not occur, there would be no additional impacts to estuarine habitats; however, cumulative impacts would be the same as Alternative A. There could be some incremental increase in impacts caused by a compensatory increase in imported oil and gas to offset reduced OCS production, but it would likely be **negligible**.

4.3.2 Coastal Barrier Beaches and Associated Dunes

The coastal barrier beaches and associated dunes are those beaches and dunes that line the coast of the northern Gulf of Mexico, including both barrier islands and beaches on the mainland.

In this chapter, BOEM reviewed and analyzed OCS oil- and gas-related routine activities and reasonably foreseeable accidental events. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts (**Table 4-5**). Routine activities associated with a proposed action that takes place on the OCS, where wells are drilled and platforms and pipelines are installed, would not impact the coastal barrier beaches, which are located from 3 to greater than 200 nmi (3.5 to 230.2 mi; 5.6 to 370.4 km) away. Other routine activities that support offshore oil and gas exploration, such as increased vessel traffic, maintenance dredging of navigation canals, pipeline installation, trash and debris, and construction of support infrastructure in the coastal areas, could potentially impact beaches and dunes. An analysis of the potential impacts from accidental events, primarily oil spills, associated with a proposed action is presented in this chapter, as is the incremental contribution of a proposed action to the cumulative impacts to beaches and dunes. Cumulative Impacts were analyzed for OCS oil- and gas-related activities and for other sources that could affect coastal barrier beaches and dunes (i.e., human impacts, storms, vessel traffic, subsidence, and sea-level rise).

Table 4-5. Coastal Barrier Beaches and Associated Dunes Impact-Producing Factors.

Coastal Barrier Beaches and Associated Dunes	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Pipeline Construction and Maintenance	Negligible	Negligible	Negligible	Negligible	None
Navigation Channel Maintenance Dredging	Negligible	Negligible	Negligible	Negligible	None
Vessel Operation (Support Use of Navigation Channels)	Negligible	Negligible	Negligible	Negligible	None

Coastal Barrier Beaches and Associated Dunes	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Disposal of OCS-Related Wastes	Negligible	Negligible	Negligible	Negligible	None
Construction and Use of Coastal Support Infrastructure	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Oil Spills	Minor	Minor	Minor	Minor	None
Cumulative Impacts					
OCS Oil and Gas	Moderate	Moderate	Moderate	Moderate	Moderate
Non-OCS Oil and Gas	Major	Major	Major	Major	Major

Impact Significance Criteria

For this analysis, the following definitions were used to categorize impacts to coastal beaches and dunes:

- **Negligible** – Little to no measurable impacts in species composition and abundance and/or altering of beach profile or ecological function.
- **Minor** – Measureable but short-term and localized impacts to species composition and abundance and/or altering of beach profile or ecological function.
- **Moderate** – Damage to coastal habitats (impacts to species composition and abundance and/or altering of beach profile or ecological function) that is detectable, spatially extensive, but temporary and not severe. Can also be used to describe localized land loss.
- **Major** – Severe, bringing about detectable changes in species composition and abundance and/or altering of beach profile or ecological function well beyond that of normal variability. Changes would likely need to be both long-lasting and spatially extensive to have such an effect.

4.3.2.1 Description of the Affected Environment

Barrier beaches and associated dune habitats from Texas to the Florida panhandle may be impacted by activities resulting from a proposed action. These areas are comprised of the following geologic subareas:

- the barrier island complex of southern Texas;
- the Chenier Plain of eastern Texas and western Louisiana;

- the Mississippi River Delta complex of southeastern Louisiana;
- the barrier-island and Pleistocene Plain complex of Mississippi and Alabama; and
- the Florida panhandle.

Barrier islands make up more than two-thirds of the northern GOM shore (Morton et al., 2004a). 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 water to the beach berm-crest. The backshore is found between the beach berm-crest and the dunes, and may be sparsely vegetated. 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.

Tropical storms and hurricanes are normal occurrences in the GOM and along the coast. The GOM has been hit extremely hard by very powerful hurricanes. These storms caused damage to barrier islands and beaches in all five of the Gulf Coast States. Beaches can recover naturally from the damage done by storms, but it may take many years (Houser et al., 2015). During storms, large waves can overwash lower coastal barriers, creating overwash fans or terraces behind and between the dunes. With time, opportunistic plants would reestablish 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 consists of scrubby woody vegetation, marshes, and forested wetlands. Saline and freshwater ponds may be found among the dunes and on the landward flats. 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.

Once formed, barrier islands are not static landforms; they are dynamic, with winds and waves constantly reworking and moving the barrier island sand, wherefore barrier landform configurations continually change, accreting and eroding, in response to these 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. Noncyclical changes in landforms can be progressive, causing barrier island movement. Barrier islands are also periodically reworked due to hurricanes and tropical storms.

Transgressive and regressive landforms are common across the GOM. A transgressive sequence moves the shore landward. Transgressive coastal landforms around the GOM have low profiles and are characterized by narrow widths; low, sparsely vegetated, and discontinuous dunes; and numerous, closely spaced, active washover channels. A regressive sequence moves the shore seaward. Regressive barriers have high and broad dune profiles. These thick accumulations of sand may form parallel ridges.

Barrier islands, particularly vegetated ones with freshwater and or saltwater pools, may serve as habitat for a wide variety of animal life, especially birds (**Chapter 4.8**), including threatened and endangered species. The islands and spits protect the bays, lagoons, estuaries, salt marshes, seagrass beds, and other wetland environments, some of which may contain threatened or endangered species (**Chapter 4.9**). Barrier islands in the northern GOM extending from Atchafalaya Bay, Louisiana, to Mobile Bay, Alabama, are disintegrating rapidly as a result of combined physical processes involving sediment availability, sediment transport, and sea-level rise.

Oil from the *Deepwater Horizon* explosion and oil spill was documented by shoreline assessment teams to have stranded on approximately 560 mi (900 km) of CPA and EPA beach shoreline. Cleanup activities were conducted on 410 mi (660 km) of the affected beach. Two years after the spill, some oil remained on 427 mi (687 km) but at much lesser amounts (Michel et al., 2013; OSAT-2, 2011). As beaches experienced erosion and deposition, oil would become buried, exposed, and remobilized multiple times, resulting in chronic re-oiling. Tropical Storm Lee (2011) and Hurricane Isaac (2012) caused extensive beach erosion and remobilization of oil residues. Oil residue mats were observed between the toe of the beach and the first offshore sand bar, providing another source of chronic sources of surface residue balls and surface residue patties (Michel et al., 2013). Over time, more of the remaining oil has continued to be removed, while toxicity has decreased as the oil is further weathered. The buried supratidal samples underwent less biodegradation due to lack of oxygen, but they were estimated in 2011 to decrease to 20 percent of current levels within the next 5 years (OSAT-2, 2011).

As a result of the *Deepwater Horizon* explosion and oil spill, protective berms were constructed in Louisiana seaward of barrier islands to protect the inland marshes, wetlands, and seagrasses from incoming oil associated with this large spill. The berms were ineffective in stopping the oil, and none of the estimates of how much oil was collected on the berms was much more than 1,000 bbl (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). It took approximately 5 months to build roughly 12.5 mi (20.1 km) of berms at a cost of approximately $220 million. Long-term effects can include changes in hydrology and sediment transport along the coastal barrier islands, the loss of sand resources, and adverse impacts to benthic and pelagic organisms (Martinez et al., 2012). As a result, such berms are not likely to be approved as a response measure in the future.

Texas Barrier Island Complex

The barrier islands in Texas extend from the Mexican border to Galveston Bay. The GOM coastline of Texas is about 367 mi (590 km) long. The average rate of erosion of the Texas shoreline, from 1950 through 2012, was 2.3 ft (0.7 m) per year. While some of the coast has been gaining land, rates vary by location, with numerous locations experiencing rates of more than 11.5 ft (3.5 m) per year (State of Texas, General Land Office, 2015).

The barrier islands 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). The Texas coast has both low- and high-profile barriers. South Padre Island is an example of a low-profile barrier, with its narrow shape and discontinuous frontal dunes that are inundated by storm surges. Matagorda Island is an example of a high-profile barrier, which is typically wide with continuous, well-vegetated dune ridges (Morton et al., 2004a).

Padre Island National Seashore encompasses 70 mi (112 km) of coastline, making it the longest stretch of undeveloped barrier island in the world. It borders the Laguna Madre, a hypersaline lagoon, and it provides habitat for numerous plants and animals. It also serves as an important nesting ground for the endangered Kemp's ridley sea turtles (**Chapter 4.9.2**).

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.

The barrier beaches of the Chenier Plain are generally narrow, low, and sediment starved due to the nature of coastal currents and the shoreface. In some places, beach erosion has exposed relic marsh platforms that were buried by past overwash events, resulting in beaches composed of shelly sand, or discontinuous mud deposits among muddy sands.

Mississippi River Delta Complex

The Mississippi River Delta region comprises much of coastal Louisiana and adjacent Mississippi. It stretches from the Atchafalaya Bay to the Chandeleur Islands of Louisiana. Most barrier shorelines of the Mississippi River Delta are transgressive and trace the seaward remains of a series of five abandoned deltas. As a lobe of the Delta is abandoned by a shift in drainage, that portion begins to subside slowly into the sea and is further reduced by erosion. Some of the sediment may be reworked by wind and waves into barrier islands. The Chandeleur Islands and Grand Isle are examples of this. Gradually, woodland vegetation became established on the dune sands (e.g., oaks and oleander). Salty meadows, marshes, and lagoons occupy the lower terrain. The shorefaces of the Mississippi River Delta complex slope gently seaward, which reduces wave energies at the shorelines. Mud flats are exposed during very low tidal events. This slope is not as shallow as that found off the Chenier Plain.

The barrier islands associated with the Mississippi River Delta are at the greatest risk for degradation from hurricanes and sand budget deficits; these include the Chandeleur-Breton Island, Timbalier Island, and Isle Dernieres chains in Louisiana. These chains of individual transgressive barrier island segments have progressively diminished in size while migrating landward (McBride et al., 1992). Most of southeastern Louisiana's barrier beaches are composed of medium to coarse sand. Most dune zones of the Mississippi River Delta contain low, single-line dune ridges that may be sparsely to heavily vegetated.

Mississippi and Alabama Coasts

The Dog Keys define the Mississippi Sound of Mississippi and Alabama. The Mississippi-Alabama barrier islands have experienced increased rates of land loss since the mid-1800's because of storms and sand budget deficits. The centers of most of the islands are migrating westward (Richmond, 1962; Otvos, 1979). These islands generally have high beach ridges and prominent sand dunes. They are well vegetated among and behind the dunes and around ponds.

Mississippi has about 33.9 mi (54.6 km) of barrier beaches (USDOI, FWS, 1999). The western district of the Gulf Islands National Seashore is located in Mississippi. Some of the habitats representative of coastal barrier and seagrass ecosystems are found on or behind Horn and Petit Bois Islands, which were designated as Wilderness Areas by Congress in 1978 through the establishment of the Gulf Islands Wilderness Area.

Dauphin Island, Alabama, represents about another 7 mi (11 km) of barrier beaches. The beaches are separated by wide passes with deep channels. Shoals (a place where a sea, river, or other body of water is shallow) are typically adjacent to these barriers. Unlike the other barrier islands, Dauphin Island is essentially a low-profile, transgressive barrier island, except for its eastern end. The western end is characterized by small dunes and many washover fans, exposed marsh deposits, and tree stumps exposed in the surf zone. The Gulf Shores region of Alabama extends from Mobile Point eastward to the Florida boundary, a distance of about 31 mi (50 km) (Smith, 1984).

Florida Panhandle

The Florida panhandle has extensive beaches with multiple habitats, including sandy mainland beaches, broad peninsulas, and narrow barrier islands. Two long, narrow barrier islands (Santa Rosa Island and Perdido Key) form the Gulf shore west of Destin and are part of the Gulf Islands National Seashore (**Figure 4-24** in **Chapter 4.12.1**). Both can be reached by road and experience tourism in the form of camping, picnicking, swimming, bird watching, and fishing.

Coastal land loss from shoreline change in the Florida panhandle is associated with erosion of sandy beaches and barrier islands, especially around inlets, while bays and lagoons tend to experience lower loss rates because the waterbodies are generally small or protected by erosion control structures (Morton et al., 2004a). The average long-term erosion rate, from the 1800's through 2001, was estimated as -2.6 ft/yr (-0.8 m/yr), which is lower than the other Gulf Coast

States. This can be attributed to relatively low wave energy and frequent beach nourishment (Morton et al., 2004a).

These barrier beaches and dune habitats also play an important role to ESA-listed species; BOEM consults on these species with the FWS. These species include sea turtles, beach mice, and birds; to read about the protected species that use these habitats, refer to **Chapters 4.9.2, 4.9.3, and 4.9.4**, respectively.

4.3.2.2 Environmental Consequences

Routine Activities

This chapter considers impacts from routine activities associated with a proposed action to the physical shape and structure of barrier beaches and associated dunes. The primary impact-producing factors from routine activities associated with a proposed action that could affect these environments include pipeline emplacements, vessel traffic (navigation channel use) and dredging, trash and debris, and infrastructure construction.

Pipeline Emplacements

Many existing OCS Program-related pipelines made landfall on barrier islands and shorelines (**Chapter 3.1.3.3**). Pipeline landfall sites on barrier islands could potentially cause accelerated beach erosion and island breaching. This occurs when pipeline canals are dug through beaches, and then widen over time. A proposed action is not expected to include new pipelines that make landfall on barrier islands or mainland beaches (0-1 new pipeline landfalls are projected). Modern pipeline construction typically employs horizontal, directional (trenchless) drilling techniques and open-water routes to the extent possible to avoid damages to estuarine systems and beaches. Similar features are now commonly required to minimize any impacts from pipeline landfalls. Studies have shown that little to no impact to barrier beaches results from techniques like directional pipeline emplacement (LeBlanc, 1985; Wicker et al., 1989). Federal and State regulatory programs and permitting processes encourage the use of directional boring technology to reduce and perhaps eliminate impacts to barrier beaches or dunes. Because of the regulations and new construction methods, and the limited projection for, at most, one new pipeline landfall, the effects on barrier beaches and dunes from pipeline laying activities associated with a proposed lease sale are expected to be **negligible.**

Vessel Traffic and Dredging

Vessel traffic that may support a proposed action and navigation channels projected to be used in support of a proposed action are discussed in **Chapter 3.1.7.6** and are shown in **Table 3-6**. As a result of a proposed action, it is not expected that the number of OCS oil- and gas-related navigation channels would change. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in coastal barrier beaches already affected by natural erosion processes. Only a limited reach of the navigation channels cross the shoreline adjacent to beaches or dunes, and these reaches are generally armored with rock. The existing armored navigation channels minimize or eliminate the potential for shoreline erosion from vessel traffic.

A proposed action is estimated to account for <2 percent of the service-vessel traffic in navigation canals associated with the OCS Program from 2017 through 2066 (**Chapter 3.1.7.6**; **Tables 3-2 and 3-6**). Erosion of coastal barrier beaches and associated dunes from vessel traffic resulting from a proposed action are expected to be **negligible** because of the small percentage of total vessel traffic related to the OCS Program and the armoring of the channels most highly used for OCS oil- and gas-related activities.

Periodic maintenance dredging is expected in existing navigation channels through barrier passes and associated bar channels. Maintenance dredging of barrier inlets and bar channels removes sediment from the system, contributing to beach erosion. Materials from maintenance dredging of bar and pass channels are typically discharged to nearby ocean dumping sites in the GOM (**Chapter 3.3.2.4.6**) or they are used for marsh creation or beach nourishment projects as part of mitigation (Morton, 2008). Jetties or bar channels serve as sediment sinks by intercepting sediment in longshore littoral drift (the movement of sediment along the shoreline by currents). Negative effects of sediment sinks created by jetties can be mitigated by filling the downdrift side of the jetty with appropriate sediment. These dredging activities are permitted, regulated, and coordinated by the COE with the appropriate State and Federal resource agencies. Effects from maintenance dredging related to a proposed action on coastal barrier beaches and associated dunes are expected to be **minor** due to the small contribution from a proposed action to total channel use and the offsetting effects of beach nourishment.

Trash and Debris

Trash and debris (**Chapters 3.1.3.5 and 3.3.2.4.8**) can be an issue for coastal habitats, including beaches and dunes and the fauna that reside in these habitats. Fauna that utilize barrier beaches and dunes could ingest or become entangled in trash and debris. This can have lethal impacts like suffocation or sublethal impacts like loss of a limb. The BSEE provides information on marine debris and awareness and requires training of all OCS personnel through NTL 2015-BSEE-G03, which also informs operators of regulations set forth by other regulatory agencies (i.e., the USEPA, USCG, and others; refer to **Chapter 4.12**). Due to the annual awareness training required by marine debris mitigations, the handling of waste and trash by industry has improved greatly and the effects on coastal habitats are minimized. Because lease stipulations and regulations, as clarified by NTLs, are in place to reduce impacts from marine trash and debris, impacts related to marine trash and debris would result in **negligible** impacts to coastal barrier beaches and associated dunes.

Coastal Infrastructure Construction

Projected new facilities that are attributed to the OCS Program and a proposed action would rarely, if ever, be located on coastal barrier beaches (**Chapter 3.1.7**). There are 0-1 gas processing plants projected to be constructed as a result of a proposed action. Existing inland facilities 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 extend the life and presence of facilities in eroding areas, which could accelerate localized erosion; however, the impacts on coastal barrier beaches and associated dunes in the vicinity of the construction of a gas processing plant from a proposed action are expected to be **negligible** or **none**, as the location of such a facility is not likely to be adjacent to beaches.

Accidental Events

The types and sources of spills that may be reasonably foreseeable from a proposed lease sale and their characteristics are described in **Chapter 3.2**. There is also a risk analysis of accidental events in **Chapter 3.2.1**. A low-probability catastrophic spill is discussed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

The only accidental event associated with a proposed action likely to impact beaches would be a spill and the associated cleanup activities. Impacts to biological, recreational, and archaeological resources associated with beach and dune environments are described in the impact analysis chapters for those specific resources (**Chapters 4.9**, Protected Species; **4.12**, Recreational Resources; and **4.13**, Archaeological Resources).

Effects of Oil on Beaches

The effects from coastal oil spills depend on the geographic location, volume, and rate of the spill, type of oil, oil-slick characteristics, oceanic conditions, season at the time of the spill, and response and cleanup efforts (**Chapter 3.2.7**). The resiliency of coastal beaches and the impact of oil on these beaches are, in part, based on the toxicity of the oil's components once it reaches the beaches. Microbial biodegradation can reduce the toxicity of crude oil by decreasing PAH concentrations. However, submerged oil mats found in GOM waters adjacent to beaches can resist weathering and may serve as long-term sources of remnant oil and PAHs to beach ecosystems (Hayworth et al., 2011; Elango et al., 2014). In addition, buried supratidal samples undergo less biodegradation due to a lack of oxygen (OSAT-2, 2011).

If unweathered oil reached the beaches, the associated interstitial microfauna would be affected in several ways, including community shifts, toxic effects, and the physical disturbance of response efforts. A shift in the microbial community would tend to increase dominance by hydrocarbon degraders (Kostka et al., 2011). This shift can occur within days of contamination with crude oil, stimulating the breakdown of the contaminants present in the oil (Horel et al., 2012). Toxic constituents of the oil can have both lethal and sublethal impacts to resident plants and fauna. Equipment and personnel used in cleanup efforts can generate the greatest direct impacts to an area, such as the removal of sand from the beaches, disturbance of beach and foredune sands through foot traffic, mechanized cleanup equipment (e.g., sifters), dispersal of oil deeper into sands and sediments, and foot traffic in marshes impacting the distribution of oils and marsh vegetation.

Coastal Spills

Coastal spills from damage to pipelines, vessel collisions, and malfunctions of onshore production or storage facilities have the greatest potential for affecting the coastal barrier beaches due to their proximity to the resources. Because very little OCS oil- and gas-related activity takes place on beaches, inland spills that occur in the vicinity of GOM tidal inlets present a greater potential risk to barrier beaches and dunes because the inlets can provide a path for oil to reach the beaches.

The number and most likely spill sizes to occur in coastal waters in the future are expected to resemble the patterns that have occurred in the past as long as the level of energy-related, other commercial, and recreational activities remains the same. BOEM's analysis shows that 96 percent of spills from OCS oil-and gas-related activity are <1 bbl, with an average size of <0.05 bbl (Anderson et al., 2012). **Table 3-13** shows that there was only one spill ≥1,000 bbl in the coastal waters from Texas through Alabama during the period 2002-2014. Because of the small contribution to all such spills from the proposed action, the small size of most spills, the percentage of spilled oil volume that would likely reach coastal barrier beaches, and the breakdown of contaminants by microbial communities, impacts of coastal spills to barrier beaches and dunes are expected to be **minor**.

Offshore Spills

There are various factors and conditions that affect the toxicity and severity of the impacts of oil spills on the barrier island systems, dunes, and the associated vegetation. 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 [5 19 km] 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 and <1,000 bbl are very infrequent (**Chapter 3.2.1.6.4**). If an oil spill contacted the shoreline, the intertidal area and the beach face would likely be contacted. For the oil to contact the dunes, extreme high tides would be needed to carry oil from a spill across and onto the dunes.

Two important variables during an oil spill for impacts on beaches and dunes involve location (distance of spill from landfall) and weather. For example, if there is sufficient distance and favorable weather conditions between the spill and landfall, the oil can be dispersed, thinned, and emulsified. This would allow for conditions supportive of biodegradation, volatilization, and photooxidation to break down the oil. Most spills from the OCS are likely to be distant enough that, should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small. Due to the distance of the spill from shore, the weather, the time oil remains offshore, and dispersant use (**Chapter 3.2.7.2.2**), OCS crude oil would be less toxic when it reaches the coastal environments. For example, after the *Deepwater Horizon* explosion and oil spill, the majority of oil deposits on GOM beaches were highly weathered and samples showed 86-98 percent depletion of total polycyclic aromatic hydrocarbons (PAHs) (OSAT-2, 2011). However, should spills from the OCS occur proximate to State waters, they could reach shore before much weathering, evaporation, or dispersal had occurred.

The probabilities of an offshore spill ≥1,000 bbl occurring and contacting environmental features are described in **Chapter 3.2.1.5.8**. The probabilities of oil spills ≥1,000 bbl occurring and contacting State waters can be found in **Figure E-20**. The highest probability as a result of a proposed action is estimated at 26 percent for the State waters of both Texas and West Louisiana. Should spills from the OCS occur proximate to State waters, they could reach shore before much weathering, evaporation, or dispersal had occurred. However, because the majority of spills estimated to occur are relatively small (>99% estimated to be <50 bbl), the distance from coastal communities, improved technologies, and the dynamic nature of the coastal environment, offshore spills are expected to have a **minor** impact on the estuarine community.

Cumulative Impacts

This cumulative analysis considers the effects of impact-producing factors related to a proposed action, prior and future OCS lease 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.

OCS Oil- and Gas-Related Impacts

Pipeline Emplacements, Vessel Traffic (Navigation Channel Use), Dredging, Trash and Debris, and Infrastructure Construction

Continued navigation channel use and dredging support of a proposed action could impact coastal habitats. Maintenance dredging of barrier inlets and bar channels is expected to continue, which removes sediment from the system, contributing to beach erosion. Mitigation of impacts involves strategically placing dredged sediment where adjacent barrier-island shores would receive it for island nourishment and rebuilding (Morton, 2008). Beneficial uses of dredged material include beach nourishment for the more sandy materials, and much of the impacts from dredging are expected to be mitigated through the beneficial use program implemented by the COE. Further discussion of the beneficial use of dredged material can be found in **Chapter 3.3.2.9.5**. Impacts to beaches from maintenance dredging would occur regardless if a proposed action is implemented or not. Less than 27 percent of traffic using navigation channels in the GOM is expected to be related to the cumulative OCS Program (**Tables 3-23 and 3-6**). A proposed action is estimated to account for less than 2 percent of the service-vessel traffic in the OCS. Impacts to beaches from maintenance dredging related to OCS oil and gas are expected to be **minor**. Impacts to beaches from OCS oil- and gas-related marine debris would be **minor** to **negligible**.

The effects to coastal barrier beaches and associated dunes from pipeline emplacements and the construction or continued use of infrastructure in support of a proposed action are expected to be restricted to temporary and localized disturbances. Existing pipelines were placed using older techniques and have caused and would continue to cause barrier beaches to narrow and breach. Pipeline landfalls projected in support of the cumulative OCS scenario are expected to cause **negligible** impacts to barrier beaches because of the use of modern, nonintrusive installation methods.

Oil Spills

Due to the proximity of coastal spills to barrier islands and beaches, such spills pose a threat to coastal barrier beaches and dunes. As noted in **Table 3-13**, a few coastal spills ≥1,000 bbl have been recorded in the coastal waters from Texas through Alabama during the period 2002-2014. Spills that occur in or near the Chandeleur or Mississippi Sounds could affect the coastal barrier beaches and dunes in the Gulf Islands National Seashore and the Breton National Wildlife Refuge.

Oil from most offshore spills, except perhaps from OCS oil- and gas-related activities close to the boundary with State waters, is expected to be weathered and normally treated offshore. Therefore, most of the toxic components would have dissipated by the time it contacts coastal beaches. The cleanup impacts of these spills could result in a short-term (up to 2 years) adjustment in beach profiles and configurations as a result of sand removal and disturbance during the cleanup operations. Cleanup efforts would be monitored in an effort to ensure the least amount of disturbance to the areas. However, spill data from the OCS shows that, over decades of activity, tens of thousands of barrels of oil have been spilled (**Chapter 3.2.1.1.3**). Impacts from OCS oil- and gas-related oil spills are expected to be **moderate** due to distance, weathering, and the estimated small number of large OCS spills that would make landfall.

Oil from the *Deepwater Horizon* explosion and oil spill was documented by shoreline assessment teams to have stranded on approximately 560 mi (900 km) of CPA and EPA beach shoreline. Cleanup activities were conducted on 410 mi (660 km) of the affected beach. Two years after the spill, some oil remained on 427 mi (687 km) of the beach but at much lesser amounts (Michel et al., 2013; OSAT-2, 2011). As beaches experience erosion and deposition, oil would become buried, exposed, and remobilized multiple times, resulting in chronic re-oiling. Tropical Storm Lee (2011) and Hurricane Isaac (2012) caused extensive beach erosion and remobilization of oil residues. Oil residue mats were observed between the toe of the beach and the first offshore sand bar, providing another source of chronic sources of surface residue balls and surface residue patties (Michel et al., 2013). Over time, more of the remaining oil has continued to be removed, while toxicity has decreased as the oil is further weathered. The buried supratidal samples underwent less biodegradation due to lack of oxygen, but they were estimated to decrease to 20 percent of current levels within 5 years (OSAT-2, 2011). Accidental spills as a result of a low-probability catastrophic event are discussed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

Non-OCS Oil- and Gas-Related Impacts

Vessel Traffic (Navigation Channel Use)

Construction of the existing navigation channels has replaced beaches with the waterways in some cases, while other channels were constructed using existing passes (**Chapter 3.3.2.8.5**). Construction of the channels involves removal of sand that is no longer available for longshore drift to adjacent beaches. Maintenance dredging of barrier inlets and bar channels would continue to remove sediment from the system, contributing to beach erosion. Sand is removed during dredging, and only a fraction of this sand is used for beach nourishment. Disposal of dredged material outside of the littoral zone represents a net loss of sand to the system, and thus, maintenance dredging has contributed to net deficits (Byrnes et al., 2012). These impacts would occur from necessary channel maintenance to accommodate all vessel traffic, resulting in **moderate** impacts to beaches. More than 98 percent of total vessel traffic is not associated with a proposed action, and therefore, the incremental impacts associated with a proposed action are expected to be **negligible**.

Oil Spills

Non-OCS oil- and gas-related oil spills can occur as a result of import tankers, barge, or shuttle tanker accidents during transit or offloading, State-related oil production activities, and various kinds of petroleum product transfer accidents. State-related oil production activities are concentrated in coastal areas, where spills could potentially cause greater impacts to beaches. The impacts of non-OCS oil- and gas-related spills are expected to be **moderate**.

The GOM has more natural oil seeps (providing ~980,000 bbl/year; refer to **Chapter 3.3.2.15.2**) than any other marine environment in North America; therefore, it has a resident population of microbiota, including oil-biodegrading bacteria, that degrades additional oil that enters the environment (Atlas and Hazen, 2011). This resident microbial population increases the resiliency of beaches to oil spill impacts.

River Hydromodification and Beach Protection

Over the course of geological history, the barrier islands have migrated toward the present coast. The Gulf-facing coasts of the barrier islands have been eroded by the steady relative rise in sea level. Human disturbance has hastened the erosion of barrier beaches and dunes. Channel deepening and widening along the Mississippi River and other major coastal rivers, in combination with channel training and bank stabilization work, has resulted in the reduced delivery of sediment to the eroding deltas along the mouths of the rivers and to the offshore barrier islands. This, coupled with beach building and stabilization projects utilizing mined sands, jetties, groins, and other means of sediment capture, is depriving natural restoration of the barrier beaches through sediment nourishment and sediment transport.

Subsidence, erosion, and dredging of inland coastal areas with the concurrent expansion of tidal influences continually increase tidal prisms around the GOM. These changes may result in the opening and deepening of many new tidal channels that connect to the GOM and inland waterbodies. Due to the increased flow, these incremental changes would cause adverse impacts to barrier beaches and dunes. Efforts to stabilize the GOM shoreline have adversely impacted barrier landscapes. Large numbers and varieties of stabilization techniques for navigation channels have been applied along the Gulf Coast. These efforts have contributed to coastal erosion by depriving downdrift beaches of sediments, which accelerates erosion there, and by increasing or redirecting the erosional energy of waves (Morton, 1982). 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. Impacts of river channelization and beach protection are expected to be **moderate** because of the disruption of sediment nourishment and sediment transport.

Other Anthropogenic and Natural Processes

Barrier beaches along the Gulf Coastal have experienced erosion and landward retreat (marine transgression) because of natural processes enhanced by human activities (**Chapter 3.3.2.**). Adverse effects on barrier beaches and dunes have resulted from changes to the natural dynamics of water and sediment flow along the coast. This can happen in an attempt to control catastrophic floods and change the natural environment to better accommodate navigation on waterways used to support OCS oil- and gas-related and non-OCS oil- and gas-related vessel traffic. Rising sea levels are expected to continue to inundate or fragment low-lying coastal areas, including sandy beaches and barrier islands (Dahl, 2011). Sea-level rise and coastal subsidence and tropical storms exacerbate and accelerate the erosion of coastal barrier beaches along the Gulf Coast. The Gulf Coast and the associated barrier islands and dunes have been impacted by high-intensity hurricanes and tropical storms over the past millenia, resulting in natural changes in barrier island topography and decreases in beach elevation (USDOI, GS, 2008; Barras, 2007a). Due to the more gentle slopes, removal of beach ridges, and cuts into the mainland barrier beaches, the remnant transition zone between the water and the current beach ridge may be more vulnerable to spills. Historically, recovery of beaches to their pre-storm state ranges from years to decades (Houser et al., 2015).

If the topography is modified, it may result in hydrological changes that enable further sediment transport from the islands. This provides pathways for further erosion and saltwater intrusion into the less salt-tolerant interior vegetated habitats of the islands. The loss of elevation, combined with the shoreline retreat and removal of vegetation further aggravated by the hurricanes, allows for the expansion of the overwash zone. This lessens the pre-storm protection of the coast provided by these barrier islands. The reduction in island elevation results in less frontline protection to valuable marshes and puts urban and industrial areas protected by these marshes at a higher risk (USDOC, NMFS, 2007b).

Hurricanes and tropical storms would remain a part of the Gulf Coast weather pattern and would continue to affect the elevations of barrier islands, mainland beaches, and dunes. Depending on storm frequency and intensity, it may be possible for coastal restoration and protection projects to mitigate some of the physical damage to these areas.

Gulf Coast barrier beaches tend to occur at low elevations, between sea level and several feet above sea level. Beach erosion due to sea-level rise has increased along certain shorelines (Dahl, 2011). If current projections are realized and the sea level increases by 3.5 ft (1.1 m) in Galveston, Texas, by 2100 (USEPA, 2013), much of Texas' coastal beaches would be under water well before 2100. A more conservative estimate of sea-level rise, known as the AR4 scenario, calls for an increase (globally) of 16 in (41 cm) by 2100 (NRC, 2010). Even this rate of increase would be likely to impact Gulf Coast beaches, especially when local, relative sea-level rise is considered.

Since 1870, global sea level has risen by about 8 in (20 cm) (USEPA, 2013d). Even at current measured rates of relative sea-level rise, large areas of GOM coastal beaches can be expected to be inundated (refer to **Chapter 3.3.2.12.1**). Impacts to coastal habitats are expected to be **major** due to the large scale of inundation from sea-level rise and the erosion due to hurricanes and human activities.

Recreational Use, Tourism, and Development

Recreational use of beaches is discussed in **Chapter 4.12** (Recreational Resources). 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. Recreational vehicles and even hikers have caused impacts where road access is available and the beach is wide enough to support vehicle use. Most barrier beaches in Texas are accessible to people for encouraged recreational use because of public road access. It also provides for public acquisition of private beachfront property. Most barrier beaches in Louisiana are relatively inaccessible for regular recreational use because they are in coastal areas with limited road access. Mississippi has coastal beaches behind the barrier islands that are accessible for recreational use, and the barrier islands experience extensive recreational use by boaters. Most barrier beaches in Alabama and the panhandle of Florida are accessible to foot traffic through road access, and their use is encouraged. There would continue to be seaside real-estate development where road access is available. The protection of dunes, beaches, and coastal environments are regulated through the Coastal Management Programs of the states, as well as the COE's permitting program. This helps to assure that projects are constructed consistent with the Federal CZMA guidelines in order to preserve the integrity of the coastal ecosystem. In the years 2004 through 2009, there were modest gains in marine and estuarine nonvegetated wetlands, a category that includes beaches (Dahl, 2011; Dahl and Stedman, 2013). A proposed action would not provide any additional access that would result in increased negative cumulative impact to the barrier beaches and dunes.

Development along the Gulf Coast has impacted coastal barrier beaches. Census data show that coastal areas are experiencing much higher growth than noncoastal areas. However, census data may underestimate this trend due to undercounting of seasonal residents. Infrastructure needed to support seasonal influxes of people can impact coastal barrier beaches (Dahl and Stedman, 2013). Hotels, restaurants, stores, and bars have been built on or adjacent to many coastal beaches, resulting in loss of habitat as well as the introduction of wastewater into coastal waters. High-use "amenity" beaches can benefit from frequent beach nourishment projects that supply large quantities of sand. Impacts are to some extent offset by coastal restoration programs. Examples of these programs are the Coastal Impact Assistance Program (CIAP), the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), and the RESTORE Act (refer to **Chapter 3.3.2.12.4**). Due to the protection from development of beaches included in the Gulf Islands National Seashore, restrictions on development by the various regulatory programs and continuing cumulative impacts of past development on coastal barrier beaches, impacts are expected to be **moderate**.

Coastal barrier beaches have experienced severe adverse cumulative impacts from human activities and natural processes. Human activities that have caused the greatest adverse impacts are navigation channel stabilization and maintenance, beach stabilization structures, oil spills, recreation and development, river channelization and damming, and pipeline canals. Most barrier beaches in Texas, Alabama, and Florida are accessible to people for recreational use, and their use is encouraged and intense. Excessive recreational use can result in damage to dunes, resulting from the loss of dune stabilizing plants. Existing pipelines were placed using older techniques and have caused and may continue to cause barrier beaches to narrow and breach. Natural and anthropogenic events have combined to cause erosion of barrier and shoreline landforms along the Gulf Coast. Cumulative impacts to barrier beaches and dunes from these sources are considered to be **major**.

While the cumulative impacts to coastal barrier beaches from the factors described above range from negligible to major, the incremental impact to beaches from a proposed lease sale would be **negligible**. The relatively small contribution of a proposed lease sale to OCS oil- and gas-related activity would have impacts that are much less than those attributed to several sources, as noted above.

Incomplete or Unavailable Information

BOEM acknowledges that there remains incomplete or unavailable information regarding coastal barrier beaches and associated dunes in the GOM. There is incomplete information about routine impacts, as the scenario forecast is only an estimate, and many global factors can affect OCS oil- and gas-related activity. There also remains unavailable information about future rates of oil spills, as well as the locations and volumes of oil. Future rates of coastal development are unknown, as is the extent of such impacts to coastal barrier beaches. There are also unknowns regarding the future restoration efforts being planned, such as what specific projects would ultimately be constructed and how successful they may be. In addition, the future rates of relative sea-level rise are not known with certainty (Hausfather, 2013), and thus, the resulting impacts to coastal barrier beaches and associated dunes are unknown.

A large body of information regarding impacts of the *Deepwater Horizon* explosion, oil spill, and response upon coastal barrier beaches and associated dunes has been developed and continues to be developed through the NRDA process, but information remains incomplete. As there is substantial information available since the *Deepwater Horizon* explosion, oil spill, and response, which has been analyzed for this Multisale EIS, BOEM believes that the incomplete or unavailable information regarding the effects of the *Deepwater Horizon* explosion, oil spill, and response on coastal barrier beaches and dunes would likely not be essential to a reasoned choice among alternatives. The incomplete information would not be available within the timeframe contemplated by the NEPA analysis of this Multisale EIS. However, much is known about the extent of the oiling of beaches and the continuing degradation of the remaining oil.

BOEM has determined that the information is not essential to a reasoned choice among alternatives. BOEM's subject-matter experts have used what scientifically credible information is available in their analyses, applied using accepted scientific methodology. Many studies have been produced that demonstrate the effects of exposure of beaches to crude oil, covering a wide range of exposure intensity, longevity, and oil characteristics. Much has been learned about the effect of oil-spill cleanup on beaches and the degradation rates of oil over time. In addition, studies have been produced regarding the long-term impacts of navigation canal dredging on beaches and barrier islands. A proposed lease sale would result in a relatively minor addition to existing routine activities and accidental events, and therefore, the incremental increase in impacts to coastal barrier beaches and dunes from a proposed lease sale would be minor given what is currently known.

The potential for impacts from changes to the affected environment (post-*Deepwater Horizon*) and cumulative impacts remains whether or not the No Action or an action alternative is chosen. Compared with the historic and ongoing threats to coastal barrier beaches and dunes, such as sea-level rise, development threats, and sediment deficits, the remaining effects of the *Deepwater Horizon* explosion, oil spill, and response on coastal barrier beaches and dunes is expected to be small.

4.3.2.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Impacts from most routine activities related to a proposed action would be expected to be **negligible** since most routine activities are located far from coastal beaches. Impacts to coastal barrier beaches and associated dunes from pipeline emplacements, navigation channel use and maintenance dredging, and construction or continued use of infrastructure in support of a proposed action are expected to be restricted to temporary and localized disturbances and to cause **negligible** impacts to barrier beaches because of the small number of expected pipeline landfalls and the small contribution from a proposed action to channel use and maintenance. Any new OCS oil- and gas-related infrastructure would not be expected to be constructed on barrier beaches. Indirect impacts from routine activities, such as disruption of sediment transport by maintenance dredging of channels or erosion resulting from pipeline emplacements, are **negligible.**

Minor and localized impacts to the physical shape and structure of barrier beaches and associated dunes may be expected to occur as a result of accidental events, such as oil spills, associated with a proposed action. Such impacts could be a result of cleanup efforts in addition to the spill itself. Should a spill contact a barrier beach, sand removal during cleanup activities would likely be minimized because current spill-response activities discourage physical cleanup methods that impact beach profiles. The Net Environmental Benefits Analysis done as part of the OSAT-2 report (2011) noted that the environmental impacts of residual oil remaining after cleanup are relatively small when compared with the impacts of continued cleanup efforts on both beach habitats and associated resources.

The impacts of oil spills and related cleanup efforts from both OCS oil- and gas-related and non-OCS oil- and gas-related sources to the Gulf Coast depend on the size, frequency, distribution, locations, and collective spatial and temporal features of the spills. Impacts would include stranding of surface residue balls and patties, and submerged tar mats may persist in adjacent waters, representing a chronic source of contamination, particularly after storms. Changes to beach topography could result from cleanup efforts. Overall impacts from oil spills are expected to be **minor**, with the exception of a catastrophic event, which is not considered reasonably foreseeable and is not part of a proposed action or likely expected to occur. Impacts as a result of a low-probability catastrophic event are discussed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

Compared with other impact-producing factors on coastal barrier beaches and dunes, the incremental contribution of a proposed action to the cumulative impacts to these resources is expected to be **minor**.

4.3.2.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

The impacts of this alternative would be similar to those of Alternative A, except that there would be **negligible** impacts to coastal barrier beaches and dunes in Texas because no OCS oil- and gas-related activity is forecast in the WPA along the Texas coast with this alternative. Under Alternative B, the resulting OCS oil- and gas-related activity would be located off the coasts of Louisiana, Mississippi, and western Florida. The greater distance between these activities and the coastal habitats of Texas would reduce impacts along the Texas coast whether from routine activities or accidental events. Less use of service bases in Texas is likely, and the distance between oil spills associated with this alternative and the Texas coast is expected to be greater.

4.3.2.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

The impacts of this alternative would be less than those under Alternative A, as only a fraction of the resulting activity forecasted for Alternative A is projected for Alternative C. For this alternative, there would be **negligible** incremental impacts to coastal barrier beaches and dunes in Louisiana; and zero to **negligible** impacts to Mississippi, Alabama, and the panhandle of western Florida; and incrementally more impacts to the beaches and dunes of Texas. However, Alternative C would have less potential for impact than Alternative A or B as the level of projected OCS oil- and gas-related activities and impact-producing factors are much less in the WPA. For example, a range of 11-67 production wells are projected to be drilled and developed under Alternative C, whereas 58-464 production wells are projected to occur under Alternative B. The significance of impact-producing factors on coastal barrier beaches and dunes would be somewhat less for Alternative C than for Alternative A, as discussed in **Chapter 2.2.2**.

4.3.2.2.4 Alternative D—Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

The impacts of this alternative would be nearly identical to those of the alternative it is combined with because the available unleased blocks with topographic features do not contain coastal barrier beaches and dunes and are too distant (over 25 km; 16 mi) from the coast to have indirect impacts. In addition, there are only 367 blocks subject to the Topographic Features Stipulation, 74 blocks subject to the Live Bottom (Pinnacle Trend) Stipulation, and 32 blocks subject to the Blocks South of Baldwin County, Alabama, Stipulation. This relatively small percentage of the total number of available unleased blocks would not be expected to generate a great contribution to OCS oil- and gas-related activity, if leased.

4.3.2.2.5 Alternative E—No Action

If a proposed lease sale does not occur, there would be no additional impacts to barrier beaches and associated dunes; however, cumulative impacts would be the same as for Alternative A. There could be some incremental increase in impacts caused by a compensatory increase in imported oil and gas to offset reduced OCS production, but it would likely be **negligible**.

4.4 DEEPWATER BENTHIC COMMUNITIES

BOEM defines "deepwater benthic communities" as including both chemosynthetic communities (chemosynthetic organisms plus seep-associated fauna) and deepwater coral communities (deepwater coral plus coral-associated fauna). This chapter presents an analysis of the potential impacts on deepwater benthic communities as a result of routine activities and accidental events associated with a GOM proposed action and a proposed action's incremental contribution to cumulative impacts. The analysis is not exhaustive of all possible impacts of routine activities and accidental events; rather, it focuses on those most relevant for decisionmakers. Potential impacts from a catastrophic oil spill, including long-term impacts and recovery, are detailed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

Because of the similarity and overlap of the effects of many activities that occur in the OCS, the primary, reasonably foreseeable routine and accidental impact-producing factors for deepwater benthic habitats can be grouped into three main categories:

(1) bottom-disturbing activities (**Chapter 3.1.3.3.1**; routine and accidental);

(2) drilling-related sediment and waste discharges (**Chapter 3.1.5.1**; routine and accidental); and

(3) oil spills (**Chapter 3.2.1**; accidental).

Cumulative Impacts were also considered, in two steps: impacts resulting from OCS oil- and gas-related activities (same as routine activities and accidental events); and impacts resulting from non-OCS oil- and gas-related sources, namely fishing and climate change.

Some impact-producing factors relevant to deepwater benthic communities are already analyzed in greater detail in other sections and need only be briefly summarized here. **Chapter 4.7** (Fishes and Invertebrate Resources) details the potential impacts to marine invertebrates from anthropogenic sound and concludes the impact would be **negligible**. Note that despite the growing body of information available for fishes, there is comparatively little information available on sound detection and sound-mediated behaviors for marine invertebrates. **Chapter 4.7** (Fish and Invertebrate Resources) also details the impacts of routine activities and the cumulative impacts from the presence and subsequent removal of OCS oil- and gas-related infrastructure. These impacts include the post-installation physical presence of OCS oil- and gas-related infrastructure, effects of decommissioning activities such as explosive and nonexplosive removals, and conversion of platforms to artificial reefs. While the total contribution of OCS infrastructure is still only a small percentage of natural hard bottoms (Gallaway et al., 2009), and is projected to further decrease throughout the period covered by this analysis (**Chapter 3.3.1.5**), the presence, removal, and/or conversion of artificial hard substrates colonized by sessile invertebrates are likely to result in localized community changes, such as changes in species diversity in the area (Schroeder and Love, 2004). While individual presence, removal, or conversion actions at specific locations do not cause more than **negligible** impacts when considered against the broader scope of this analysis, when the sum of such actions are considered cumulatively for all planning areas and over 50 years, such impacts could be greater for individual species . This is because select sessile benthic species commonly associated with OCS oil and gas structures could be noticeably influenced over time by the overall presence (or removal) of OCS oil- and gas-related infrastructure. For example, a particular deepwater coral species' Gulfwide spatial distribution may shift over time because of the presence or removal of structures in otherwise soft bottom-dominated areas. Such a change (were it to occur) could be considered a moderate level impact for that species If it represented a detectable change in the species' spatial distribution, such a range shift might have potential long-term effects related to dispersal and genetic connectivity to other populations of that species. Such potential impacts are not necessarily either positive or negative; that would be dependent on the species and a number of complex ecological factors. Some evidence of these types of changes (in particular, range expansion) has been documented for some shallow-water hermatypic species (Sammarco et al., 2012), but similar research specific to deepwater coral is lacking, as noted in the "Incomplete or Unavailable Information" section below. More peer-reviewed literature about this topic is available for fish resources, as detailed in **Chapter 4.7**.

Several additional impact-producing factors described in **Chapter 3.1** were evaluated for potential impacts on deepwater benthic communities. These impact-producing factors were not carried forward for full analysis because any potential effects were judged to be either not reasonably foreseeable or having such a miniscule impact that they would not rise to the level of negligible impact. These impact-producing factors include surface oil-spill response efforts (refer to **Chapter 4.6.1**, Topographic Features), impacts from geological and geophysical activities other than bottom disturbance (bottom disturbance is covered below), and potential impacts from a sinking vessel. A sinking vessel settling on a deepwater benthic community is not a reasonably foreseeable impact-producing factor. Even if such an incident did occur, it would not have a population-level impact despite likely crushing or smothering deepwater benthic organisms in the local area of direct contact.

Some potential impact-producing factors are already regulated by other Federal agencies and/or international treaties. For example, the discharge of marine debris is subject to a number of laws and treaties (refer to **Chapter 3.1.5.3.4**). These include the Marine Debris Research, Prevention, and Reduction Act; the Marine Plastic Pollution Research and Control Act; and the MARPOL-Annex V Treaty. Regulation and enforcement of these laws is conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. To further reduce potential impacts, the BSEE provides information on marine debris and requires training of all OCS personnel through the “Marine Trash and Debris Awareness and Elimination” NTL (NTL 2015-BSEE-G03). This NTL instructs OCS operators to post informational placards that outline the legal consequences and potential ecological harm of discharging marine debris. This NTL also states that OCS workers should complete annual marine debris prevention training; operators are also instructed to develop a certification process for the completion of this training by their workers. Typically, compliance with this NTL has been mandatory as a result of the Protected Species Stipulation that has been applied at the lease sale stage. These various laws, regulations, and NTL would likely minimize any potential damage to live bottom resources from the discharge of marine debris related to OCS oil- and gas-related operations. Nonetheless, some accidental release of marine debris is still likely to occur as a result of OCS oil- and gas-related operations and could theoretically have limited effects on deepwater benthic organisms (e.g., physical damage caused by strong currents pushing debris into fragile organisms or ingestion of plastics by invertebrates). However, the amount of debris in question would not suffice to cause even negligible impacts when considered at the scale of the overall population of deepwater benthic communities in the GOM. One possible exception would be frequent accidental losses of very large items such as pipeline segments with the potential to crush or smother organisms. That impact-producing factor is briefly discussed under “Accidental Events: Bottom-Disturbing Activities” below, even though any such losses are expected to be very rare. In all cases, the likelihood of spatial overlap with debris from OCS oil- and gas-related vessels or infrastructure is inherently small due to the relatively rare and patchy distribution of live bottom communities in the GOM, particularly in areas of the western and northern GOM, which have the greatest amount of OCS oil- and gas-related operations.

Another potential impact-producing factor that is largely governed by (and potential impacts reduced by) external regulations is the potential presence of toxins in drilling muds and cuttings and/or produced waters (**Chapter 3.2.6**). Because of the regulations issued by the USEPA and/or international treaties designed to keep toxins below harmful levels, hazardous levels of toxins are generally not expected to reach deepwater benthic communities. Nonetheless, potential impacts from toxins are briefly discussed under “Routine Activities” below.

The impact significance criteria and resulting conclusions presented in **Table 4-6** focus on the overall functioning, resilience, and ecosystem level importance of deepwater benthic communities throughout U.S. waters of the GOM. Postlease, site-specific analyses would focus more on potential localized impacts of individual development activities (e.g., proposed drilling of a well) to individuals, discrete communities, and small patches of benthic habitat. Those analyses would also detail site-specific protective mitigations required prior to approval of such activities.

Table 4-6. Deepwater Benthic Communities Impact-Producing Factors.

Deepwater Benthic Communities	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Bottom-Disturbing Activities and Drilling-related Sediment and Waste Discharges					
Without Mitigation	Minor to Major	Minor to Moderate	Minor to Moderate	Minor to Major	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Bottom-Disturbing Activities and Drilling-Related Sediment and Operational Waste Discharges					
Without Mitigation	Minor to Major	Minor to Moderate	Minor to Moderate	Minor to Major	None
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Oil Spills					
Without Mitigation	Minor to Major	Minor to Moderate	Minor to Moderate	Minor to Major	None
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Cumulative Impacts					
OCS Oil and Gas					
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Non-OCS Oil and Gas					
Fishing and Climate Change (dependent on unpredictable future conditions)	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major

N/A = not applicable.

Impact-Level Definitions

For this analysis, the following definitions were used to categorize impacts to pinnacles and low-relief features:

- **Negligible** – Impacts to deepwater benthic communities are largely undetectable. There is some potential for even undetectable impacts to cause slight changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not alter the overall status of GOM deepwater benthic communities.
- **Minor** – Impacts to deepwater benthic communities are detectable but cannot be clearly distinguished from natural variation. Such impacts could result in changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but would be spatially localized, short term in duration, and would not alter the overall status of GOM deepwater benthic communities.
- **Moderate** – Impacts to deepwater benthic communities detectably cause substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive but are expected to only temporarily alter the overall status of GOM deepwater benthic communities; long-term recovery to pre-impact levels is likely.
- **Major** – Impacts to deepwater benthic communities detectably cause substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive and noticeably alter the overall status of GOM deepwater benthic communities such that long-term recovery to pre-impact levels is unlikely.

Historical Protections of Deepwater Benthic Communities

Protective measures have been developed over time based on the nature and sensitivity of various benthic habitats and their associated communities, as understood from decades of BOEM-funded and other environmental studies. NTL 2009-G40, "Deepwater Benthic Communities," provides operators with relevant information and consolidates guidance for the avoidance and protection of the various types of potentially suitable habitat for chemosynthetic organisms and deepwater coral. As detailed in NTL 2009-G40, all plans submitted for permitted deepwater (300 m [984 ft] or greater) activities are reviewed for the presence of deepwater benthic communities that may be impacted by the proposed activity. Lessees must provide site-specific survey and narrative information regarding sensitive benthic features with each exploration plan (EP), development operations coordination document (DOCD), and development and production plan (DPP). These plans are reviewed by subject-matter experts on a case-by-case basis to determine whether a proposed operation could impact a benthic community. If an impact from drilling or other seafloor disturbance (e.g., anchors, anchor chains, rig emplacement, pipeline emplacement) is judged likely based on site-specific information derived from the geohazard survey data, BOEM's databases and studies, other published research, or another creditable source, the operator would be required to relocate the proposed operation (i.e., distancing) or undertake other appropriate mitigations to prevent such an impact. As detailed above, BOEM's subject-matter experts make use of the best available datasets to identify probable habitat that could support deepwater chemosynthetic and coral communities, including BOEM's publicly available database of water-bottom anomalies (USDOI, BOEM, 2015c). This analysis assumes continuation of the protective measures outlined in NTL 2009-G40.

4.4.1 Description of the Affected Environment

Chemosynthetic communities are formed around natural hydrocarbon seepages where bacteria consume methanes and sulfides and chemosynthetically derive amino acids and sugars for respiration, and then excrete carbon dioxide that may result in calcium carbonate precipitation. Eventually, sufficient precipitates can form hard carbonate substrates on which higher order organisms such as structure-forming deepwater sponges and corals can settle. Relatively large numbers of invertebrate and fish species may be attracted to structurally complex microhabitats, which can provide shelter, feeding areas, and nursery grounds (Fraser and Sedberry, 2008). Over 330 chemosynthetic communities have been confirmed in the GOM to date; more communities likely exist but much of the seafloor has not yet been visually surveyed. Much is still unknown about these communities, despite increasing research in recent decades.

Deepwater coral communities are known to occur throughout the GOM (**Figure 4-12**) and new communities are routinely discovered with almost every new deepwater research cruise (USDOC, NOAA, 2014). As with shallow-water live bottom communities (**Chapter 4.6**), almost all GOM deepwater corals require exposed hard substrate for attachment and growth. They often co-occur on authigenic substrates (substrates that have been generated where they are found) created by chemosynthetic processes; however, they also routinely colonize other natural or artificial hard substrates not associated with hydrocarbon seepage. In addition to hard and soft deepwater corals, these communities include other associated sessile and motile fauna such as sponges, anemones, echinoderms, crustaceans, and fishes.

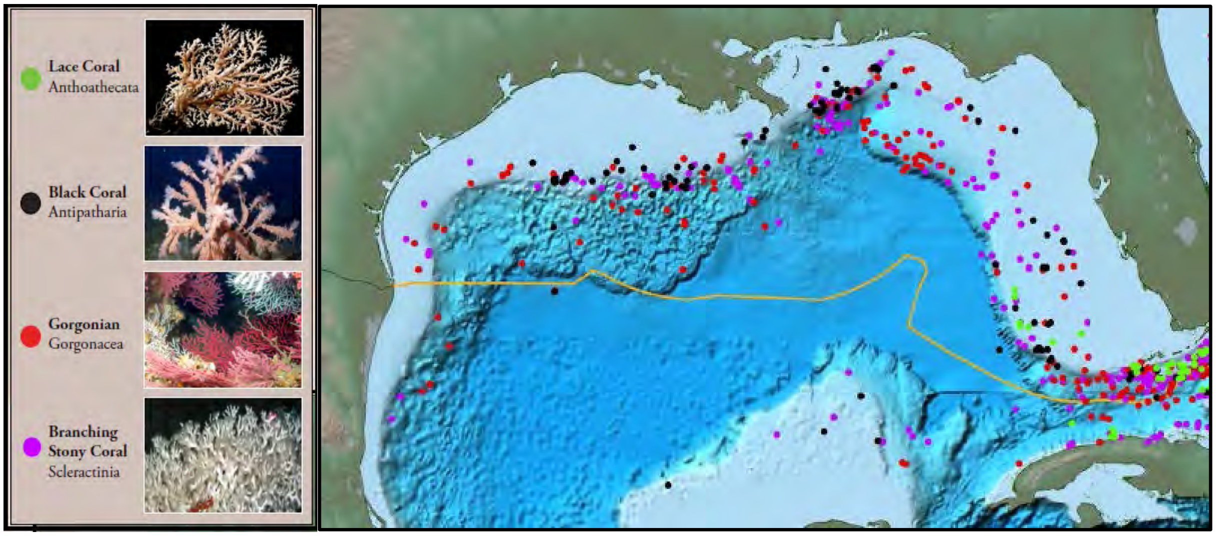

Figure 4-12. Deepwater Coral Records from NOAA's National Deep-Sea Coral and Sponge Database (USDOC, NOAA, 2014).

Gulf of Mexico Continental Slope and Deepwater Biological Resources

The northern GOM's continental slope region has been described as the most complex in the world (Carney, 1997 and 1999; Rowe and Kennicutt, 2009). It is a transitional environment influenced by processes of both the shelf (<650 ft; 200 m) and the abyssal GOM (>3,199 ft; 975 m). This transitional character applies to both the pelagic and the benthic realms. Regional topography of the slope consists of basins, knolls, ridges, and mounds derived from the dynamic adjustments of salt to the introduction of large volumes of sediment over long time scales.

Deepwater environments of the GOM have only been well studied in recent decades; historically there have been relatively few studies due to the logistical difficulties involved in deepwater research. The first substantial collections of deep GOM benthos were made during the cruises of the USCG and Geodetic Steamer, *Blake*, between 1877 and 1880. Rowe and Menzel (1971) reported the first quantitative data published about GOM infauna for this region. Texas A&M University researchers performed the first major study of the deep northern GOM between 1964 and 1973 (Pequegnat, 1983). A more recent study was completed by LGL Ecological Research Associates and Texas A&M University in 1988 (Gallaway et al., 1988). The major *Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study* (Rowe and Kennicutt, 2009) lasted 6 years. The recent studies provide extensive background information on deepwater GOM habitats and biological communities relevant to this analysis and can be referenced for more detail.

The proposed lease sale area encompasses a vast range of habitats and water depths. The shallowest portions start nearshore at the boundary of State waters, and the deepest portions extend to approximately 11,483 ft (3,500 m) south of the Sigsbee Escarpment (which is centrally located in the Gulf of Mexico), nearly into the deepest part of the GOM (14,383 ft; 4,384 m). De Soto and Mississippi Canyons are perhaps the two most notable geologic seafloor features in the northern GOM, exerting control over water currents, upwelling features, and biological productivity. The sediment-laden freshwater plume from the Mississippi River and the Gulf Loop Current are the major controlling oceanographic factors in the GOM.

"Deepwater" is a term of convenience used in this analysis to refer to water depths greater than 300 m (984 ft). The majority of deepwater seafloor in the GOM is typically covered by clay and silt (Jenkins, 2011). In, on, and directly above these sediments live a wide variety of "benthos," or benthic organisms, from microbiota up through megafauna. Their ecological adaptations are extremely varied and can include absorption of dissolved organic material, symbiosis, collection of food through filtering, mucous webs, seizing, or other mechanisms, including chemosynthesis.

Deepwater fauna can be grouped into major assemblages defined by depth: (1) upper slope; (2) mid-slope; (3) lower slope; and (4) abyssal plain (Rowe and Kennicutt, 2009). The 450-m (1,476-ft) depth contour delimits the approximate beginning of the aphotic zone where visible light no longer penetrates and where photosynthesis cannot occur, with resultant changes to processes of food consumption, biological decomposition, and nutrient regeneration. The continental shelf-slope transition zone begins at approximately 150 m (492 ft) and the abyssal zone begins at approximately ≥1,000 m (3,281 ft). The different zones can be subdivided into the following divisions and characteristic faunal assemblages:

- Shelf-Slope Transition Zone (150-450 m; 492-1,476 ft)—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.
- Archibenthal Zone – Horizon A (475-740 m; 1,558-2,428 ft)—Although less abundant, demersal fish are a major constituent of the fauna, as are gastropods and polychaetes. Sea cucumbers are more numerous.
- Archibenthal Zone – Horizon B (775-950 m; 2,543-3,117 ft)—This zone 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.
- Upper Abyssal Zone (1,000-2,000 m; 3,281-6,562 ft)—Number of fish species decline while the number of certain invertebrate species appear to increase. Sea cucumbers and galatheid crabs are common
- Mesoabyssal Zone (2,300-3,000 m; 7,546-9,843 ft)—Fish species are few, and echinoderms continue to dominate the megafauna.
- Lower Abyssal Zone (3,200-3,800 m; 10,499 to 12,468 ft)—A large asteroid is the most common megafaunal species.
- The lowermost layer is the benthic zone, defined as the seafloor itself and the waters immediately above it. This zone is a repository of sediments where nutrient storage and regeneration take place in association with the solid and

semisolid substrate (Pequegnat, 1983). Characteristic fauna may be different depending on the actual depth of the seafloor.

The vast majority of the GOM seabed is comprised of soft sediments (Rezak et al., 1983; Jenkins, 2011). Sediments in the EPA consist primarily of sand, while a more heterogeneous mix of sand, silt and clay sediments are found in the CPA and WPA (Brooks and Darnell, 1991). Grain size is the most important substrate characteristic affecting the distribution of benthic fauna (Vittor, 2000). Major groups of animals that live in sediments include (1) megafauna (visible to the naked eye), (2) macrofauna (>0.01 in; 0.3 mm), (3) meiofauna (0.002-0.01 in; 0.063-0.3 mm), and (4) bacteria and other microbiota. All of these groups are represented throughout the entire GOM − from the continental shelf to the deepest abyssal depths. This analysis focuses on the better known megafauna and their habitats.

4.4.1.1 Chemosynthetic Communities

Chemosynthetic communities begin with chemosynthetic bacterial mats that consume methane and sulfides; their respiration results in the precipitation of calcium carbonate, forming a new, hard substrate. Certain deepwater coral and sponge species can then attach to exposed hard substrates, thereby adding to the structural complexity of the microhabitat. The new benthic habitats provided by chemosynthetic fauna themselves (i.e., tubeworm bushes), the precipitated hard substrates, and the framework-forming corals can all be used by a variety of benthic invertebrates, including echinoderms (e.g., brittle stars and basket stars), sea anemones, crustaceans, and other benthic megafauna such as fishes, forming a broader chemosynthetic community.

The GOM has some of the most active natural oil and gas seeps in the world (refer to **Chapter 3.3.2.9.2**; NRC, 2003), and these seeps can support development of complex deepwater faunal communities (MacDonald, 1993; Cordes et al., 2010). The food chain for this ecosystem relies on bacterial primary producers that consume methanes and sulfides rather than performing photosynthesis. Chemosynthetic bacteria, which live on mats, in sediment, and in symbiosis with chemosynthetic invertebrates, use a carbon source independent of photosynthesis to make sugars and amino acids. Chemosynthetic invertebrates including tube worms and bivalves occur at or near hydrocarbon seeps and are dependent upon these symbiotic chemosynthetic bacteria as their primary food source (MacDonald, 1992). The bacteria live within specialized cells in the invertebrate organisms and are supplied with oxygen and chemosynthetic compounds by the host via specialized blood chemistry (Fisher, 1990). The host, in turn, lives off the organic products subsequently released by the chemosynthetic bacteria and may even feed on the bacteria themselves.

Distribution and Detection

Chemosynthetic communities typically occur in the GOM at water depths greater than 300 m (984 ft). Temperatures at these depths range from about 55°F to 39°F (13°C to 4°C). Water currents at the seafloor are typically about 2-4 inches/second (5-10 centimeters/second). The chemosynthetic communities occur as widely scattered, patchy habitat, developing where hydrocarbons seep up with a moderate flow.

Seeps occur where hydrocarbons vertically migrate up through faults, fractures along the flanks of salt, or other conduits to the seafloor. The exact number of natural oil prone seeps in the GOM is not known, although volume estimates have been made using surface oil slicks and the numbers are considerable (MacDonald et al., 1993; NRC, 2003). Even less is known about the number and flux of gas prone seeps in the GOM since no observable sea-surface slicks are present. What is known is that the overwhelming majority of seeps are gas prone, not oil prone. Hydrocarbon source rocks occur over broad areas several kilometers beneath the seafloor of the GOM, but chemosynthetic communities occur in isolated areas at the seafloor. Seepage from deep hydrocarbon sources through subsurface conduits tends to be focused through the sediments, carbonate outcrops, and hydrate deposits at the seafloor. Therefore, GOM 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).

As of 2015, at least 330 chemosynthetic communities have been confirmed (by government, academia, and industry) to exist in the Gulf of Mexico (**Figure 4-13**). Chemosynthetic communities dependent on hydrocarbon seepage have been documented in water depths as shallow as 951 ft (290 m) (Roberts et al., 1990) and at least as deep as 9,000 ft (2,743 m) (Roberts, 2010). But these known depth limits may only be reflective of the current limits of exploration due to the logistic difficulties of deepwater research; relatively few available submersibles are capable of exploring deeper than 3,281 ft (1,000 m). Given the rapid rate of discovery and improved understanding in recent years, the evidence suggests chemosynthetic communities could be more prevalent than once thought.

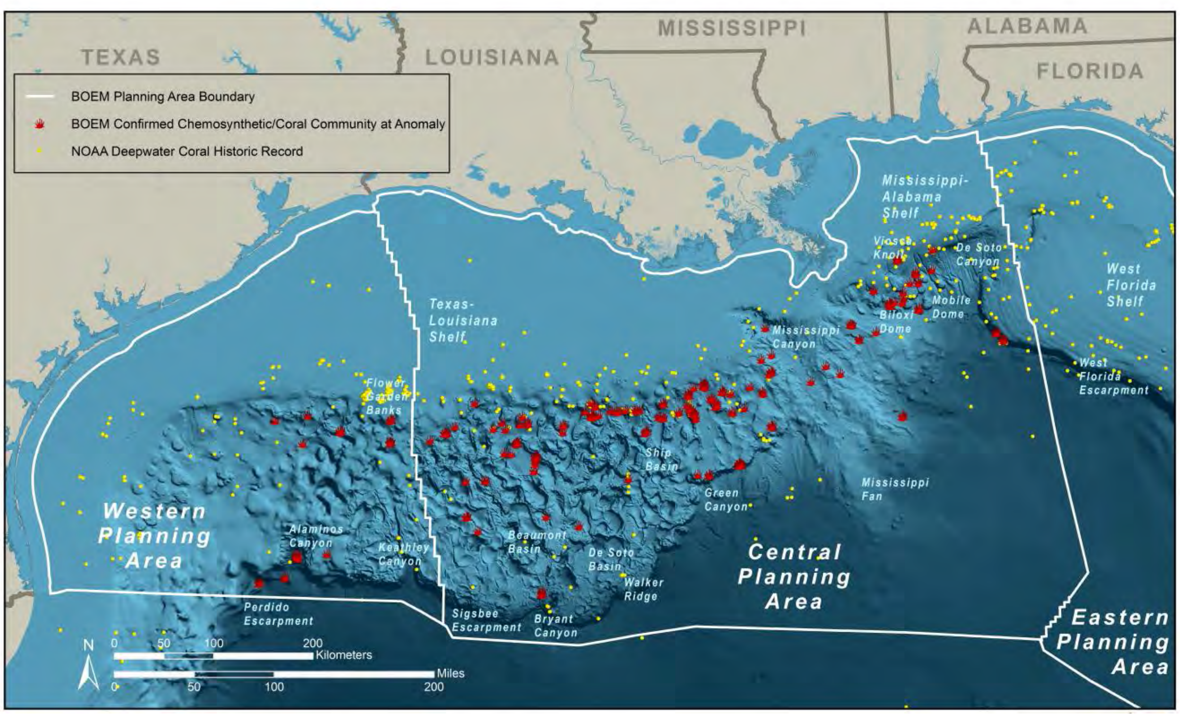

Figure 4-13. Estimated Distribution of Known Deepwater Benthic Communities in the Gulf of Mexico as of 2015.

Hydrocarbon seeps and chemosynthetic communities living on them modify the near-surface geological characteristics in ways that can be remotely detected, such as through 2D and 3D seismic anomaly detection (USDOI, BOEM, 2015c). These known sediment modifications include the following: (1) precipitation of authigenic carbonate in the form of interstitial cements, 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 various detectable acoustic effects (details in Behrens, 1988; Roberts and Neurauter, 1990). Potential locations for most types of communities can be estimated by careful interpretation of these various geophysical modifications (Sager, 1997) and can help direct and focus follow-up visual surveys needed to definitively confirm the presence or absence of chemosynthetic communities.

BOEM's subject-matter experts make use of the best available datasets to identify probable habitat that could support deepwater benthic communities. A primary such dataset is BOEM's publicly available database of water-bottom anomalies (USDOI, BOEM, 2015c). Using decades of 3D seismic amplitude data, BOEM geoscientists have identified and mapped over 31,000 water-bottom (seafloor) acoustic amplitude anomalies covering a majority of the deep waters in the northern Gulf of Mexico (**Figure 4-14**). One of the purposes of this effort is to better understand the distribution of natural hydrocarbon seeps and related chemosynthetic communities and deepwater coral communities. The areas of anomalously high or low seafloor reflectivity have been classified into general categories of seafloor features, including those that are thought to support chemosynthetic and deepwater coral communities (USDOI, BOEM, 2015c). As of 2015, BOEM is aware of a total of 332 seep anomalies that have been visually confirmed through photography, video, and manned submersible dives to contain associated chemosynthetic and/or coral communities (**Figure 4-14**, shown in orange); however, that relatively low number is largely due to a lack of visual survey effort required for definitive visual confirmation. Several of the other anomaly categories may also contain potential habitat capable of supporting deepwater chemosynthetic and coral communities. Additional information is being collected and analyzed by BOEM's geoscientists and provided to BOEM's subject-matter experts on an ongoing basis.

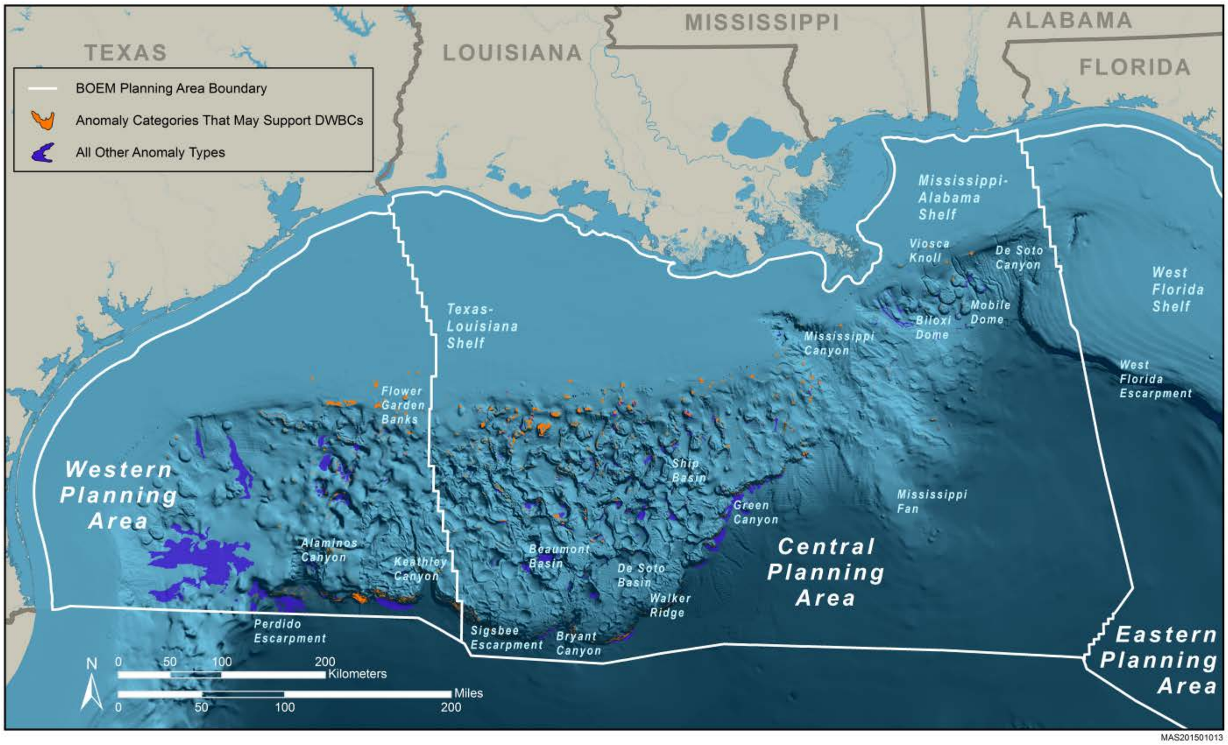

Figure 4-14. BOEM's Water Bottom Seismic Anomaly Database Showing Grouped Anomaly Categories Thought Likely to Support Deepwater Benthic Communities (shown in orange) and Those That Generally Do Not (shown in purple)

Biology

MacDonald et al. (1990) described four general community types: (1) tube worms; (2) mussels; (3) clams at the seafloor surface; and (4) burrowing clams. 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 associated with them. Individual tube worms can reach lengths of over 10 ft (3 m) and live hundreds of years (Fisher et al., 1997). Average growth rates determined from marked tube worms have been variable, but they average approximately 7.1 millimeters/year (0.28 inches/year) for some species. Tube worm spawning and recruitment is episodic. Mytilid mussels have been found to reach reproductive age relatively quickly, with growth rates slowing in adulthood (Fisher, 1995). These factors lead to long-lived individuals and communities. Powell (1995) estimated that some clam and mussel communities at chemosynthetic sites have been present in the same location for between 500 and 4,000 years, with most communities showing no evidence of changes in the dominant faunal organisms over time. Local extinctions and recolonizations are likely gradual and rare.

Other common heterotrophic organisms often found at chemosynthetic community sites include a variety of mollusks, crustaceans, and echinoderms (Carney, 1993). 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). Some of the species found at GOM seep communities are new to science and remain undescribed.

Persistence

According to Sassen (1998), the role of naturally occurring methane hydrates to influence the morphology and characteristics of chemosynthetic communities has been greatly underestimated. Gas hydrates are a unique and poorly understood class of chemical substances. The dynamics of hydrate alteration could play a major role in the release of hydrocarbon gases to fuel biogeochemical processes and could influence community stability (MacDonald, 1998). Changes in bottom-water temperature of several degrees (39-41 °F [4-5 °C] at 1,640-ft [500-m] depth) may result in dissociation of hydrates and an accompanying 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 could clearly affect sessile animals around the seepage barrier because of the potential for an entire layer of shallow hydrate to break free of the bottom, which would result in considerable impacts to local communities of chemosynthetic fauna. At deeper depths (>3,281 ft; >1,000 m), the bottom-water temperature is colder and undergoes less fluctuation.

Precipitation of authigenic carbonates and other geologic events would alter surface seepage patterns and available substrates over periods of only a few years. However, through taphonomic (death assemblages of shells) studies and interpretation of seep assemblage composition from cores, Powell (1995) reported that, overall, seep communities were persistent over periods of 500-4,000 years. Powell found few cases in which the community type changed (from mussel to clam communities, for example) over time. When recovery occurred after a past destructive event, the same chemosynthetic species reoccupied a site. MacDonald et al. (1995) observed no changes in chemosynthetic fauna distribution or composition at seven separate study sites. In the case of one well-known chemosynthetic community (Bush Hill), no mass die-offs or large-scale shifts in faunal composition were observed over 12 years of research.

4.4.1.2 Deepwater Coral Communities

Deepwater corals are sessile invertebrates in the phylum Cnidaria. They live at great depths (as deep as 10,000 ft [3,048 m] in some cases) where there is little to no light. As with the better known shallow-water corals, deepwater corals are colonial animals. Individual polyps extend tentacles into passing currents to feed on nutrients, which can be relatively scarce at depth. Energy supply is further limited by the lack of light-dependent mutualistic zooxanthellae algae that benefit many shallow-water coral species. As a result, deepwater coral colonies grow very slowly; colonies may live to be hundreds or even thousands of years old (USDOC, NOAA, 2014).

Deepwater corals are found in all the world's oceans and actually have a higher overall diversity of species than shallow-water coral (Cairns, 2007). Yet it is only in recent decades that they have become a focus of scientific research (Freiwald et al., 2004) and management concern (USDOC, NOAA, 2014; CSA, 2002), as anthropogenic threats such as bottom disturbance (e.g., from fishing gear) have become more clear. Their very slow growth rates and fragile skeletal structures make them especially vulnerable to physical disturbance. Once damaged, deepwater corals and the associated communities they support may take centuries to fully recover (USDOC, NOAA, 2014).

In the GOM, almost all deepwater corals are found attached to exposed surfaces of hard substrates. These substrates include chemosynthetically produced carbonate substrates (**Chapter 4.4.1.1**), but they can also include exposed sedimentary bedrock and even artificial structures such as shipwrecks and oil platforms.

Some species of deepwater corals and sponges are known to create large, three-dimensional structures, which are sometimes referred to as deepwater reefs. Some of these have grown many feet tall over time. Structure-forming corals include branching scleractinian species, Antipatharians (black corals) and gorgonians (sea whips/sea fans). *Lophelia pertusa*, the most well-known scleractinian deepwater coral, can form vast reef-like thickets that can stretch to over 3,280 ft (1,000 m) in surface extent. In a historic 1955 trawl collection from a depth of 1,381-1,680 ft (421-512 m), Moore and Bullis (1960) retrieved more than 300 pounds (136 kilograms) of *Lophelia pertusa* from the Viosca Knoll area in the CPA.

Similar to shallow-water live bottom microhabitats (**Chapter 4.6**), deepwater coral microhabitats enhance the structural complexity of the local environment, providing shelter, feeding sites, and nursery grounds that are attractive to a large variety of other invertebrates and fishes, including a few commercially harvested species (Schroeder et al., 2005; Fisher et al., 2007; Fraser and Sedberry, 2008; Sulak et al., 2008; Cordes et al., 2008; USDOC, NOAA, 2014; Hourigan, 2014). Common crustaceans include golden crab (*Chaceon fenneri*) and squat lobster (*Eumunida picta*). Common echinoderms include brittle stars (order Ophiurida) and baskets stars (order Euryalida). Deepwater reef-associated fish are known to include barrelfish (*Hyperoglyphe perciformis*), wreckfish (*Polyprion americanus*), and snowy grouper (*Epinephelus niveatus*) at shallower locations and blackbelly rosefish (*Helicolenus dactylopterus*), roughys (*Hoplotsethus* spp.), and thornyheads (*Sebastolobus* spp.) at deeper sites (Hourigan, 2014; refer to **Chapter 4.7**).

Distribution

Distribution of individual deepwater coral and associated species assemblages is influenced by depth, available substrate, and other environmental conditions such as bottom currents. At least six different types of octocoral assemblages occur in the deep northwestern Gulf and the West Florida Slope at depths of 820-8,200 ft (250-2,500 m). The black coral, *Leiopathes* spp., appears broadly distributed across both regions. Although *Lophelia pertusa* is best represented in water depths of the upper slope, it has occasionally been reported as deep as 9,842 ft (3,000 m) in some parts of the world.

The NOAA's Deep Sea Coral Research and Technology Program and NOAA's National Centers for Coastal Ocean Science have been continuously compiling a detailed national database of known observations of deepwater corals and sponges (USDOC, NOAA, 2014 and 2015)

(**Figures 4-12 and 4-13**), but these confirmed visual observations likely represent only a fraction of the populations. Deepwater research cruises, for example those undertaken by the NOAA deep-sea research vessel *Okeanos Explorer*, routinely discover additional deepwater coral locations. However, even with ongoing additions of observation records, the majority of deepwater coral communities would not be directly observed and documented in the near future due to the inherent logistical difficulties of deepwater research and data collection.

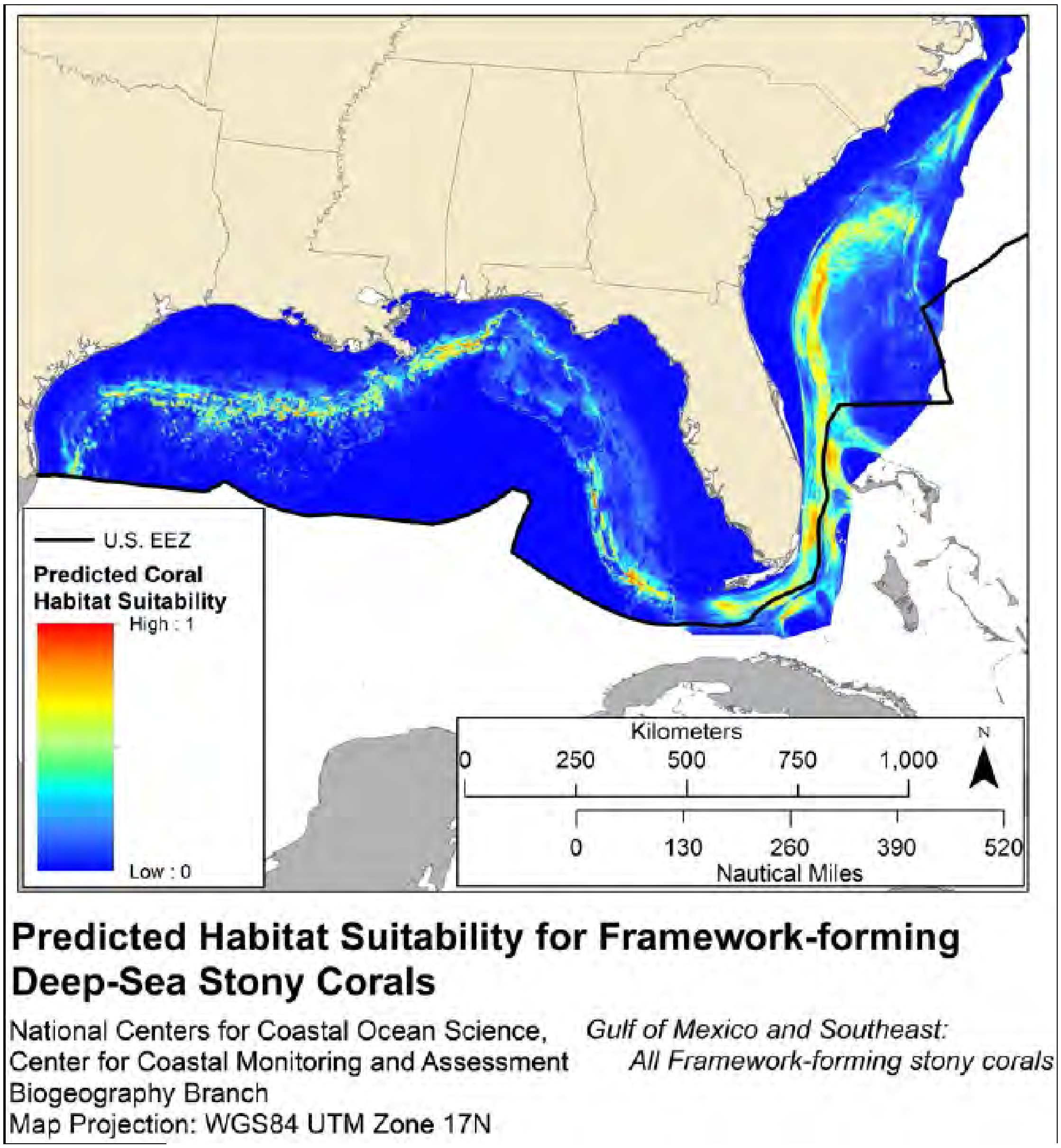

Figure 4-15. Example of a Predictive Habitat Suitability Model for Selected Deepwater, Framework-Forming Scleractinian Corals (excerpted with permission from USDOC, NOAA, 2014).

Therefore, extrapolative analyses such as one undertaken by NOAA (**Figure 4-15**) have also included efforts to predictively model suitable habitat for deepwater coral and sponges, based on existing observation records combined with the best available physical datasets. These models can serve as an important tool to help identify where deepwater coral communities are likely to be found and to help focus future data collection and research efforts. For example, based in part on previous databases and models, the Gulf of Mexico Fishery Management Council (GMFMC) is currently evaluating advisory panel recommendations to designate up to 47 new, small areas as deepwater coral Habitat Areas of Particular Concern (CSA, 2002). Future research, including a planned BOEM-funded study (Interagency Agreement #M15PG00020), may improve on previous deepwater coral modeling and expand to include chemosynthetic communities.

4.4.2 Environmental Consequences

Routine Activities

A number of routine OCS oil- and gas-related impact-producing factors may cause adverse impacts to deepwater benthic communities. As noted above, some factors with only minimal impacts are presented in greater detail in other chapters, and full analyses are not repeated here. The potential routine impact-producing factors on deepwater benthic habitats analyzed here are grouped into two main categories having similar impacts: (1) bottom-disturbing activities; and (2) drilling-related sediment and waste discharges. These impact-producing factors have the potential to damage deepwater benthic habitats and disrupt associated communities if not sufficiently distanced via mitigations.

Bottom-disturbing activities can be described as any activities that result in the physical disturbance of the seafloor during the exploration, production, or decommissioning phase of OCS operations (refer to **Chapters 3.1.2, 3.1.3.3, and 3.1.6**). Anchoring, drilling, trenching, pipe-laying, and structure emplacement and removal are examples of OCS oil- and gas-related activities that disturb the seafloor (refer to **Chapters 3.1.3.3 and 3.1.6**). The spatial extent of the seafloor disturbance and the magnitude of the effect on deepwater benthic organisms would depend on the specific activity, local environmental conditions (e.g., currents, water depth, etc.), and species-specific behaviors and habitat preferences.

Drilling of new wells is one of the activities with the greatest impact potential due to the associated sedimentation/turbidity caused by the drilling process and from the release of drilling cuttings and discharges (**Chapter 3.1.5.1**). Drilling an exploratory well produces approximately 2,000 metric tons of combined drilling fluid and cuttings, though the total mass may vary widely for different wells (Neff, 2005). Cuttings discharged at the surface tend to disperse in the water column and be distributed at low concentrations (CSA, 2004). In deep water, the majority of cuttings discharged at the sea surface are likely to be deposited within 820 ft (250 m) of the well (CSA, 2006). Cuttings shunted to the seafloor form piles concentrated within a smaller area than do sediments discharged at the sea surface (Neff, 2005).

Turbidity from suspended sediments, along with sediment displacement resulting from routine, bottom-disturbing oil- and gas-related activities, generally has localized effects. Impacts to deepwater benthic communities could include any or all of the following: reduced settlement and growth opportunities due to loss of available hard substrate; inhibited feeding leading to reduced reproductive fitness; and mortality of individuals (e.g., coral polyps and 1 or 2 tubeworms) and groups (e.g., entire coral colonies and tubeworm "bushes"). Reductions in overall biological cover could have secondary ecological effects on organisms that were using the complex structural microhabitats, for example the loss of a shark spawning ground (some sharks deposit eggs in deepwater coral [Etnoyer and Warrenchuk, 2007]) that reduces future shark populations. Some mobile invertebrates (e.g., brittle stars) are expected to be able to move to avoid the heaviest sediment displacement and highest suspended sediment loads within 33 ft (10 m) of a disturbance, while sessile invertebrates (e.g., corals) cannot. Sessile and mobile invertebrate species adapted to living in turbid environments, such as many gorgonians, may be less affected by increased turbidity. Such organisms may also be adapted to remove some covering sediment via tentacle motion and mucus secretion (Shinn et al., 1980; Hudson and Robbin, 1980). Other species that typically inhabit less turbid waters would suffer relatively greater impacts (Rogers, 1990; Gittings et al., 1992a). Solitary octocorals and gorgonians may be tolerant of a certain amount of sedimentation, partly because they grow tall and are flexible, reducing sediment accumulation and allowing for easier removal (Marszalek, 1981; Torres et al., 2001; Gittings et al., 1992a), but are not completely resilient to impacts (Doughty et al., 2014).

Apart from the direct impacts of turbidity and sedimentation, the chemical content of drilling muds and cuttings (and, to a lesser extent, produced waters) are another potential impact-producing factor since these may contain hydrocarbons, trace metals including heavy metals, elemental sulfur, and radionuclides (Kendall and Rainey, 1991; Trefry et al., 1995). Substances containing heavy metals and other potentially toxic compounds would have the potential to be moderately toxic to deepwater benthic organisms, but only if they were to come into contact in undiluted strengths (CSA, 2004b). Although the literature has not reported impacts to chemosynthetic organisms, gorgonians, or soft corals as a result of exposure to contaminants in cuttings, infauna have shown effects at distances <330 ft (<100 m) from the discharge. These include reduced reproductive fitness, altered populations, and acute toxicity (Montagna and Harper, 1996; Carr et al., 1996; Kennicutt et al., 1996; Hart et al., 1989; Chapman et al., 1991; CSA, 2004b). Because of BOEM's distancing requirements for new wells, contact with concentrated (and potentially harmful) levels of any such toxins is not expected. As they travel from a source, produced waters (refer to **Chapter 3.1.5.1.2** for more detail) are rapidly diluted with distance, and impacts are generally only observed within very close proximity of the discharge point (Gittings et al., 1992a; Neff, 2005). In addition to the protection offered by BOEM's distancing requirements, releases of toxic discharges are regulated by the USEPA through the issuance of NPDES permits. Adherence to these regulations would help ensure that water quality is maintained at nontoxic levels.

In addition to drilling activities, the process of installing and removing OCS oil- and gas-related infrastructure (i.e., pipelines, platforms, and subsea systems including cables) also has the potential to displace large volumes of sediment (**Chapter 3.1.3.3**). The resulting localized increases in turbidity and sedimentation would have the same indirect impacts as those caused by drilling-related sediment movement.

The OCS oil- and gas-related infrastructure/equipment also has the potential to damage or kill deepwater benthic organisms should the equipment itself make direct contact. Any object placed on or through (e.g., a piston-driven core sampler) a deepwater benthic organism or supporting substrate can cause partial or complete breakage, crushing, or smothering. In addition to mortality, there could be any or all of the potential sublethal impacts already described above in relation to turbidity and sediment displacement. The severity of community impacts from direct physical contact would vary in direct proportion to the surface area and mass of the specific equipment. For example, the placement of a large bottom-founded platform on a deepwater benthic community would have a much greater impact than placement of a small umbilical cable.

Similarly, anchor damage is one of the greatest threats to benthic biota in the GOM (Rezak and Bright, 1979; Rezak et al., 1985; Gittings et al., 1992a; Hudson et al., 1982). Anchors may break, fragment, or overturn tubeworms, bivalves, corals, sponges, or any other sessile benthic organisms, and the anchor chain or cable may drag across and shear organisms off the substrate (Dinsdale and Harriott, 2004). This would result in consequences ranging from increased stress to mortality (Dinsdale and Harriott, 2004). The impact of dragging an anchor across a deepwater benthic community would depend on the distance and duration of bottom contact, but it could be considerable due to the forces involved; dragged anchors often leave seafloor scars noticeable on sidescan sonar imagery years later. Damage to a coral community may take decades to recover (Fucik et al., 1984; Rogers and Garrison, 2001).

As further detailed in other chapters, explosive severance methods used during decommissioning activities could result in damage or mortality to any organisms within the vicinity of the blast or associated sediment plume, although long-term turbidity is not expected from platform removal operations. The shockwave from a nearby blast could also damage or destroy the underlying hard substrates required to support some deepwater benthic communities. The BSEE Interim Policy Document 2013-07, "Rigs-to-Reefs Policy," specifies that the use of explosive severance methods would not be approved if analysis determines they would cause harm to natural deepwater benthic communities.

Compared with shallow-water live bottom communities, some deepwater benthic organisms may be slower to recover from any of the impacts described above due to the generally much slower growth and recruitment rates that are typical of these longer-lived species and communities (Powell, 1995). For example, Doughty et al. (2014) demonstrated that *Paramuricea* spp., some of the most common deepwater corals in the GOM, may have very low recruitment rates and therefore slow recovery.

Potential impacts resulting from all of the above routine activities are mitigated through the protective measures (primarily distancing) described above and in NTL 2009-G40. The postlease, site-specific survey information and mitigation options described in NTL 2009-G40 would allow BOEM to identify and sufficiently distance deepwater benthic features from any proposed OCS oil- and gas-related routine activity during postlease reviews. If all of these requirements are applied as expected, at the scope of this analysis, the impacts of routine activities would be expected to be **negligible**.

Without adherence to those requirements or absent expected USEPA restrictions on discharges, impacts to deepwater benthic communities from the above routine activities could rise to minor, moderate, or even major, depending on the number and locations of specific activities. The highest impact levels are possible in the improbable (but theoretically possible) case that a large number of routine activity disturbances were to physically impact a large number of deepwater benthic communities. Even without mitigations, the likelihood is very low that a large number of OCS oil- and gas-related activities would occur in close proximity because the hard substrate habitats supporting deepwater benthic communities are patchily distributed throughout the GOM and are relatively rare compared with soft bottom substrates. But this possibility cannot be definitively ruled out without knowing both the precise spatial distribution of both future OCS oil- and gas-related activities and deepwater benthic communities.

Accidental Events

The primary accidental impact-producing factors affecting deepwater benthic communities analyzed here are grouped into two categories: (1) bottom-disturbing activities; and (2) oil spills (surface and subsurface) and associated clean up responses. These factors have the potential to damage deepwater benthic habitats and disrupt associated benthic communities if not sufficiently distanced or otherwise mitigated.

Bottom-Disturbing Activities

Impacts resulting from bottom-disturbing activities were already detailed in "Routine Activities" section above and are largely the same for accidental events. There are only slight differences that need to be considered here and are related to mechanisms and potential severity. The primary, accidental bottom-disturbing activity is the inadvertent deposition or placement of equipment on deepwater habitats. Accidental loss of equipment could occur during transfer operations between vessels and platforms, during vessel transit, during an "on deck" accident, as a consequence of a severe storm, or if a structure, drill, or anchor is unintentionally placed in the wrong location during operations. During routine operations, the distancing mitigations offer some protections against these types of impact, but those protections may not apply to all accidents, other than to reduce the likelihood of routine activities occurring in those areas in the first place. Any object placed on or through a deepwater benthic habitat could cause partial or complete breakage, crushing, or smothering of both substrate and organisms, and/or increased sedimentation as equipment disturbs the seafloor. In addition to mortality, deepwater benthic communities could experience any or all of the potential sublethal impacts already described in the "Routine Activities" section above. The severity of impacts from direct physical contact would vary in direct proportion to the surface area and mass of the specific equipment. Given the relative rarity of deepwater benthic habitats and communities in the GOM, accidental impacts from bottom-disturbing equipment are expected to be infrequent and highly localized, with the likelihood of accidental contact further reduced by the expected distancing mitigations. However, because of the unplanned and potentially uncontrolled nature of accidental bottom-disturbing events, there exists greater uncertainty about their potential impact severity than exists for planned routine activities. Therefore, at the scale of this analysis, impacts to deepwater benthic communities could range from **negligible** to **minor**, depending on their overall frequency and severity and whether or not community-level accidental impacts can be clearly distinguished from natural variation.

Without the protective mitigations provided by postlease reviews and distancing, the potential impacts of accidental bottom disturbances could rise to moderate or even major levels, in the improbable (but theoretically possible) case that a large number of accidental disturbances were to physically impact a large number of deepwater benthic communities. Even without mitigations, the likelihood is very low that a large number of OCS oil- and gas-related activities would occur in close proximity to the relatively rare hard substrate habitats supporting deepwater benthic communities, but this possibility cannot be definitively ruled out without knowing both the precise spatial distribution of both future OCS oil- and gas-related activities and deepwater benthic communities.

Oil Spills and Associated Impacts

Oil spills, historic trends, the characteristics of oil, and factors affecting the fate of oil released into the marine environment are discussed in detail in **Chapter 3.2.1** (Oil Spills), and the potential impacts to water quality are analyzed in **Chapter 4.2** (Water Quality). For additional information on impacts resulting specifically from a catastrophic spill, refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

Impacts related to an accidental release of oil or other contaminants could adversely affect deepwater benthic communities. Potential impacts related to an accidental spill would depend on the combination of these various components: surface oil; subsurface oil; chemical dispersants and dispersed oil; sedimented oil (oil adsorbed to sediment particles); sedimentation caused by a loss of well control; and certain spill-response activities. Adherence to well-distancing requirements should serve to reduce such impacts.

Biological impacts resulting from exposure to accidentally released oil droplets and/or chemical dispersants are anticipated to be mostly sublethal and recoverable. Sublethal impacts that may occur to exposed deepwater benthic organisms may include reduced feeding, reduced reproduction and growth, physical tissue damage, and altered behavior. For example, short-term, sublethal responses of a shallow-water coral species included mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, and localized tissue rupture reported after 24 hours of exposure to dispersed oil at a concentration of 20 ppm (Knap et al., 1983; Wyers et al., 1986). Laboratory tests by DeLeo et al. (2015) on the relative effects of oil, chemical dispersants, and chemically dispersed oil mixtures on three species of northern GOM deepwater corals found much greater health declines in response to chemical dispersants and to oil-dispersant mixtures than to oil-only treatments, which did not result in mortality. It is important to note that, generally, laboratory experimental concentrations are designed to discover toxicity thresholds (as in DeLeo et al., 2015) that exceed probable exposure concentrations in the field.

Chemosynthetic organisms are naturally adapted to handle the limited amounts of hydrocarbons typical of slow-flowing seeps. While they have not been as well studied as deepwater corals, there have not been documented impacts from the *Deepwater Horizon* oil spill to chemosynthetic communities (USDOI, BOEM, 2012b; Shedd, official communication, 2015). It is possible that some deepwater coral species also have limited capabilities to endure oil exposure. Al-Dahash and Mahmoud (2013) suggest that a possible mechanism for this is coral harboring of symbiotic oil-degrading bacteria. Results from DeLeo et al. (2015) suggested that *Callogorgia delta*, a soft coral often associated with natural hydrocarbon seeps, may have some natural adaptation to short-term oil exposure. Oil spills originating at the surface have fairly limited potential to directly impact deepwater benthic communities. Oil becomes diluted as it physically mixes with the surrounding water and moves into the water column, and the physical mixing zone of surface oil is generally limited to approximately 33 ft (20 m) (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Thompson et al., 1999; Schroeder, 2000). In one extraordinary circumstance, a tropical storm forced a large volume of dispersant/oil mixture as deep as 246 ft (75 m), causing exposure to mesophotic corals in the Pinnacle Trend area (Silva et al., 2015), but that depth is still far shallower than that of the deepwater benthic communities analyzed in this chapter.

The USCG may allow the application of chemical dispersants in certain spill situations. Chemical dispersion of oil can help to break up concentrations of oil, accelerate natural weathering processes, and promote bacterial biodegradation (**Chapter 3.2.7**). Use of dispersants may, however, have unintended effects. For example, it may allow surface oil to penetrate to greater depths than expected from normal physical mixing, and dispersed oil more often remains below the water's surface (McAuliffe et al., 1981b; Lewis and Aurand, 1997), possibly leading to negative impacts such as those observed by Silva et al. (2015). DeLeo et al. (2015) demonstrated that concentrated amounts of dispersant and oil/dispersant mixtures caused more severe health declines to deepwater coral than oil-only mixtures.

In a subsurface spill or loss of well control situation, it is expected that the majority of released oil would rise quickly to the surface due to the characteristics of northern GOM oil reserves. However, if an oil spill occurs at great depths and is subjected to higher water pressures, some oil droplets may emulsify and become entrained deep in the water column (Boehm and Fiest, 1982), creating a subsurface plume (Adcroft et al., 2010). During the *Deepwater Horizon* oil spill, dispersants were applied subsea at the source of the blowout. Stratified density layers of water allowed the oil/dispersant plume to remain at depth instead of dispersing up into the water column (Joint Analysis Group, 2010), and these concentrated plumes likely contributed to the serious (but localized) damage to deepwater coral communities. If a concentrated plume comes into continuous contact with a deepwater benthic community, the general impacts could include mortality, tissue loss, opportunistic hydroid overgrowth, failed reproductive success, reduced biodiversity, reduced coverage of fauna and flora on hard substrates, and changes in community structure (White et al., 2012; Hsing et al., 2013; Fisher et al., 2014a; Silva et al., 2015). Exact impacts would depend on the location, age of the spill, and the hydrographic characteristics of the area. Adherence to the mitigating well-distancing requirements should reduce such impacts.

For any accidental spill (refer to the *Catastrophic Spill Events Analysis* white paper for larger events that are not reasonably foreseeable [USDOI, BOEM, 2016c]), it is expected that a certain quantity of oil may eventually settle on the seafloor through a binding process with suspended sediment particles (adsorption) or after being consumed and excreted by phytoplankton (Passow et al., 2012, Valentine et al., 2014). The product of these processes is sometimes referred to as “marine snow.” It is expected that the greatest amount of adsorbed oil particles would occur close to the spill, with the concentrations reducing over distance. Adherence to the original well distancing requirements should therefore reduce such impacts.

If a spill does occur close to a deepwater benthic habitat, some of the organisms may become smothered by marine snow particles and/or other sediments, and experience long-term exposure to hydrocarbons and/or oil-dispersant mixtures that could persist within the sediments (Hsing et al., 2013; Fisher et al., 2014a; Valentine et al., 2014). White et al. (2014) found the anionic surfactant DOSS (dioctyl sodium sulfosuccinate) persisting for at least 6 months within a deepwater coral community, although that study did not measure toxicity. Krasnec et al. (2015) did measure toxicity of sediments collected within 2 km (1.2 mi) of the *Macond*o wellhead, but they did not measure the effects on deepwater megafauna. The study found varying levels of mortality and growth inhibition for a small shrimp-like crustacean species, with the relative degree of toxicity decreasing over time (lower toxicity found in 2014 samples than in 2011 samples). Beyond the localized area of impact in such cases, particles would become increasingly biodegraded and dispersed. Localized impacts to deepwater benthic organisms from marine snow would be expected to be mostly sublethal and could include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment (Rogers, 1990; Kushmaro et al., 1997).

Sediments suspended or displaced as a result of a loss of well control could also impact deepwater benthic organisms. These impacts would be largely identical to those caused by sedimentation stirred up by bottom-disturbing equipment, with the possible addition of toxic hydrocarbons or drilling muds in the sediments (refer to “Routine Activities” above). Because OCS-permitted wells would have been distanced from deepwater benthic habitats before installation, it is expected that the heaviest sediment concentrations would fall out of suspension and disperse before reaching sensitive benthic communities, preventing most impacts. Some live bottom organisms, such as flexible sea fans, are naturally adapted to turbid conditions and may not be as negatively affected. Outside of a catastrophic blowout situation, a very substantial amount of sediment burial of organisms during an accidental spill event is not reasonably foreseeable (refer to the *Catastrophic Spill Events Analysis* white paper, USDOI, BOEM, 2016c).

Finally, spill cleanup/response activities could themselves have negative impacts (**Chapter 3.2.7**). During a response operation, the risk of accidental impacts of bottom-disturbing equipment is increased. There could be unplanned emergency anchoring or accidental losses of equipment from responding vessels. Response-related equipment such as seafloor-anchored booms may be used and could inadvertently contact deepwater habitats and organisms. In addition, drilling muds may be pumped into a well to stop a loss of well control. It is possible that during this process some of this mud may be forced out of the well and deposited on the seafloor near the well site. If this occurs, the impacts would be severe for any organisms buried; however, the impact beyond the immediate area would be limited and adherence to the original distancing requirements should prevent or reduce most impacts.

Accidental spills have historically been small and are low-probability events (**Chapters 3.2.1.4, 3.2.1.5, and 3.2.1.6**; **Table 3-12**). The total amount of deepwater benthic communities is small and the habitats are widely distributed, so a localized impact from one noncatastrophic accidental event would only impact a small portion of the overall resource.

All of these activities could lead to lethal or sublethal impacts on individual deepwater benthic communities, with the range of impacts dependent on the quantity of spilled oil and proximity to habitats. While a spill resulting from a catastrophic-level blowout in deep water (such as the *Deepwater Horizon* oil spill) has the potential to seriously impact individual deepwater benthic communities over a long time period, such a spill is not reasonably foreseeable as a result of a proposed lease sale. Impacts from individual routine activities and reasonably foreseeable accidental events are usually temporary, highly localized, and expected to impact only small numbers of organisms and substrates at a time. Natural adaptations to small quantities of oil (Al-Dahash and Mahmoud, 2013; DeLeo et al., 2015) and/or recovery over time (Hsing et al., 2013) is possible for certain deepwater benthic species. Moreover, use of the expected site-specific plan reviews/mitigations would distance activities from deepwater benthic communities, greatly diminishing the likelihood and severity of potential effects. Therefore, at the scale of this analysis and with application of the expected mitigation practices, impacts on deepwater benthic communities from accidental spills are expected to range from **negligible** to **minor**. This range of potential impact levels reflects the relative uncertainty associated with unplanned and potentially uncontrolled accidental events. The exact impact would depend on overall frequency and severity of accidental spills and whether or not community-level accidental impacts can be clearly distinguished from natural variation.

Without the protective mitigations provided by postlease reviews and distancing, the potential impacts of accidental spills could rise to moderate or even major levels, in the improbable (but theoretically possible) case that a large number of accidental spills were to occur at wells in close proximity to a large number of deepwater benthic communities. Even without mitigations, the likelihood is very low that a large number of accidental spills would occur in close proximity to the relatively rare hard substrate habitats supporting deepwater benthic communities, but this possibility cannot be definitively ruled out without knowing both the precise distribution of such spills and deepwater benthic communities.

Cumulative Impacts

Cumulative impacts on deepwater benthic communities are of concern because of their very slow growth rates, which may increase their vulnerability to disturbance over time (Prouty et al., 2014). This analysis considers the cumulative impacts on deepwater benthic communities resulting from (1) the incremental impacts from future routine and accidental oil- and gas-related operations from a proposed lease sale, as well as those resulting from past and future OCS leasing; and (2) potential impacts stemming from non-OCS oil- and gas-related factors.

OCS Oil- and Gas-Related Impacts

The Cumulative OCS Oil and Gas Program impacts to deepwater benthic communities include the long-term, incremental contribution of the routine and accidental bottom-disturbing activities outlined above: (1) bottom-disturbance; (2) sediment and waste discharges; and (3) noncatastrophic oil spills (**Chapter 3.3.1**). As already detailed, these impact-producing factors have the potential to damage individual deepwater habitats and disrupt associated benthic communities if insufficiently distanced or otherwise mitigated.

Bottom-disturbing activities could result in the physical destruction of benthic habitat and organisms or the disturbance of sediments within the environment, resulting in partial or complete burial and/or increased turbidity (**Chapter 3.3.1.5**). Routine and accidental waste discharges could be toxic if contacted in undiluted form near the source, but that is generally unlikely.

Oil spills and chemical dispersants are known to have negative, acute effects on deepwater benthic organisms such as corals (e.g., DeLeo et al., 2015). The cumulative, long-term effects of persistent, low-level exposure to oil are not yet fully understood, although such research is ongoing following the *Deepwater Horizon* oil spill (e.g., White et al., 2014; Baguley et al., 2015). All of these activities could lead to lethal or sublethal impacts on individual deepwater benthic communities. Although a spill resulting from a catastrophic-level blowout in deep water, such as *Deepwater Horizon* blowout (refer to the *Catastrophic Spill Events Analysis* white paper, USDOI, BOEM, 2016c), has the potential to seriously impact individual deepwater benthic communities over a long time period (Hsing et al., 2013), the spatial extent of impacts from even such a large spill remains relatively limited (Montagna et al., 2013; Fisher et al., 2014b) and the probability of additional catastrophic-level spills of that size is low.

Impacts from these individual routine activities and accidental events are usually temporary, highly localized, and expected to impact only small numbers of organisms and substrates at a time. Recovery over time from such impacts is possible for certain species (e.g., Hsing et al., 2013). Moreover, use of the expected site-specific plan reviews/mitigations would distance activities from deepwater benthic communities, greatly diminishing potential effects. Therefore, the incremental cumulative contribution of OCS oil- and gas-related activities is expected to have only **negligible** to **minor** impacts.

Non-OCS Oil- and Gas-Related Impacts

The cumulative, long-term impacts on deepwater benthic communities of reasonably foreseeable, non-OCS oil- and gas-related anthropogenic activities and shifting baseline environmental conditions could be substantial, although they are difficult to quantify, particularly when projecting future conditions over the next 50 years. A brief summary analysis is provided here. It should be noted that BOEM's site-specific mitigations are designed to protect deepwater benthic resources from OCS oil- and gas-related activities within BOEM's jurisdiction and to mitigate against any proposed action's incremental cumulative impact contribution to the overall OCS and non-OCS cumulative impacts.

The primary anthropogenic activities are related to commercial fishing (**Chapter 4.10**). Bottom-tending fishing gear of any type (e.g., trawls, traps, bottom-set longlines, and gillnets) can affect deepwater benthic communities by dislodging or crushing organisms attached to the bottom, with trawls representing the most serious threat (Hourigan, 2014). Currently, the overall amount of fishing effort in very deep waters is spatially and temporally limited and primarily consists of a relatively small royal red shrimp fishery and only sporadic reports of golden crab traps (CSA, 2002). Therefore, at the present time, commercial fishing impacts on GOM deepwater benthic communities are **negligible**. Should the overall amount of effort or types of gear used change dramatically over time, fishing impacts could become considerably greater, perhaps as great as major, although that theoretical impact level is highly speculative and dependent on unknown and perhaps improbable future changes in fishery practices.

Climate change-related effects have the potential to alter baseline environmental conditions in the GOM, including in deep waters. A review of climate change is presented in Chapter 4.2.1 of the Five-Year Program EIS (USDOI, BOEM, 2016b). Of primary concern for deepwater benthic communities is a projected decline of ocean pH of 0.3-0.5 units over the next century, a shift which would significantly alter calcium carbonate saturation states in the ocean (Doney et al., 2009). Decreased calcification rates have been observed in numerous shallow-water zooxanthellate corals (refer to Hofmann et al., 2010). Similar effects could be expected for deepwater corals such as *Lophelia pertusa* (Lunden et al., 2013; Lunden et al., 2014, Hennige et al., 2015) and for various other calcifying organisms in deep water (Thresher et al., 2015) and could make it more difficult for deepwater calcifying organisms to form or maintain calcium carbonate-based skeletons or shells. At the depths of these communities, little to no effect is expected from potential increases in storm frequency and intensity that could be attributed to climate change. However, any such increases might exacerbate some other types of bottom-disturbing accidental impacts, such as equipment lost overboard or toppling of a platform. The cumulative impact level of future climate change-related factors is difficult to accurately estimate with the current level of scientific understanding. Important baseline data, such as basic measurements of aragonite saturation horizons, are still in the early years of collection and analysis, and the many unknown factors involved make it difficult to accurately assign an authoritative impact level for this impact-producing factor at the long-term scope of this analysis. At present, the overall impact of climate change-related effects is likely **negligible**. However, over the next 50 years, this impact level could rise to as great as major, should the most extreme impacts projected as a result of climate change-associated factors come to pass.

Incomplete or Unavailable Information

For decades, BOEM has funded research related to deepwater benthic environments in order to further the scientific understanding necessary for informed decisionmaking. However, due in part to the inherent difficulty of data collection in deepwater environments, there is (and likely always would be) incomplete or unavailable information about deepwater benthic communities. BOEM has specifically identified incomplete information for OCS oil- and gas-related impacts related to the following: locations of deepwater benthic communities in the GOM; toxicity of oil and dispersants to deepwater benthic organisms; long-term effects of the totality of the presence of OCS oil- and gas-related infrastructure; long-term effects associated with various climate change-related factors; cascading ecological effects and interactions between deepwater benthic communities and deepwater fish communities; and long-term impacts from the *Deepwater Horizon* explosion, oil spill, and response (refer to the *Catastrophic Spill Events Analysis* white paper, USDOI, BOEM, 2016c).

As described above, BOEM's databases of confirmed deepwater benthic communities and 3D seismic water-bottom anomalies are used when reviewing deepwater exploration and development plans. As part of postlease, site-specific development plans, operators must provide a variety of high-resolution survey data such as seismic amplitude, multibeam sonar, and sidescan-sonar data and interpretations of those data, including assessments about potential habitat for sensitive benthic communities. If data are sparse or additional detail is needed, site-specific video or photographic surveys can be requested and used to develop appropriate mitigations. While extremely helpful, BOEM's databases and survey data are not comprehensive of all deepwater benthic communities. For example, available information may not always be of sufficient resolution to identify small areas of scattered hard substrate, such as dead clam shells, that may support small patches of deepwater benthic habitat, as discussed by Quattrini et al. (2013).

To help fill data gaps about locations of deepwater benthic communities, BOEM may also be able to make use of additional datasets created by other Federal agencies. For example, NOAA's Deep Sea Coral Research and Technology Program and NOAA's National Centers for Coastal Ocean Science have been compiling a database of known observations of deepwater corals and sponges (USDOC, NOAA, 2015i). This database of confirmed deepwater coral observations could be used as an ancillary information source during site-specific plan reviews. However, even with the continued additions of observation records over time, it is unlikely that the majority of deepwater coral communities would be directly observed and documented because of the inherent logistical difficulties involved in deepwater research and data collection. Past research by NOAA (Kinlan et al., 2013) has also included efforts to predictively model suitable habitat for deepwater coral and sponges, based on the best available physical/environmental datasets. Future research may improve on these efforts and expand to include chemosynthetic communities. New datasets and models such as these, once they are complete, scientifically vetted, and publicly available, could provide helpful ancillary information to further assist BOEM's site-specific evaluations.

BOEM will continue to analyze and support the continued collection of the best available scientific information related to deepwater benthic communities. However, the best available information does not provide all of the data necessary for a complete understanding of these communities; knowledge gaps exist. For example, there is incomplete information with respect to potential long-term effects resulting from exposure to spilled oil, including potential impacts of a catastrophic spill such as the *Deepwater Horizon* oil spill (refer to the *Catastrophic Spill Events*

Analysis white paper, USDOI, BOEM, 2016c). Detailed information on these impact-producing factors may be relevant to the evaluation of impacts on deepwater benthic communities. However, in completing this analysis and in making conclusions, BOEM used the best available science to determine the range of reasonably foreseeable impacts, applying accepted scientific methodologies to both integrate existing information and extrapolate potential outcomes. Therefore, BOEM has determined that the incomplete information is not essential to a reasoned choice among alternatives.

4.4.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

The activities proposed under Alternative A could directly impact deepwater benthic communities within the GOM. The primary, reasonably foreseeable impact-producing factors for deepwater benthic habitats can be grouped into three main categories: (1) bottom-disturbing activities; (2) sediment and waste discharges; and (3) oil spills.

BOEM's site-specific reviews of permit applications would, through distancing and other appropriate mitigations, greatly reduce potential impacts to deepwater benthic communities as a result of routine activities and accidental events. At the broad scope of this analysis, and assuming adherence to all expected postlease, protective restrictions and mitigations, the routine activities are expected to have largely short-term, localized and temporary effects on deepwater benthic communities that may not be easily detectable or clearly distinguishable from natural variation. Therefore, the impacts of routine activities would be expected to be **negligible**. Accidental events (below the threshold of a catastrophic spill, detailed in the *Catastrophic Spill Event Analysis* white paper [USDOI, BOEM, 2016c]) do have the potential to cause detectable, severe damage to individual deepwater benthic communities. However, the number of such events is expected to be very small and is not expected to have population-level localized impacts and, therefore, might not be clearly distinguishable from natural variation. Therefore, the impacts of accidental events would be expected to be **negligible** to **minor**. Taken together, at the regional, population-level scope of this analysis, overall impacts to deepwater benthic communities from reasonably foreseeable routine activities and accidental events are expected to be **negligible** to **minor**.

Proposed and existing OCS oil- and gas-related activities would also contribute incrementally to the overall OCS and non-OCS cumulative effects experienced by deepwater benthic communities. The OCS oil- and gas-related cumulative impacts are estimated to have **negligible** to **minor** impacts. Non-OCS oil- and gas-related activities such as commercial fishing (currently negligible) and shifting baseline environmental conditions related to climate change (currently negligible but likely to increase to major over time given current trends) could cause more noticeable impacts on deepwater benthic communities over the next 50 years.

4.4.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Under Alternative B, BOEM would hold a lease sale excluding the available unleased blocks in the WPA and would offer all available unleased blocks in the CPA and a portion of the EPA. Alternative B would not fundamentally alter the conclusions reached for Alternative A, but it would reduce the potential impacts of a proposed lease sale in the available unleased blocks in the WPA. The impacts from proposed activities to deepwater benthic communities would remain the same in leased portions of the CPA/EPA. Impacts resulting from accidental events should remain relatively localized, with the number of features affected being directly proportional to the size of the accident. An accident along the CPA/WPA border has the possibility to impact features in either planning area. Although the area proposed for leasing in the WPA is relatively smaller than the proposed area of the CPA/EPA and would experience less projected OCS oil- and gas-related activity (refer to **Chapter 3**), deepwater benthic communities are found throughout all deep waters of the GOM (refer to **Figures 4-12 through 4-15** above) and, therefore, the impacts associated with Alternative B could still potentially cause some population-level effects.

At the regional, population-level scope of this analysis, the overall impact to deepwater benthic communities as a result of the activities proposed under in Alternative B are expected to be the same as Alternative A, i.e., **negligible** to **minor**, assuming the continuation of expected mitigation practices. BOEM's mitigation practices would reduce potential routine activities, accidental events, and OCS oil- and gas-related cumulative impacts of a proposed lease sale under Alternative B to the range of **negligible** to **minor**. Absent these mitigations, the impacts resulting from the routine activities and accidental events of a proposed lease sale could be greater; the overall population-level impact could range from negligible to moderate (in a theoretical, if improbable, worst-case scenario). This impact level is less than the potential major level impact that would be possible (absent mitigations) under Alternatives A and D. This difference is due to the greatly reduced area available for new leasing under Alternatives B and C, which would somewhat limit the number of potentially affected deepwater benthic communities and increase the likelihood of long-term recovery to pre-impact levels. However, it is believed that existing mitigation practices would continue to be applied to the proposed activities under Alternatives A-D, reducing the expected level of OCS oil- and gas-related impacts.

The incremental cumulative impacts of proposed and existing OCS oil- and gas-related activities under Alternative B are considered to add only a **negligible** to **minor** contribution to the overall cumulative impact, which includes the relatively greater influence of non-OCS oil-and gas-related cumulative impacts occurring throughout the GOM over the 50-year analysis period.

4.4.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Under Alternative C, BOEM would hold a lease sale excluding the available unleased blocks in the CPA/EPA and would offer all available unleased blocks in the WPA. Alternative C would not fundamentally alter the conclusions reached for Alternative A, but it would reduce the potential impacts of a proposed lease sale in the available unleased block in the CPA/EPA. The impacts from the proposed activities to deepwater benthic communities would remain the same in leased portions of the WPA. Impacts resulting from accidental events should remain relatively localized, with the number of features affected being directly proportional to the size of the accident. An accident along the WPA/CPA border has the possibility to impact features in either planning area. Although the area proposed for leasing in the WPA is relatively smaller than the proposed area of the CPA/EPA and would experience less projected OCS oil- and gas-related activity (refer to **Chapter 3**), deepwater benthic communities are found throughout all deep waters of the GOM (refer to **Figures 4-12 through 4-15** above) and, therefore, the impacts associated with Alternative C could still potentially cause some population-level effects.

At the regional, population-level scope of this analysis, the overall impact to deepwater benthic communities as a result of the activities proposed under Alternative C are expected to be the same as Alternative A, i.e., **negligible** to **minor**, assuming the continuation of expected mitigation practices. BOEM's mitigation practices would reduce potential impacts as a result of routine activities, accidental events, and OCS oil- and gas-related cumulative impacts of a proposed lease sale under Alternative C to the range of **negligible** to **minor**. Absent these mitigations, the impacts as a result of the routine activities and accidental events of a proposed lease sale could be greater; the overall population level impact could range from negligible to moderate (in a theoretical, if improbable, worst-case scenario). This impact level is less than the potential major level impact that would be possible (absent mitigations) under Alternatives A and D. This difference is due to the greatly reduced area available for new leasing under Alternatives B and C, which would somewhat limit the number of potentially affected deepwater benthic communities and increase the likelihood of long-term recovery to pre-impact levels. However, it is believed that existing mitigation practices would continue to be applied to the proposed activities under Alternatives A-D, reducing the expected level of OCS oil- and gas-related impacts.

The incremental cumulative impacts of proposed and existing OCS oil- and gas-related activities under Alternative C are considered to add only a negligible to minor contribution to the overall cumulative impact, which includes the relatively greater influence of non-OCS oil-and gas-related cumulative impacts occurring throughout the GOM over the 50-year analysis period.

4.4.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

The exclusion of any or all of the available unleased blocks subject to the either the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations (Alternative D) would not alter the above conclusions reached for Alternatives A, B, or C. Under Alternative D, BOEM could hold a lease sale excluding the leasing of all blocks subject to the Topographic Features and Live Bottom (Pinnacle Trend) Stipulations. This would do relatively little to reduce the impacts as a result of the routine activities, accidental events, or cumulative impacts to deepwater benthic communities. Deepwater benthic communities are generally found in depths greater than 300 m (984 ft), and the vast majority of lease blocks covered by the Topographic Features and Live Bottom (Pinnacle Trend) Stipulations are in shallower waters. The exclusion of blocks subject to the Blocks South of Baldwin County, Alabama, Stipulation is not expected to change the impacts to deepwater benthic communities because of the small number of blocks and their distance from these communities. Non-OCS oil- and gas-related activities are also not expected to decrease under this alternative. At the regional, population-level scope of this analysis, the overall impact to deepwater benthic communities as a result of the (mitigated) activities proposed under Alternative D are expected to be the same as Alternatives A-C, i.e., **negligible** to **minor**.

4.4.2.5 Alternative E—No Action

Under Alternative E, a proposed lease sale would be cancelled. The potential for impacts would be none because new impacts to deepwater benthic communities related to a cancelled lease sale would be avoided entirely. Continuing impacts to the communities would be limited to existing routine activities, accidental events, and cumulative impacts associated with previous OCS lease sales and development. BOEM's current mitigation practices already regulate these activities and should continue to limit associated new impacts to the **negligible** to **minor** range.

Development of oil and gas would, in all likelihood, be proposed again in a future lease sale; in that case, the overall level of OCS oil- and gas-related activity would only be delayed, not reduced, at least in the short term.

Ongoing non-OCS oil- and gas-related activities are negligible at present time, but they could potentially become greater, even rising to major, should there be future changes in fishing practices or worst-case changes in climate change-related environmental conditions.

4.5 *SARGASSUM* AND ASSOCIATED COMMUNITIES

In the Gulf of Mexico, *Sargassum* and the organisms that reside within or around the matrix of plants are some of the most widely distributed and easily recognizable species in the GOM. *Sargassum* occurs across the GOM and is part of a cycle that spans most of the Northern Hemisphere of the Atlantic Ocean including the Caribbean Sea. As such, *Sargassum* might be potentially vulnerable to the development of OCS resources and it is necessary to examine the potential impact-producing factors and determine the susceptibility to these impacts as they relate to a proposed action. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), accidental events, and cumulative activities (**Table 4-7**). The description of the environment provides a baseline that encompasses all previous and current OCS oil- and gas-related and non-OCS oil- and gas-related activities to date.

> *The* Sargassum *cycle is truly expansive, encompassing most of the western Atlantic Ocean and the Gulf of Mexico with the growth, death, and decay of these plant and epiphytic communities, which may play a substantial role in the global carbon cycle.*

Table 4-7. *Sargassum* and Associated Communities Impact-Producing Factors.

Sargassum and Associated Communities	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Vessel Operations	Negligible	Negligible	Negligible	Negligible	None
Drilling Operations	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Drilling Operations	Negligible	Negligible	Negligible	Negligible	None
Vessel Operations	Negligible	Negligible	Negligible	Negligible	None
Oil Spill and Cleanup	Negligible	Negligible	Negligible	Negligible	None
Cumulative Impacts					
OCS Oil and Gas	Negligible	Negligible	Negligible	Negligible	Negligible
Non-OCS Oil and Gas	Negligible	Negligible	Negligible	Negligible	Negligible

Within this chapter, characteristics unique to *Sargassum* are discussed along with life history. In addition, the roles of *Sargassum* functioning as a habitat, the species that depend on *Sargassum,* and factors that influence *Sargassum* are also discussed. During this analysis, many potential impact-producing factors were identified; however, only several posed a potential enough threat to carry forward to a full analysis. The following impact-producing factors were examined for their potential impact to *Sargassum*:

- vessel operations (**Chapter 3.1.4.4**);
- presence of toxins in water column (**Chapters 3.1.5.1 and 3.1.5.2**);
- sediment deposition on seafloor (**Chapters 3.1.3.3.1 and 3.1.3.3.2**);
- sediment deposition into water column (**Chapter 3.1.3.3.2**);
- alteration of water-flow patterns;
- impingement (**Chapter 3.1.5.1.6**);
- vessels sinking (**Chapter 3.2.5**);
- marine debris (**Chapter 3.1.5.3**);
- oil spills (**Chapter 3.2.1**);
- oil-spill cleanup (**Chapter 3.2.7**); and
- chemical and drilling-fluid spills (**Chapter 3.2.6**).

An in-depth analysis of these potential factors determined that, although many may occur within the GOM, few occur at an extent that could cause impacts to the population of *Sargassum* as a whole. This includes sediment deposition on the seafloor or in the water column, vessels sinking, impingement, marine debris, and alteration of water flow patterns. Additionally, impacts associated with the presence of toxins and sediments in the water column from discharges during routine operations are managed through the NPDES permitting process or by the MARPOL Annex V Treaty. Regulation and enforcement of these laws is conducted by a number of agencies, such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. These regulations ensure that water quality is maintained at a level that is nontoxic to the organisms in the water where it is being discharged and are not addressed in this chapter for Sargassum, but rather are discussed in Chapter 4.2 (Water Quality). Additionally, cooling water discharges from vessels are also not addressed because, compared with the surface area of the environment, the area that could be impacted by vessel discharges is miniscule. Finally, the spatial extent and the transient nature of the *Sargassum* cycle is such that it would take a low-probability catastrophic event larger than the *Deepwater Horizon* oil spill to affect enough *Sargassum* to result in population-level impacts across the GOM for more than a season, which is not reasonably foreseeable as a result of a proposed lease sale. Other events like deposition of sediments onto the seafloor do not occur within the same section of the water column where *Sargassum* occurs. As such, only the following impact-producing factors were identified as having the potential to impact *Sargassum* and were carried forward to a full analysis:

- vessel operations (**Chapter 3.1.4.4**; routine only; minus discharges);
- chemical and drilling-fluid spills (**Chapter 3.2.6**; accidental only);
- oil spills (**Chapter 3.2.1**; accidental only); and
- oil-spill cleanup (**Chapter 3.2.7**; accidental only).

To facilitate a discussion on the spatial extent of the *Sargassum* cycle and to put the impact-producing factors in context, **Figure 4-16** depicts how these plants move around the Northern Hemisphere. The *Sargassum* loop system initiates in the Sargasso Sea. Atmospheric conditions create wind patterns that push *Sargassum* south, into the Caribbean Sea where it is pushed west by the oceanic and atmospheric currents carrying it into the Gulf of Mexico. There it washes ashore on the Gulf Coast or gets swept out the Florida Strait via the Gulf Stream (Gower et al., 2013; Frazier et al., 2015). **Figure 4-16** represents the spatial extent of many of the species that use *Sargassum*, demonstrating that there is a high degree of connection among the Gulf of Mexico OCS planning areas and other oceanic basins and mesoscale oceanic features (e.g., Gulf Stream).

Figure 4-16. Sargassum *Loop System (adapted from Gower et al., 2013, and Frazier et al., 2015).*

Impact-Level Definitions

For this analysis, the following criteria were used to categorize the effects of impact-producing factors:

- **Negligible** – Impacts to *Sargassum* and associated communities are undetectable or limited in scale to the immediate area of the impact-producing factor. This may include mortality of the plants or animals associated with *Sargassum*. Such impacts may result in changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not alter the overall status of *Sargassum* or associated communities in the GOM.
- **Minor** – Impacts to *Sargassum* and associated communities are detectable and result in changes beyond the immediate area of the impact-producing factor. Such impacts could result in noticeable changes to a local community's species abundance and composition, community structure, and/or ecological functioning,

but would be spatially localized, short term in duration, and would not alter the overall status of *Sargassum* or associated communities in the GOM.

- **Moderate** – Impacts to *Sargassum* and associated communities cause substantial, population-level changes in species composition, community structure, and/or ecological functioning beyond the immediate area of the impact-producing factor. These impacts would be expected to be spatially extensive and may impact communities that rely on *Sargassum* for transportation of larvae, settlement, or food beyond the area of the impact-producing factor. However, impacts are expected to be temporary to *Sargassum* and associated communities, and there would be no disruption of the global *Sargassum* cycle.
- **Major** – Impacts to *Sargassum* and associated communities result in the loss of *Sargassum* over large sections of the GOM. This would result in substantial, population-level changes in species composition, community structure, and/or ecological functioning for *Sargassum* and communities that rely on *Sargassum* for transportation of larvae, settlement, or food beyond the area of the impact-producing factor. These impacts would be expected to be spatially extensive and possibly disrupt the global *Sargassum* cycle.

4.5.1 Description of the Affected Environment

Plant Characteristics

The pelagic complex in the GOM is comprised of *S. natans* and *S. fluitans* (Lee and Moser, 1998; Stoner, 1983; Littler and Littler, 2000). Both species of macrophytes are hyponeustonic and are fully adapted to a pelagic existence (Lee and Moser, 1998). *Sargassum* is characterized by a brushy, highly branched thallus with numerous leaf-like blades and berrylike pneumatocysts (Coston-Clements et al., 1991; Lee and Moser, 1998; Littler and Littler, 2000). These air bladders contain mostly oxygen and can facilitate buoyancy (Hurka, 1971). Net production in *Sargassum* also exceeds respiration by 1.3 times (Blake and Johnson, 1976), and the population can double in size every 3 months (Lapointe, 1986), suggesting that *Sargassum* may be important in the global carbon cycle. *Sargassum* plants may be up to a few meters in length and may be found floating alone or in larger rafts or mats depending on the environmental and physiochemical factors. Reproduction typically occurs through fragmentation, and the size, shape, and distribution of *Sargassum* mats can change rapidly depending on currents, wind, and other factors.

Life History

The life history of *Sargassum* in the GOM is part of a larger cycle that includes the mid-Atlantic Ocean and the Caribbean Sea (Frazier et al., 2015). This cycle begins in the Sargasso Sea where *Sargassum* remains year round. However, winds and currents move some of this *Sargassum* south into the Caribbean Sea and eventually into the GOM via the Yucatan Channel. Once in the GOM, it moves into the western area where it uses nutrient inputs from coastal rivers, including the Mississippi River, for growth. As *Sargassum* abundance increases, plants would continue to travel east during the summer months; however, a large quantity of plants would travel in to the nearshore where they would be deposited on coastal beaches. *Sargassum* deposition on Gulf Coast beaches is important because *Sargassum* facilitates dune stabilization and provides a pathway for nutrient and energy transfer from the marine environment to the terrestrial environment (Webster and Linton, 2013). Eventually the plants moving east would be incorporated into the Gulf Stream where they return to the Sargasso Sea (**Figure 4-16**). Throughout this cycle, plants would continue to grow, die, and reproduce. When a plant dies, it can sink to the seafloor, transporting nutrients and resources to the seafloor (Coston-Clements et al., 1991; Parr, 1939; Wei et al., 2012). Although the cycle continues year round, the rapid growth of *Sargassum* populations in the western GOM typically occurs during the spring/summer of the year (Gower et al., 2006; Gower and King, 2008; Gower and King, 2011). Estimates suggest that between 0.6 and 6 million metric tons of *Sargassum* are present annually in the GOM, with an additional 100 million metric tons exported to the Atlantic basin (Gower and King, 2008; Gower and King, 2011, Gower et al., 2013). The spatial expanse of this life history facilitates the rapid recovery from episodic environmental perturbations because of the remote probability that any single event could impact the entire spatial distribution.

Habitat Function

While in the oligotrophic waters of the GOM, *Sargassum* provides islands of high energy and carbon content in an otherwise nutrient and carbon poor environment (Stoner, 1983). *Sargassum* mats, comprised of a single or multiple plants in a matrix, support a diverse assemblage of marine organisms, including micro- and macro-epiphytes (Carpenter and Cox, 1974; Coston-Clements et al., 1991), fungi (Winge, 1923), more than 100 species of invertebrates (Coston-Clements et al., 1991; Huffard et al., 2014), over 100 species of fish (Dooley, 1972; Stoner, 1983; Huffard et al., 2014), four species of sea turtles (Carr, 1987a; Manzella et al., 2001), and various marine birds (Lee and Moser, 1998). *Sargassum* serves as nurseries, sanctuaries, and forage grounds for both commercially and recreationally exploited species (Adams, 1960; Bortone et al., 1977; Dooley, 1972; Wells and Rooker, 2004). *Sargassum* has also been identified as a critical habitat for the loggerhead sea turtle (*Caretta caretta*) (*Federal Register*, 2014a). Community composition of *Sargassum* mats vary spatiotemporally depending on the environmental and physiochemical factors of the waters where the *Sargassum* mats reside, resulting in a high degree of biologic diversity in species abundance, composition, and life history (Wells and Rooker, 2004).

***Sargassum*-Dependent Communities**

Invertebrates

Epiphytic cyanobacteria contribute to overall production and nutrient recycling within the *Sargassum* complex (Wells and Rooker, 2004). *Sargassum* is colonized by bacteria, hydroids, and bryozoans, providing the base of a food web (Dooley, 1972). Both sessile and motile invertebrates are found within the *Sargassum* community. Epifaunal organisms include colonial hydroids, encrusting bryozoans, the polychaete Spirorbis, barnacles, sea spiders, and the tunicate Diplosoma (Dooley, 1972; Coston-Clements et al., 1991; Huffard et al., 2014). Older plants can become heavily encrusted with these organisms, causing them to sink to the seafloor. Some of the motile fauna found within the *Sargassum* matrix include polychaetes, flatworms, nudibranchs, decapod crustaceans, and various molluscs (Parr, 1939; Coston-Clements et al., 1991). *Sargassum* matrices provide a habitat that affords a degree of protection, entrains food, and is an effective method for traversing long distances for *Sargassum*-dependent and *Sargassum* and associated organisms.

Sea Turtles

Four of the five species of sea turtles found in the GOM (all are listed under the ESA) are associated with floating *Sargassum* (Carr and Meylan, 1980; Carr, 1987a; Coston-Clements et al., 1991; Schwartz, 1988; Witherington et al., 2012). The hatchlings of loggerhead, green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*) sea turtles are thought to find the *Sargassum* rafts when actively seeking frontal zones, then utilizing the habitat as foraging grounds and protection during their pelagic "lost years" (juvenile years in which turtle sightings are scarce) (Carr, 1987a; Coston-Clements et al., 1991; Witherington et al., 2012; Putman and Mansfield, 2015). In 2014, the FWS designated critical habitat for the Northwest Atlantic Ocean Distinct Population Segment for loggerhead sea turtles in waters including associated *Sargassum* habitat and beach habitat of the GOM and along the U.S. Atlantic Coast (*Federal Register*, 2014a). For additional information on sea turtles, refer to **Chapter 4.9.2** (Protected Species).

Birds

The presence of *Sargassum* can also influence local abundance and occurrence of certain species of marine birds by concentrating food, as many birds actively feed on or around the mats (Lee and Moser, 1998; Moser and Lee, 2012). Birds with over 25 percent of their prey living in *Sargassum* are classified as *Sargassum* specialists. Specialist species included several species of shearwaters, terns, phalaropes, petrels, and gulls (Moser and Lee, 2012). For the birds that rely on *Sargassum* for food, the importance of the *Sargassum* and associated communities to seabird abundance and seasonal distribution is expected to be high (Moser and Lee, 2012). For additional information on the importance of *Sargassum* to birds, refer to **Chapter 4.8**.

Fish

The assemblages of fishes using *Sargassum* as a habitat are highly variable in time and space (Huffard et al., 2014). Jacks, pompanos, mackerels, scads, triggerfishes, filefishes, seahorses, pipefishes, and frogfishes represent up to 97 percent of the fishes in *Sargassum* mats (Dooley, 1972; Bortone et al., 1977). Some species that are endemic to *Sargassum* utilize the habitat for early life stages as well as adult stages, while other species may rely on the habitat only as a source of food, protection, and a method of passive transportation during early life stages (Bortone et al., 1977; Wells and Rooker, 2004). The abundance of juvenile fish associated with these mats suggests that they serve as an important nursery habitat for numerous species (Dooley, 1972). By serving as a nursery habitat for pelagic, benthic, and even estuarine species, *Sargassum* may have influence on the recruitment success of the fishes using it as habitat. For additional information on fish, refer to **Chapter 4.7**.

4.5.2 Environmental Consequences

Because of the spatial extent of the *Sargassum* cycle, the community dynamics of *Sargassum* and *Sargassum*-dependent species are influenced by a myriad of complicated factors. Many of these factors are poorly understood due to the size and scope of the *Sargassum* cycle. For example, without any substantial changes in environmental conditions, the biomass of *Sargassum* was 200-fold greater in 2011 than the previous 8-year average (Gower and King, 2011). Additionally, comparisons across a 40-year period documented that there were no changes in the biodiversity of species, but there was a change in community composition for the *Sargassum*-dependent species found in the Atlantic Ocean (and presumably a pre-cursor to GOM populations). However, no specific anthropogenic or environmental factor could be identified as the source of change (Huffard et al., 2014). One factor that may influence *Sargassum* communities is that the oceanographic processes that concentrate *Sargassum* into mats and rafts may also concentrate surface pollutants and marine debris (Burns and Teal, 1973; Laffoley et al., 2011; Powers et al., 2013). This was evident during the *Deepwater Horizon* explosion, oil spill, and response as many *Sargassum* mats were found immersed in oil with little or no visible living-associated organisms (Powers et al., 2013). Additionally, S*argassum* may be influenced by many nonpoint sources of pollution as pollutants are concentrated, possibly magnifying the environmental impacts of those substances (Laffoley et al., 2011).

These communities play an important role to ESA-listed species by providing food, habitat, and a method of transportation. BOEM consults on these species with the FWS and NMFS. These species include sea turtles and birds; to read about the protected species that use these habitats, refer to **Chapters 4.9.2 and 4.9.4**, respectively.

Routine Activities

Impact-producing factors associated with routine activities for a proposed action that could affect *Sargassum* are limited to impacts from vessel operations and impingement on oil and gas structures. However, the impediment of the movement of *Sargassum* mats is expected to affect such a small quantity of algae that impacts would be **negligible** with no consequences to the overall *Sargassum* community.

Vessel Operations

It is expected that a fleet of vessels would be used to support oil and gas exploration, production, and possibly other OCS oil- and gas-related operations across the GOM (**Chapter 3.1.4.4**). Because of the pelagic life history of *Sargassum,* vessels supporting oil and gas operations would routinely come in contact with *Sargassum* and associated communities. When impacts occur, it would be the result of *Sargassum* coming in contact with the vessel hull or in contact with the propulsion system. The consequence could be the break-up of *Sargassum* plants into smaller pieces, death of *Sargassum* plants, or dislodging and/or death of epiphytic organisms or organisms living in close proximity to *Sargassum.* However, impacts to *Sargassum* would only occur if the vessel is traveling at a high rate of speed and comes in contact with the plants. If individual plants are broken into moderately sized pieces during low-speed travel, it is expected that the plants would continue to grow as multiple separate entities through vegetative propagation. For *Sargassum*-dependent organisms that are physically attached to the plant matrix (e.g. epiphytes), dislodgement would result in death as they sink to the seafloor or are preyed upon. For animals that live in close proximity to *Sargassum*, it is expected that dislodgement would be temporary as they would find their way back to the plant, or other plants, after the vessel had passed. Again, this would only occur if contact occurs with the vessel traveling at a rate of speed great enough to actually dislodge organisms. This critical speed would be dependent on sea-state, types of organisms present, vessel size, and depth of *Sargassum* in the water column.

Regardless of the possibility of impacts to individual *Sargassum* plants and associated communities, vessel operations are expected to have **negligible** impacts on the population of *Sargassum* or to the animals that colonize the plants. The primary reason is that the *Sargassum* cycle (refer to "Life History" in **Chapter 4.5.1** above) rapidly replaces (days to weeks) any plants that are damaged or destroyed by OCS oil- and gas-related vessels in a given area. Vessels would also have to be travelling at a high rate of speed and contact *Sargassum*. Vessels and *Sargassum* each move haphazardly, minimizing the possibility of contact to any particular piece of *Sargassum*. If contact does occur, there are few locations on the vessel (e.g. rudders, intakes) where *Sargassum* could actually become impinged. Additionally, the oceanographic processes that cause *Sargassum* to form large rafts would also cause large pieces of marine debris (e.g. trees, lumber, and trash) to collect with the *Sargassum*. As such, many vessels would avoid large rafts or slow down as they pass through, minimizing potential impacts to *Sargassum*. Finally, many of the vessels working in the OCS oil- and gas-related fields rely on displacement hulls rather than planning hulls. Because of this, most vessels would push plants away from the vessel rather than colliding with the plants. Damage would be limited to those that pass through the propulsion system of the vessel. Even on the largest vessels, the diameter of the propellers is relatively small, resulting in short-term, localized damage that should have **negligible** impacts to the population of *Sargassum* or the organisms that coexist within the plant matrix.

Accidental Events

Impact-producing factors associated with accidental events for a proposed action include (1) impacts associated with drilling operations, (2) impacts due to vessel operations, and (3) impacts resulting from an oil spill and associated cleanup operations. These impact-producing factors would have varied effects depending on the intensity of the spill, the presence of *Sargassum*, and the abundance of *Sargassum* in the vicinity of the spill.

Drilling Operations

Accidental events associated with drilling operations are limited to the accidental discharge of drilling muds and chemicals into the water column (**Chapter 3.2.6**). This type of event may occur if the equipment separating SBFs from the cuttings malfunctions. Although the toxicity of SBFs is regulated by the USEPA and are not typically toxic (USEPA, 2004, 2007, and 2009), an unexpected release into a *Sargassum* raft could potentially result in damage to the plants or the organisms that inhabit *Sargassum*. Because of the cost of SBFs, the systems responsible for separating SBFs from the drill cuttings for reuse are monitored closely; as such, any accidental discharge of SBFs would be limited in size and scope. Once in the water column, SBFs would clump and sink quickly and impact only the plants and animals that come in contact with the SBFs. Because *Sargassum* is constantly moving horizontally within the environment, the abundance of plants that could be impacted by any given accident would be minimal. Due to the cyclical life history of *Sargassum*, dead plants would sink to the seafloor and would rapidly be replaced by new plants moving into the area. Although impacts could occur at isolated locations and at a small scale, they would be limited in size, scope, and duration, with **negligible** population-level impacts expected.

Vessel Operations

Although regulated by MARPOL and other regulations, the only reasonably foreseeable accidental event associated with vessel operations that may impact *Sargassum* is the release of floating debris into the surface waters of the GOM (**Chapters 3.1.5.2 and 3.1.5.3.4**). The accidental release of marine debris could occur when cargo is not properly restrained on deck while underway or during transfer operations between vessels and platforms. Losses of large quantities of debris are rare; however, losses of smaller pieces of debris might happen (e.g., trash, safety vests, hardhats, etc.). Floating debris is subject to the same oceanographic process that influences and moves *Sargassum*, resulting in marine debris and *Sargassum* rafting together. Marine debris may have little impact on the plants, but the organisms living in close proximity might be impacted. This includes the ingestion of plastics by sea turtles, ingestion of microplastics by fishes and invertebrates, or the release of toxins from within an object (e.g., a bucket of paint) or as an object undergoes degradation, which are discussed in **Chapters 4.7** (Fish and Invertebrate Resources) and **Chapter 4.9.2** (Sea Turtles) (Engler, 2012; Schuyler et al., 2012; Wright et al., 2013). Given the lack of stationary gyres in the GOM, OCS oil- and gas-related floating debris would not be expected to remain long enough to undergo substantial degradation before washing ashore along a beach or sinking to the seafloor. There is a remote possibility that some debris might be advected within the Gulf Stream and carried to the gyre in the mid-Atlantic. This debris could remain long enough to undergo degradation or be ingested; however, this would be a small enough amount of debris from OCS oil- and gas- related activities to have a **negligible** impact. BOEM and BSEE have addressed the marine debris issue by historically imposing marine debris awareness and prevention on the oil and gas industry through NTL 2015-BSEE-G03 as a part of the Protected Species Stipulation. Overall, vessel operations are expected to have a **negligible** impact on *Sargassum* and their associated communities because of the minimal volume expected and reduced residency times.

Oil Spills and Associated Cleanup Operations

Oil spills are the major accidental events of concern to the *Sargassum* community (refer to **Chapter 3.2.1** for information on oil spills). The risk of various sizes of oil spills occurring as a result of a proposed lease sale is presented in **Table 3-17**.

All known reserves in the GOM have specific gravity characteristics that indicate the oil would float to the sea surface (**Chapter 3.2.1.2**). Oil on the sea surface has the potential to negatively impact *Sargassum* communities. Some components of oil on the sea surface would be removed through evaporation, dissipation, biodegradation, and oil-spill cleanup operations; however, depending on the size of the spill, some of them could persist, contacting shore (**Chapters 3.2.1.3 and 3.2.7**). Oil at the sea surface can be mixed into the upper water column by wind and wave action to a depth of approximately 33 ft (10 m) (Lange, 1985; McAuliffe et al., 1975 and 1981b; Knap et al., 1985). With vigorous wave action, the oil can form an emulsion with water that is viscous and persistent. Oil treated with dispersant on the sea surface would mix with the water where its contact with *Sargassum* may be temporarily increased in the upper few meters of the water column (McAuliffe et al., 1981a). As time passes, the oil would begin to adhere to particles in the water column, form clumps, and sink toward the seafloor (International Tanker Owners Pollution Federation Limited, 2002; Kingston et al., 1995; Powers et al., 2013).

The impacts of oil contact with *Sargassum* communities would vary depending on the severity of exposure. *Sargassum* that contacts concentrated oil that coats the algae and attached organisms would likely die and sink to the seafloor (Powers et al., 2013). Motile organisms that are dependent on the algae for habitat (e.g., shrimp, crabs, nudibranchs, snails, *Sargassum* fish, etc.) may also be directly contacted by the oil, resulting in death, or may be displaced into open water. *Sargassum* exposed to oil in lower concentrations may suffer sublethal impacts and concentrate hydrocarbons, toxins, and chemicals (Burns and Teal, 1973). Exposure to these low-level toxins could result in the loss of associated organisms that use the algae as a substrate and other organisms that use the matrix as habitat due to the presence of bacterial-mediated hypoxic conditions in the immediate vicinity of the plant as the oil is consumed (Powers et al., 2013). However, hypoxia would be naturally mitigated due to wave action. Pelagic organisms feeding on or around the community may suffer sublethal effects that could reduce health and reproduction-like reduced growth or fecundity. For information on fauna that are part of the *Sargassum* community, refer to **Chapters 4.7** (Fish and Invertebrate Resources), **4.8** (Birds), **4.9.2** (Sea Turtles), **and 4.9.4** (Protected Birds).

Spill-response activities may contribute to negative impacts on *Sargassum* (refer to **Chapter 3.2.7** for information on oil-spill response activities). The number of vessels concentrated in a given area to clean up a spill can increase physical damage to the *Sargassum* community, especially in the immediate vicinity of the spill. Response activities, such as skimming oil from the sea surface or burning oil at the surface, can damage and remove *Sargassum* that may not have contacted oil. However, for oil-coated *Sargassum*, these impacts may be inconsequential, as a large part of the *Sargassum* affected would not be expected to survive (Powers et al., 2013). Another major response activity that may occur is the spraying of dispersant. Direct effects of dispersant on many of the more mobile constituents of the *Sargassum* community are limited, but dispersants are toxic to *Sargassum* plants and many invertebrates (Powers et al., 2013; Almeda et al., 2014). The use of dispersants is a trade-off to achieve the least overall environmental damage. For example, dispersants may increase short-term contact of oil with *Sargassum* and may have some inherent toxic properties, but their use can prevent the formation of persistent emulsions and promote diffusion of oil, resulting in biodegradation, clumping, and sinking.

A spill may impact the survivability and productivity of *Sargassum* in an area (Powers et al., 2013). However, an accidental spill would only be expected to have an impact in the immediate area and would be short in duration. Given the life history of *Sargassum,* it is expected that, for an accidental spill, fresh plants would replace the old plant within days to weeks. The new plants would also provide habitat for any organisms with the desire to leave impacted plants, which could happen in the natural life cycle of *Sargassum*. The *Sargassum* community is widely distributed over a very large area, including two oceans, and appears to have an annual cycle of growth that lends itself to resilient recovery in a short time. Due to the spatial extent of the *Sargassum* cycle, impacts due to an accidental oil spill are expected to be **negligible** to the *Sargassum* population; however, in the immediate area of a spill, the short-term impacts could range from moderate to major depending directly on the size of the spill and amount of *Sargassum* in the area.

Cumulative Impacts

Several impact-producing factors can affect *Sargassum*, including vessel-related operations, oil and gas drilling discharges, operational discharges, accidental spills, non-OCS oil- and gas-related vessel activity, and coastal water quality.

OCS Oil- and Gas-Related Impacts

Vessels transiting the GOM pass through *Sargassum* mats, producing slight impacts to the *Sargassum* community by their passage, some propeller impacts, and possible impingement impacts (refer to **Chapter 3.3.1.7** for information on cumulative service-vessel numbers). None of these would have more than minor localized impacts to the mats, but they could lead to the loss of plants or stress for organisms. The OCS oil- and gas-related structures can impede the movement of *Sargassum* mats and may entrap small quantities of the algae. This is expected to have a **negligible** impact with no consequences to the overall *Sargassum* community.

The OCS oil- and gas-related drilling results in discharges of drill cuttings with small quantities of associated drilling muds and well treatment chemicals. Most cuttings from well drilling are discharged from the drill platform at the sea surface where they disperse (CSA, 2006; Kennicutt et al., 1996; NRC, 1983). Floating mats of *Sargassum* that pass by a drilling operation would experience short-term exposure to drill cuttings with associated muds and well treatment chemicals. Discharges are regulated and tested by the USEPA to ensure that discharges released into the environment are nontoxic or not concentrated enough to become toxic (USEPA, 2004, 2007, and 2009b). Drilling operations create an area of high turbidity in the vicinity of drilling operations where cuttings are discharged. Impacts from sedimentation to the community organisms may include "changes in respiration rate, abrasion and puncturing of structures, reduced feeding, reduced water filtration rates, smothering, delayed or reduced hatching of eggs, reduced larval growth or development, abnormal larval development, or reduced response to physical stimulus" (Anchor Environmental CA, L.P., 2003).

The OCS oil- and gas-related platforms and drill ships produce similar effects with operational discharges. Larger vessels and offshore platforms discharge effluents from sanitary facilities (gray water) and circulate seawater to cool ships' engines, electric generators, and other machines. The cooling water discharge may be up to 20 °F (11 °C) warmer than the surrounding seawater (USDHS, CG and USDOT, MARAD, 2003; Patrick et al., 1993). This temperature difference can accumulate in the vicinity of the discharge. For OCS oil- and gas-related stationary platforms and drill ships, localized warming of the water could occur (Emery et al., 1997; USDHS, CG, and USDOT, MARAD, 2003). However, the warm water is rapidly diluted, mixing to background temperature levels within 328 ft (100 m) of the source (USDHS, CG and USDOT, MARAD, 2003). Additionally, produced waters from stationary locations are rapidly diluted, and impacts are only observed within 328 ft (100 m) of the discharge point (Neff and Sauer, 1991; Trefry et al., 1995; Gittings et al., 1992b). Those effects are localized, with only brief contact to passing *Sargassum* before dilution to background levels; however, this could result in discomfort, displacement, or death to some of the more sensitive organisms. These effects would comprise a **negligible** portion of the overall cumulative impact to *Sargassum* communities.

Accidental spills of oil and other chemicals could affect *Sargassum* and its community wherever they contact the algae. Small spills would have a limited local effect on a small portion of the *Sargassum* community. Short-term exposure of passing *Sargassum* to high concentrations of oil and chemicals could result in death and sinking of the algae and organisms contacted. The size of the overall impact on *Sargassum* would depend on the size of the spill and the success of spill-response efforts; therefore, impacts from an accidental release of oil could range from negligible to moderate. Impacts would not affect the population, but substantial impacts could be expected to the organisms exposed, although limited in spatial extent and duration. This includes death if oil concentrations in the water column are great enough to result in ingestion of oil or coating of the organisms residing in the vicinity of *Sargassum* mats (Fucik et al., 1995; Brewton et al., 2013).

Non-OCS Oil- and Gas-Related Impacts

Marine vessels of all types produce at least some minor effects to the environment (refer to **Chapter 3.3.2.2**). Increased abundance of non-OCS oil- and gas-related vessels operating in the same environment as *Sargassum* presents an increase in the expected vessel-related damage to *Sargassum* and associated communities. Given that most vessels are limited to the waters nearshore (e.g., recreational fishermen), the impacts on *Sargassum* is expected to be minor. *Sargassum* found in near-coastal waters is expected to eventually senesce (the process of aging in plants) and sink to the seafloor or be deposited on coastal beaches. As such, additional damage to any *Sargassum* that may occur would not impact the population. Offshore traffic would be limited and occur in a haphazard manner beyond shipping lanes. As such, the movement of *Sargassum* combined with the movement of vessels ensures that no impacts occur routinely to any given *Sargassum*, resulting in **negligible** cumulative impacts by non-OCS oil- and gas-related vessel traffic.

Declining coastal water conditions, due to eutrophication, are a non-OCS oil- and gas-related impact that could result in landscape level impacts to *Sargassum* (**Chapter 3.3.2.11**). Increased nutrient loading can lead to increased turbidity from plankton growth and a reduction in oxygen during periods of hypoxia (e.g., in the summer; refer to **Chapter 3.3.2.12**). Turbidity could result in a decrease in *Sargassum* production and result in stress to the organisms inhabiting these habitats, while increased nutrients could result in an increased growth of *Sargassum*. A reduction in production could result in a decrease in the ability of *Sargassum* to sequester nutrients and carbon dioxide and to produce oxygen, while an increase in production could provide more habitat. The exact impact of declining water quality is unknown because *Sargassum* can pass in and out of these waters depending on the prevailing conditions, and much of the more hypoxic and highly turbid waters occur nearshore where *Sargassum* would not normally survive because it would be deposited on a coastal beach or senesce (the process of aging in plants) and sink to the seafloor.

Combined, the cumulative impacts of OCS oil- and gas-related operations would be **negligible** to the population, but there may be localized impacts to a small portion of the total *Sargassum* population. Because the *Sargassum* cycle occurs across a large portion of the Western Hemisphere (Frazier et al., 2015) and because OCS oil- and gas-related operations rarely occur in dense aggregations, especially with respect to drilling operations, the cumulative impacts of a proposed action on the population of *Sargassum* would be **negligible**. The impacts of OCS oil- and gas-related operations, combined with non-OCS oil- and gas-related factors would not result in an increase in the overall impact of oil and gas operations resulting from a proposed action. Non-OCS oil- and gas-related vessel traffic is not expected to have a substantial impact on *Sargassum* and associated communities; however, declining coastal water quality as a result of eutrophication could, as described in **Chapter 4.2** (Water Quality). Regardless, the incremental impact of OCS oil- and gas-related operations on the population of *Sargassum* would be **negligible** and not result in cumulative impacts to the population. Impacts from changing water quality would be much more influential on *Sargassum* than OCS development and would still occur without the presence of OCS oil- and gas-related operations.

Incomplete or Unavailable Information

Although much is known about *Sargassum* and its life history, incomplete or unavailable information still remains. This incomplete or unavailable information includes information on the effects of *in situ* oil exposure and the factors impacting the movement patterns of *Sargassum.* BOEM used existing information and reasonably accepted scientific methodologies to extrapolate in completing the analysis above. BOEM has determined that there are few foreseeable significant adverse impacts to the *Sargassum* population associated with OCS oil- and gas-related routine activities or accidental events, using publications such as Frazier et al. (2015), Gower and King (2011), Gower et al. (2013), and Powers et al. (2013). Gower and King (2011) and Gower et al. (2013) suggest that *Sargassum* is continually present in the west-central GOM and that it moves in a general west-to-east pattern during the growing season; however, movements at a finer temporal or spatial scale are more difficult to predict. Frazier et al. (2015) built upon these studies and developed a more finite life cycle for *Sargassum* that links the Sargasso Sea *Sargassum* populations with the GOM populations. With respect to the effects of oiling, Liu et al. (2014) noted that the toxicity or the presence of oil across the surface waters of the GOM was also variable at any given time, suggesting that it is difficult to predict the effects of coming in contact with surface oil.

Additionally, Lindo-Atichati et al. (2012) suggested that patterns of larval fish in the surface currents in the northern GOM were not consistent spatially or temporally and that they were highly dependent on mesoscale current structures like the Loop Current and associated eddies. Combined, these studies suggest that, as *Sargassum* is passively moved in the surface waters, its presence at any given location or at any given time is difficult to predict, especially as the population grows exponentially during the growing season. Powers et al. (2013) also suggest that there were adverse impacts to *Sargassum* due to contact with oil and dispersants under the proper conditions, but the spatial or temporal extent of those impacts remain unknown. It is expected that, for routine activities or accidental events, the probability of enough *Sargassum* coming in contact with oil and dying as a result of this contact are low given that oil and *Sargassum* are each controlled by surface currents in differential manners. Ultimately, the ephemeral and wide-ranging nature across the northern GOM and the reproductive capabilities of *Sargassum* provide a life history that is resilient towards localized or short-term deleterious impacts, such as those expected to be associated with OCS oil- and gas-related routine activities and noncatastrophic oil or SBF spills. Therefore, BOEM has determined that the incomplete information on *Sargassum* is not essential to a reasoned choice among alternatives and that the information used in lieu of the unavailable information is acceptable for this analysis.

4.5.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Sargassum, as pelagic algae, is a widely distributed resource that is ubiquitous throughout the northern GOM and northwest Atlantic. *Sargassum* has a yearly cycle that promotes quick recovery from impacts. Therefore, most routine and accidental impact-producing factors would be expected to result in **negligible** impacts because they only impact a small percentage of the population and be limited in size and scope as new plants rapidly replace the impacted plants. In addition, the cumulative impact on *Sargassum* and associated communities for Alternative A would be **negligible**, as all expected impacts are from non-OCS oil- and gas-related activities and are mutually exclusive from any impacts resulting from a proposed action and previous OCS oil- and gas-related actions. Because the impacts of routine activities, accidental event, and cumulative impacts are **negligible**, the overall impacts to *Sargassum* and associated communities are expected to be **negligible**.

4.5.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Under this Alternative, impacts to *Sargassum* and associated communities would be eliminated in the WPA area. This would exclude those impacts from vessels docking in the WPA and operating in the CPA or EPA and the cumulative impacts associated with previous OCS oil- and gas-related development and non-OCS oil- and gas-related activities. Any spill-related impacts would be limited to the areas along the WPA/CPA boundary and would not impact *Sargassum* communities beyond the area of the spill. While the CPA/EPA has this greatest potential for OCS oil and gas-related activity, *Sargassum* is common throughout the area and it routinely moves across the Gulf. As such, any localized impacts would be short-term as plants are replaced, resulting in no population-level impacts, and therefore, impact conclusions do not differ from Alternative A, which are **negligible**.

4.5.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Under this Alternative, impacts to *Sargassum* and associated communities would be eliminated in the CPA/EPA area. This would exclude those impacts from vessels docking in the CPA and operating in the WPA and the cumulative impacts associated with previous OCS oil- and gas-related development and non-OCS oil- and gas-related activities. Any spill-related impacts would be limited to the areas along the WPA/CPA boundary and would not impact *Sargassum* communities beyond the scope of the spill. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), *Sargassum* is common throughout the area and it routinely moves across the Gulf. As such, any localized impacts would be short-term as plants are replaced, resulting in no population-level impacts, and therefore, impact conclusions do not differ from Alternative A, which are **negligible**.

4.5.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Under this Alternative, impacts to *Sargassum* would be similar to those described in Alternative A, which are **negligible**. *Sargassum* moves in the Gulf of Mexico over great spatial scales and it would be expected to move in and out of the unleased blocks depending on prevailing meteorological processes. In addition, many of these blocks already have OCS oil- and gas-related development, and *Sargassum* would continue to be impacted by the impacts of routine activities and accidental events from pre-existing OCS oil- and gas-related development.

4.5.2.5 Alternative E—No Action

Under Alternative E, a proposed lease sale would be cancelled and the potential for impacts from routine activities and accidental events would be **none**. Under this Alternative, impacts to *Sargassum* would be limited to cumulative impacts associated with previous OCS oil- and gas-related development and non-OCS oil- and gas-related activities. *Sargassum* moves in the Gulf of Mexico over great spatial scales and it would be expected to move in and out of the previously leased blocks depending on prevailing meteorological processes. In addition, many of these blocks already have OCS oil- and gas-related development, and *Sargassum* would continue to be impacted by the impacts of routine activities and accidental events from pre-existing OCS oil- and gas-related development.

4.6 Live Bottom Habitats

This chapter describes shallow-water hard/live bottom habitats in Gulf of Mexico OCS planning areas. Hard bottoms are naturally occurring, rocky, consolidated substrates that are geological (e.g., exposed sedimentary bedrock) or biogenic (e.g., carbonate relic coral reef) in origin.

These habitats occur throughout the GOM but are relatively rare compared with the soft bottoms that are ubiquitous throughout most of the GOM. Hard bottoms, particularly those having measurable vertical relief, can serve as important habitat for a wide variety of marine organisms. Encrusting algae and sessile invertebrates such as corals, sponges, sea fans, sea whips, hydroids, anemones, ascidians, and bryozoans may attach to and cover hard substrates, thereby creating "live bottoms," a term first coined by Cummins et al. (1962). The attached flora and fauna of live bottoms, such as large sponges and structure-forming corals, further enhance the structural complexity of the benthic environment. Complex structure offers shelter that can be attractive to smaller invertebrates and fishes (Fraser and Sedberry, 2008), which, in turn, can provide food for a variety of larger fishes, including some commercially important fisheries (Szedlmayer and Lee, 2004; Gallaway et al., 2009). Refer to **Chapter 4.7** (Fishes and Invertebrate Resources) and the *Essential Fish Habitat Assessment* white paper (USDOI, BOEM, 2016d) for more detail. Seagrasses can also be considered a type of live bottom, but they have very different physical characteristics and species assemblages than the above and are thus analyzed separately in **Chapter 4.3.1**.

Defined topographic features (**Chapter 4.6.1**) are a subset of GOM live bottom habitats that are large enough to have an especially important ecological role, with specific protections defined in the Topographic Features Stipulation. The Live Bottom (Pinnacle Trend) Stipulation (**Appendix D**) has historically been applied to specific lease blocks in the CPA and EPA (**Figure 4-17**) with the highest known concentrations of other live bottom features. These features are much smaller in size than the topographic features. Live bottom habitats found outside these stipulation lease blocks are not specifically included in the stipulation but are still given site-specific protections by BOEM during site-specific plan reviews. In **Figure 4-17**, the smaller black polygons represent the 38 named topographic features; selected fishery management areas on the West Florida Shelf, with known high concentrations of live bottoms, are shown in gray. The GOM live bottoms are not limited to the features/areas shown in **Figure 4-17**.

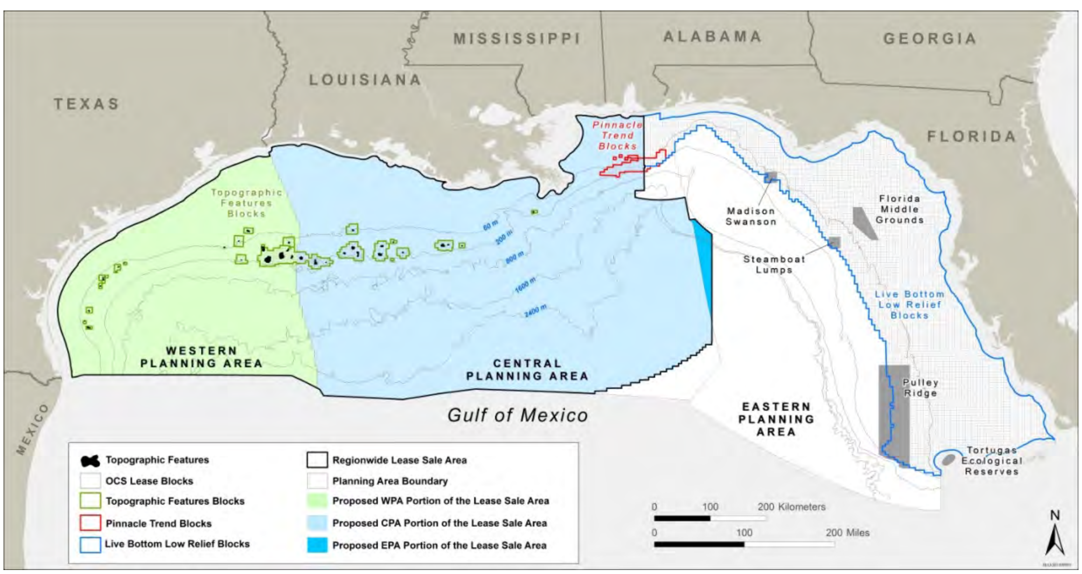

Figure 4-17. Lease Blocks Subject to the Topographic Features and Live Bottom (Pinnacle Trend) Stipulations.

4.6.1 Topographic Features

In the Gulf of Mexico, geologic features are known to function as hard substrate habitats that enable settlement of sensitive benthic organisms, concentrate fishes, and contribute substantially to the ecology of the GOM. Known as topographic features, many of these features have been identified by stakeholders as locations of value that may require a greater degree of protection from OCS development. As such, beginning in 1973, BOEM's predecessor agency established and implemented a Topographic Features Stipulation that OCS operators must respect when working around these features. This stipulation has been applied historically in the GOM and establishes a No Activity Zone for each feature where no bottom-disturbing activities are allowed and, in most cases, establishes additional areas around the No Activity Zones where shunting of drill cuttings and drilling fluids is required. This stipulation protects resources by distancing any OCS oil- and gas-related activity away from topographic features to minimize the impacts of routine activities or accidental events. In addition, BOEM enforces a 500-ft (152-m) buffer around each of the No Activity Zones where activity is generally not permitted. This policy was developed in consultation with NOAA to further protect areas of topographic features not protected by the No Activity Zone. Beyond the No Activity Zone, restrictions are placed on how drilling operations discharge cuttings at distances of up to 4 mi (6 km) away. These requirements are designed to allow oil to rise to the surface prior to contacting a topographic feature or for waterborne substances resulting from OCS oil- and gas-related operations to dilute and disperse. It is expected that this stipulation would continue to be a requirement for OCS operators throughout the entire time period covered by this analysis (2017-2022).

To facilitate the understanding of the ecology of topographic features, **Figure 4-18** is included to present a generalized ecological description of the habitats present at different depths. Each of the labels represents different ecological zones common to topographic features; however, rarely do all the zones occur on a single feature. For example, the East Flower Garden Bank is comprised of all but one ecotone, the Millepora-Sponge Zone. This zone occupies depths comparable to the Diploria-Montastraea-Porites Zone on the claystone-siltstone substrate of the Texas-Louisiana midshelf banks. Crusts of hydrozoan corals (*Millepora alcicornis*), sponges, and other epifauna typically occupy the tops of outcrops in this zone, but Scleractinian corals and coralline algae are rare (Rezak et al., 1990). In addition, for this analysis, the description of the resource includes the baseline environment, including the cumulative impacts from all previous OCS oil- and gas-related operations on the resource.

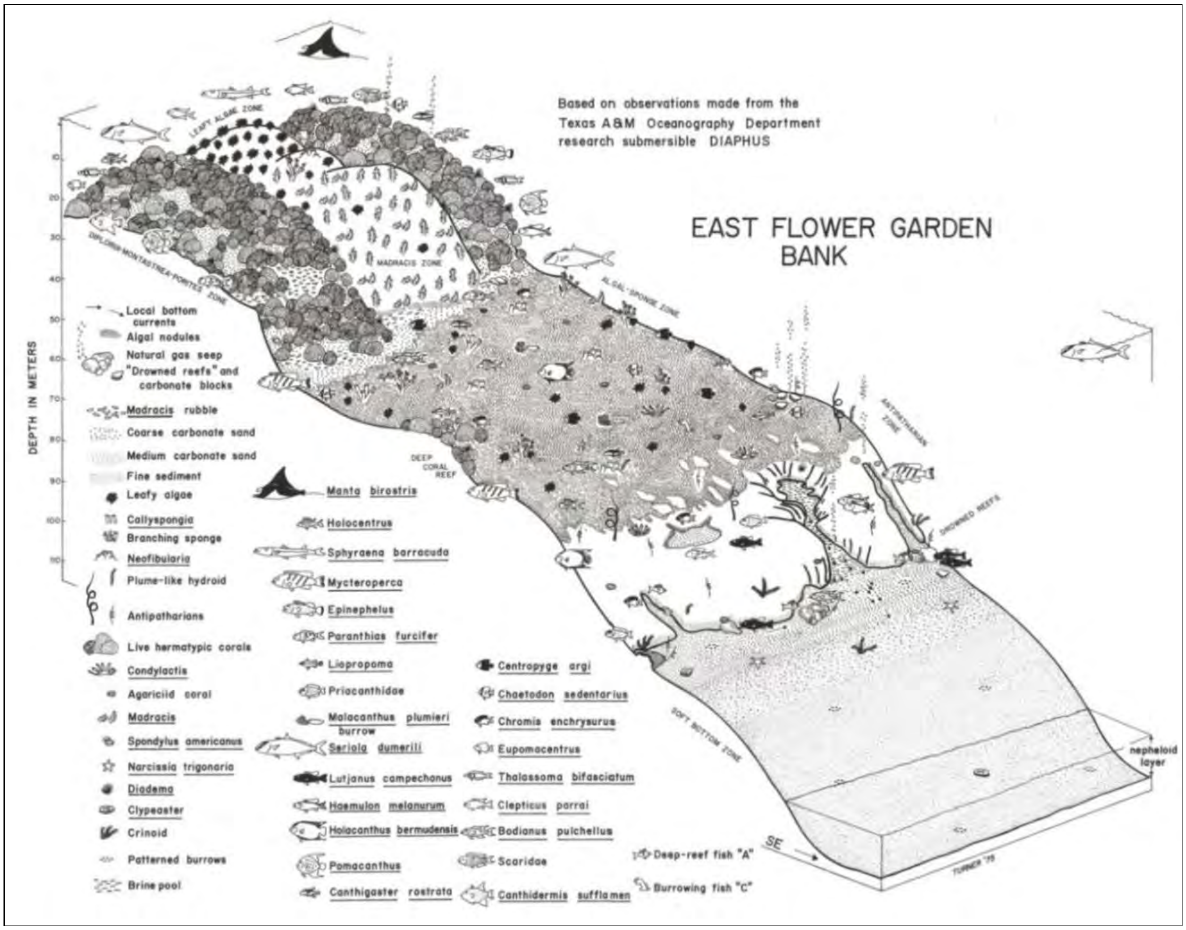

Figure 4-18. Ecological Representation of Common Features on Topographic Features in the Gulf of Mexico.

Because of the similarity and overlap of the effects of many activities that occur in the OCS, all possible impact-producing factors considered can be divided into three broad categories: drilling and exploration operations; vessel operations; and oil spill and associated cleanup activities. The impact-producing factors evaluated for this resource are listed below.

- Drilling, Exploration, and Decommissioning
  - Bottom-disturbing activities (**Chapter 3.1.3.3.1**)
  - Chemical and drilling-fluid spills (**Chapter 3.1.5**)
  - Deposition of sediments onto the seafloor (**Chapter 3.1.3.3.2**)
- Vessel Operation
  - Bottom-disturbing activities (**Chapter 3.1.3.3.1**)
  - Loss of debris

- Oil Spill and Associated Cleanup
  - Large and small spills resulting from surface or subsea sources
  - Cleanup operations not related to vessel operation
  - Sediment burial

An in-depth analysis of these potential factors determined that, although many may occur within the GOM, few are at an extent that could cause impacts to the topographic features as a whole (**Table 4-8**) because these habitats are spread across the GOM.

Table 4-8. Topographic Features Impact-Producing Factors.

Topographic Features	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Drilling, Exploration, and Decommissioning					
Bottom-Disturbing Activities					
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	N/A
Vessel Operations					
Bottom-Disturbing Activities					
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	N/A
Accidental Impacts					
Drilling, Exploration, and Decommissioning					
Bottom-Disturbing Activities					
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	N/A
Chemical and Drilling-Fluid Spills					
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	N/A
Vessel Operations					
Bottom-Disturbing Activities					
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	N/A
Oil Spills and Associated Cleanup Activities					
Large and Small Spills Resulting from Surface or Subsea Sources					
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	N/A

Topographic Features	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Cleanup Operations Not Related to Vessel Operation					
Without Mitigation	Moderate	Moderate	Moderate	Negligible	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	N/A
Cumulative Impacts					
OCS Oil and Gas					
Without Mitigation	Moderate	Moderate	Moderate	Moderate	Moderate
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	N/A
Non-OCS Oil and Gas					
Without Mitigation	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
With Mitigation	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate

N/A = not applicable.

The impact-producing factors related to the release of toxins and sediments were not carried forward because impacts associated with the presence of toxins and sediments in the water column from discharges during routine operations are managed through the NPDES permitting process or MARPOL Annex V Treaty. Regulation and enforcement of these laws is conducted by a number of agencies, such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. These regulations ensure that water quality is maintained at a level that is nontoxic to the organisms in the water where it is being discharged and are not addressed in this evaluation. Similarly, the release of any debris is also regulated by the USCG and MARPOL and is strictly prohibited; this is reinforced by NTL 2015-BSEE-G03, which imposes marine debris awareness and prevention measures on the oil and gas industry. Historically, NTL 2015-BSEE-G03 has been made a binding part of leases through the Protected Species Stipulation. As such, accumulations of debris at a level great enough to impact a topographic feature is unlikely. Additionally, impact-producing factors not carried forward include impacts resulting from a vessel sinking and coming to rest on a topographic feature. An OCS vessel sinking is a rare event and it is not reasonably expected that a vessel sinking on the OCS would come to rest on a topographic feature. Also, sediment burial and surface response operations that would occur during an oil spill are impact-producing factors not carried forward. Surface cleaning operations may occur in the surface water above a topographic feature; however, none of the technologies employed to remove oil at the surface operate at a depth deep enough to impact a topographic feature. An accidental burial of organisms by sediment during a spill was also not carried forward because it is not reasonably foreseeable that this type of event would occur in a noncatastrophic setting. A review of BSEE's records show that an accidental burial event has not occurred since at least 2006, which was when reporting requirements changed to require reporting of this type of event (USDOI, BSEE, 2015e). As such, the following impact-producing factors were carried forward to a full analysis for routine activities and accidental events:

- Routine activities
  - Drilling, exploration, and decommissioning
    - Bottom-disturbing activities
  - Vessel operation
    - Bottom-disturbing activities
- Accidental events
  - Drilling, exploration, and decommissioning
    - Bottom-disturbing activities
    - Chemical and drilling-fluid spills
  - Vessel operation
    - Bottom-disturbing activities
  - Oil spill and associated cleanup
    - Large and small spills resulting from surface or subsea sources
    - Cleanup operations not related to vessel operations

Impact-Level Definitions

For this analysis, the following definitions were used to categorize impacts to topographic features:

- **Negligible** – Impacts to topographic feature communities are largely undetectable. There is some potential for even undetectable impacts to cause slight changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not impact other topographic features.
- **Minor** – Impacts to topographic feature communities are detectable but cannot be distinguished from natural variation. Such impacts could result in noticeable changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but would be spatially localized, short term in duration, and recovery would be expected.
- **Moderate** – Impacts to topographic feature communities that result in substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive, spanning across several topographic features, but impacts are expected to result in temporary changes and recovery would be likely.

- **Major** – Impacts to topographic feature communities that result in substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive and noticeably alter the overall status of many topographic features in the GOM. Long-term recovery to pre-impact community structure, species abundance, or ecological function is unlikely.

4.6.1.1 Description of the Affected Environment

BOEM defines topographic features as a subset of hard bottom habitats found in the GOM that are large enough to have a particularly important role in the GOM ecosystem. Although large in size, these features are relatively rare compared with the expansive soft bottoms in the central and western GOM (Parker et al., 1983). Topographic features can be created by rock uplifted by salt diapirs, by relic carbonate reefs, or by the exposure of fossilized barrier islands (Rezak and Bright, 1981a and 1981b; Berryhill et al., 1987). Regardless of origin, these subsea banks provide areas of hard substrate that support benthic and fish communities with relatively high biomass, high diversity, and high abundance of plants and animals. Within the context of the larger Gulf ecosystem, these features also provide shelter, food, and nursery grounds that support large numbers of commercially and recreationally important fishes (Johnston et al., 2015; Nash et al., 2013). Finally, many of these habitats remain relatively pristine and have a high aesthetic and scientific value because they represent ecologic extremes for many species (Rezak and Bright, 1981a; Nash et al., 2013; Johnston et al., 2015).

Within the GOM, BOEM has identified 38 topographic features where some degree of protection from oil and gas development is historically warranted based on the geography and ecology (Rezak and Bright, 1981a; Rezak et al., 1983). If adopted, 22 protected banks are in the WPA, 16 are in the CPA, and 0 are in the EPA (**Figure 4-17**). For previous lease sales, all banks had at least a No Activity Zone where bottom-disturbing activities during oil and gas development are prohibited. Most banks have had restrictions beyond the No Activity Zone regulating drilling discharges. The No Activity Zones have been defined by BOEM's policy and are based on a specific depth contour. They are designed to protect the most sensitive area of the features. In addition, based on EFH programmatic consultation with NMFS, NTL 2009-G39 recommends that drilling should not occur within 152 m (500 ft) of a No Activity Zone of a topographic feature. Any bottom-disturbing activities within the buffer would require project-specific EFH consultation with NMFS.

Topographic features in the GOM span a range of environmental conditions, resulting in a wide range of community types. This includes a range from the highly productive hermatypic (i.e., reef building) corals found at the Flower Garden Banks to habitats like Dunn Bar that have less productive and less diverse benthic habitats but are known to concentrate fishes (Rezak and Bright, 1981b; Nash et al., 2013).

Bank Classification

Shelf-Edge Banks

The shelf-edge banks generally exhibit the greatest range of habitat types of all the topographic features because they have the greatest relief (Rezak et al., 1983). The habitats of topographic features can be classified into seven categories, and all habitat types can be found on the shelf-edge banks, although not all on the same bank (Rezak et al., 1983) (**Figure 4-18**). These habitats range from the reef-building corals, the most complex and diverse of the habitat types, to the highly turbid nepheloid layer habitats that have substantially less diversity and production due to the presence of high levels of suspended sediments. In general, banks that have the greatest vertical relief also have the greatest number of habitat categories present. Light penetration, depth, and sediment loading are the most influential environmental parameters to communities colonizing topographic features (Rezak et al., 1983). There is a direct relationship between light levels at depth and the biodiversity of these habitats.

Among the shelf-edge banks, the Flower Garden Banks and McGrail Bank have been identified as exceptionally important components of the GOM ecosystem because these banks represent the northern-most colonies of hermatypic corals and may provide larvae/recruits for other reefs at great distances away (Goodbody-Gringley et al., 2012). Shelf-edge banks also host seasonal feeding and mating, and serve as nursery grounds for many species like manta and devil rays, whale sharks, and hammerhead sharks (Burks et al., 2006; Johnston et al., 2015; USDOC, NOAA, 2010c; Johnston et al.; 2013). Additionally, many of these banks are important for commercial or recreational fisheries because they provide habitat for recruitment and concentrate harvestable quantities of fish (Rezak et al., 1983). There is also a diverse group of tropical reef fish species found on these banks. 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).

Midshelf Banks

The midshelf banks typically have less vertical relief than the shelf-edge banks and are present in waters that have less light penetration due to primary production or sediment loading. As such, the presence of reefs built by hermatypic corals is rare and limited to Stetson Bank (part of the Flower Garden Bank National Marine Sanctuary). Most benthic species on these banks are ahermatypic (i.e., non-reef building) corals, algaes, and sponges. The nepheloid layer often enfolds many of these banks because most have a lower profile than the shelf edge banks. This can influence light penetration and ultimately reduce biodiversity to the most robust species. Midshelf banks are known to concentrate many pelagic species of fishes and are visited regularly by commercial and recreational fishermen (Simmons et al., 2014).

South Texas Banks

The South Texas Banks are geographically and geologically distinct from the shelf-edge and midshelf banks (Rezak and Bright, 1981b; Berryhill et al., 1987). Several of the South Texas Banks are also low-relief banks comprised of a series of patch-reef habitats. Many of these banks were created from the exposure of fossilized shorelines along the prehistoric coastline or from drowned reefs created during a period when sea levels were considerably lower. These banks exhibit a reduced biota and have relatively low relief compared with the other banks, few hard-substrate outcrops, and a thicker sediment resulting from the presence of a nepheloid layer covering many of the banks (Rezak et al., 1983). The dominant benthic species on the South Texas Banks include sponges, hydroids, octocorals, and ahermatypic corals, although large areas of these reefs remain barren (Rezak and Bright, 1983; Dokken et al., 1993). These banks are known to provide habitat for many species of commercially and recreationally important species of fishes. These habitats are also important because they are closer to shore than many of the other banks and comprise the backbone of the recreational fisheries in that area (Simmons et al., 2014).

Environmental Sensitivity of Banks

The importance of these topographic features to GOM ecology and stakeholders has long been understood by BOEM. It is also known that the same geologic processes that create these topographic features also create reservoirs where hydrocarbons can become trapped and subsequently harvested. As such, in the 1970's, BOEM's predecessor developed the Topographic Features Stipulation to ensure that the most sensitive sections of these features were not negatively impacted by OCS oil- and gas-related activities. The primary concern was sediment deposition and subsequent smothering of organisms during drilling operations. As such, BOEM funded a series of exploratory cruises to better understand the ecology of these banks. The result was an environmental priority index to rate the sensitivity of topographic features (Rezak and Bright 1981a). From this index, BOEM developed the No Activity Zones and additional discharge restrictions. The Topographic Features Stipulation imposes these No Activity Zones and requirements have historically been applied in the GOM since 1973. In order of decreasing sensitivity, the following classification was used:

(1) 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 276-656 ft [84-200 m], crests 49-246 ft [15-75 m]).

(2) Midshelf, Tertiary-outcrop banks bearing clear-water, Millepora-Sponge Zone and turbid-water-tolerant Nepheloid Zone (surrounding depths of 164-203 ft [50-62 m], crests 59-131 ft [18-40 m]).

(3) Midshelf and South Texas carbonate banks bearing poorly developed elements of the Algal-Sponge Zone, transitional Antipatharian Zone assemblages, and Nepheloid Zone (surrounding depths of 328-361 ft [100-110 m], crests 220-240 ft [67-73 m]).

(4) Midshelf and South Texas banks bearing turbidity-tolerant assemblages approximating the Antipatharian Zone and Nepheloid Zone (surrounding depths of 197-262 ft [60-80 m], crests 184-230 ft [56-70 m]).

The most sensitive features to turbidity were given the greatest protection. For example, the Flower Garden Banks were given the most liberal No Activity Zone and a 4-mi (6-km) buffer where discharge restrictions are in place. Banks like McGrail Bank were given No Activity Zones that outlined the most sensitive habitats and a 1-mi (1.6-km) zone and a 3-mi (4.8-km) zone with varying degrees of discharge regulations. Banks like Sackett Bank have only a No Activity Zone and a 3,280-ft (1,000-m) zone where discharge restrictions are in place. Finally, low-relief banks with a high degree of tolerance for turbidity like Big Adam Bank only have a No Activity Zone.

There is evidence of a large-scale die-off of seaweeds and rhodoliths on several topographic features (Sackett and Ewing Banks) that occurred in 2010, possibly related to changes in environmental conditions and, as of 2013, there was only a limited recovery (Felder et al., 2014; Fredericq et al., 2014). The result is a reduction in diversity and abundance of benthic species at Ewing Bank, a reduction in abundance of benthic species at Sackett Bank, and an increase in injuries and population declines of decapods at both banks. Although there was little *in situ* recovery, it was found that the rhodoliths on these banks may be functioning as a “seed bank” for these habitats (Felder et al., 2014; Fredericq et al., 2014). This suggests that there is an unknown environmental variable in-place that may be preventing *in situ* conditions required for recovery.

The ultimate cause of these changes remains unknown; however, this area was subjected to ecosystem level insults from 2009 through 2012, in addition to the *Deepwater Horizon* explosion and oil spill. With respect to oil exposure, Sackett and Ewing Banks had some degree of exposure in the surface waters. There is no direct evidence that implicates oil-related impacts as the trigger for these changes (Felder et al., 2014; Fredericq et al., 2014). However, to place these banks in a wider environmental context, they are located in areas highly influenced by the outfall of the Mississippi River. Between 2009 and 2012, the Mississippi River outfall was highly irregular compared with normal outfall patterns (Pollak, 2013). From late 2009 to late 2010 and 2011, the Mississippi River maintained an exceptionally high flow rate with an abnormal seasonal pattern, and this was followed by record low outfall levels in 2012. These areas were also subjected to differing levels of hypoxia, with major hypoxic events occurring in the vicinity of Ewing Bank in the summers of 2009, 2010, and 2011 (USDOC, NOAA, 2010d and 2015j). Although there were many hypoxic events prior to 2009, these occurred during periods of river outfall patterns exhibiting a more “normal” seasonal pattern, possibly impacting these banks. Finally, the banks of the northern GOM also experienced exponential population growth of the invasive lionfish (*Pterois volitans*) during this same time period (USDOI, GS, 2015; Johnston et al., 2013). This fish is known to drive down diversity and abundance of benthic organisms, especially crabs, demersal fishes, and shrimps (Green et al., 2012). The lionfish expansion could result in a top-down control of grazers, ultimately preventing recolonization by seaweeds due to increased grazing on seaweed recruits by herbivores released from decapod predation due to lionfish. It is a reasonable conclusion that the possible ecosystem-level changes on these two banks are the result of the cumulative impacts of many factors (e.g., Karnauskas et al., 2015) rather than a single cause-effect relationship (i.e., the *Deepwater Horizon* oil spill), especially with respect to recovery.

Habitat Areas of Particular Concern and Endangered Species Act Listings

The NMFS has designated habitat areas of particular concern (HAPCs) within identified EFHs. The HAPCs provide important habitat for federally managed fish species and are areas for conservation priorities. Designation is based on habitat ecological importance, sensitivity to fishing, sensitivity to nonfishing, developmental stress, and rarity (GMFMC, 2005 and 2010). The only bank designated as coral HAPC is McGrail Bank (GMFMC, 2005 and 2010; Simmons et al., 2014). Hard-bottom HAPCs include Sonnier Bank, Geyer Bank, Bouma Bank, Rezak Bank, Sidner Bank, Alderice Bank, Jakkula Bank, and parts of McGrail Bank (GMFMC, 2005 and 2010; Simmons et al., 2014). The HAPC designation has no regulatory consequences for BOEM-permitted activities; however, BOEM does consult with the NMFS on issues related to HAPCs when appropriate. Finally, in 2014, 20 additional corals were listed as threatened under the ESA, and several of these species are found in the northern GOM (*Federal Register,* 2014b). For more information on these corals, refer to **Chapter 4.9.6**.

4.6.1.2 Environmental Consequences

Routine Events

The only potential routine impact-producing factors that could affect topographic features in the GOM are caused by bottom-disturbing activities that may occur during drilling and exploration operations and vessel operations.

Drilling, Exploration, and Decommissioning Operations

Bottom-disturbing activities can be described as any activity that results in the disturbance of the seabed during the exploration, production, or decommissioning phase of OCS operations. This includes (but is not limited to) drilling activities (**Chapters 3.1.2 and 3.1.3.1**), structure installation and removal (**Chapters 3.1.3.3 and 3.1.6**), and pipelaying activities. Regardless of the activity, the severity of the impact to topographic features is the same, although the extent of the impact may vary. For example, the placement of a bottom-founded platform would result in a larger impact area compared with a pipeline passing across a feature; however, both would result in the loss of organisms.

The bottom-disturbing activity with the largest areal impact would be the discharge of cuttings into the water column. Operations in close vicinity to topographic features could deposit large amounts of sediment onto the features (maximum amounts estimated to be approximately 2,000 metric tons) (Neff, 2005). This could have severe impacts, including increased stress as the organisms cope with the increased sediment load, a decline in production due to decreased light, or mortality caused by smothering (Wilber et al., 2005). Sedimentation of uncolonized substrates could also render these areas uninhabitable for future recruits settling on the topographic feature; however, with the proposed mitigation defining the No Activity Zones, potential impacts are reduced to negligible. Additionally, once the casings are emplaced and cuttings are no longer being discharged, the impact of routine bottom-disturbing activities becomes **negligible**.

The placement of any structures or equipment on the seafloor would also result in substantial impacts to the benthic communities on the topographic features. Any object placed on the seafloor could result in the crushing deaths of any organisms contacted during emplacement activities. Mortality due to smothering could also occur if sediments are moved from the seafloor to a new location (e.g., trenching a pipeline or emplacement of initial casings). Sedimentation of uncolonized substrates could also render these areas uninhabitable for future recruits to settle on the topographic feature.

Explosive severance for the removal of structures is another bottom-disturbing activity associated with OCS oil- and gas-related operations that can impact the community of the topographic features. This would result in damage or death to any organisms within the vicinity of the blast or associated sediment plume, although long-term turbidity is not expected from platform removal operations. The shockwave from the blast could also damage or destroy the underlying hard substrates required by many benthic organisms.

Without adherence to the distancing and shunting requirements of the Topographic Features Stipulation, impacts to topographic features would be severe and long lasting. However, if the requirements of the Topographic Features Stipulation are applied, operations would remain a safe distance away from critical areas of topographic features and no impacts would be expected. Additionally, restrictions on discharges would be in place and few organisms would experience substantial levels of sedimentation. It is expected that this stipulation would continue to be a requirement for OCS operators throughout the entire time period covered by this analysis (2017-2022). With adherence to the requirements of the Topographic Features Stipulation, impacts would be **negligible**.

Vessel Operations

The only aspect of routine vessel operations that would result in bottom-disturbing activities that could impact topographic features would be the use of anchors by vessels. Anchor damage is one of the greatest threats to the biota of the offshore banks in the GOM (Rezak and Bright, 1979; Rezak et al., 1985; Gittings et al., 1992a; Hudson et al., 1982). Anchors may break, fragment, or overturn corals, sponges, and other benthic organisms, and the anchor chain or cable may drag across and shear organisms off the substrate (Dinsdale and Harriott, 2004). This would result in consequences ranging from increased stress to mortality (Dinsdale and Harriott, 2004). Damage to a coral community may take 10 or more years to recover (Fucik et al., 1984; Rogers and Garrison, 2001).

Without adherence to the distancing requirements of the Topographic Features Stipulation, any impacts to topographic features would be severe and long lasting. However, if the requirements of the Topographic Features Stipulation are applied, anchor placement from OCS oil- and gas-related vessels would not be allowed on or near the most sensitive areas of the features and impacts would be **negligible**.

Accidental Events

The potential impact-producing factors resulting from accidental events on topographic features in the GOM include bottom-disturbing activities, release of toxins and sediment into the water column, and an oil spill and associated cleanup activities. Each of these impact-producing factors can occur during hydrocarbon extraction activities or during vessel operations.

Drilling, Exploration, and Decommissioning Operations

Bottom-Disturbing Activities

The only reasonably foreseeable accidental bottom-disturbing activity is the deposition or placement of equipment on a topographic feature. Accidental loss of equipment could occur during transfer operations between vessels and platforms, while in transit on vessels, from "on deck" accidents on platforms, or as a consequence of a storm event. They could also occur if a platform (or other structure) is placed in the wrong location during installation. Regardless of the cause, the consequence would be the same. Any organisms that are underneath the equipment would suffer a mortality event. The degree of impact would be directly related to the size of the equipment. Large pieces of equipment could also influence water-flow patterns on or around topographic features, potentially influencing the movement of larvae and food. However, any equipment that is deposited on the seafloor would become a new substrate that could be colonized by benthic organisms, potentially providing larvae to new areas and enhancing the biodiversity of an area while the structure remains in place. Any recovery operations would have to abide by the stipulation's restrictions, and bottom-disturbing activities would be prohibited.

Without adherence to the distancing requirements of the Topographic Features Stipulation, impacts to topographic features would be severe and long lasting. However, if the requirements of the Topographic Features Stipulation are applied, impacts would be restricted to losses of equipment from vessels that happen to be over a topographic feature when the loss occurs, from equipment that drifts before sinking, or from storm-related movement. Most equipment would be expected to be in use outside of the No Activity Zone, except for transit. Although damage from equipment hitting a topographic feature would have a deleterious effect at the impact site, the low probability of an accidental event, combined with the reduced probability of equipment falling from a vessel with the correct trajectory to contact a topographic feature, and the relatively small area that these features occupy, the possibility of this type of impact occurring is minuscule. Because of the unlikelihood of such events, the understanding that impacts would be limited in size and scope, and assumed in compliance with the stipulation, the overall impact of accidental bottom-disturbing activities is expected to be **negligible**.

Chemical and Drilling-Fluid Spills

Any release of toxins into the water column would result from a spill from a platform or vessel. Spills could include releases of substances such as diesel fuel, marine paint, drilling fluids, and untreated sewage, or could occur through the incorrect separation of cuttings and drilling muds (**Chapter 3.2.6**). Most spills on the OCS would have little impact on the organisms of a topographic feature because spills of this type are expected to be relatively small, and the substance would either remain in the surface waters or would be rapidly diluted and dispersed. For substances like drilling muds, an accidental release could have substantial impacts to a topographic feature as those materials rapidly settle to the seafloor, smothering any organisms that cannot cope with large quantities of sediments. However, the impact would be proportional to the size of the spill. The composition of muds is strictly regulated, and discharges of cuttings/muds are tested to ensure that toxicity levels are below the limits allowed by NPDES permits (USEPA, 2004, 2007, and 2009b). It is expected that any spill would be stopped quickly or would be relatively small given the limitations on how transfer occurs between vessels and platforms. Quantities are limited by the lifting ability of the cranes or reliance on hoses to transfer fluids from vessels to platforms. Exposures to drilling mud concentrations can result in a wide range of impacts to corals, ranging from mortality to multiple sublethal responses to no response at all (Thompson, 1979).

Without adherence to the distancing requirements of the Topographic Features Stipulation, any impacts to topographic features would be **moderate** and long lasting. However, if the requirements of the Topographic Features Stipulation are applied, any impacts would be restricted because of the increased distance the feature would be from an OCS oil- and gas-related operation. This would allow more time and distance for dilution and dispersion of substances or allow more distance for substances to settle on the seafloor. Given that the probability of an accident is inherently low and adherence to the Topographic Features Stipulation, combined with the reduced probability of this type of spill occurring at a structure near a topographic feature, the impact of accidental releases of toxins into the water column is **negligible**.

Vessel Operations

The aspect of vessel operations that would result in bottom-disturbing activities that could impact topographic features would be the use of anchors during an accident or an emergency (e.g., loss of propulsions). Anchoring impacts during an accidental event would be similar to those outlined above in the “Routine Activities” section for vessel operations.

Regardless of the Topographic Features Stipulation, anchor placement during an emergency would occur to preserve the safety of the vessel and crew. Impacts to benthic organisms on topographic features would be severe at the location where the anchor lands; however, they would be limited to that location and not likely to threaten communities across the entire topographic feature. In addition, an accident requiring anchoring would be an isolated event, and responding vessels would not be expected to anchor. Overall, the impacts of an anchoring event that occurs during an emergency would have a **negligible** impact on an entire topographic feature, even if it did have severe impacts at the anchoring location.

Oil Spill and Cleanup Activities

Impacts that may occur to benthic communities on topographic features as a result of a spill would depend on the type of spill, distance from the spill, relief of the biological feature, and surrounding physical characteristics of the environment (e.g., turbidity). Oil transport and fate is discussed in **Chapter 3.2.1.3**, and oil spills <1,000 bbl and oil spills ≥1,000 bbl are discussed in **Chapters 3.2.1.4 and 3.2.1.5**, respectively. In large enough quantities, this could result in lethal or sublethal impacts to organisms, reducing fitness, growth, or reproduction. Therefore, the depth of topographic features below the sea surface should minimize contact with surface oil where it is advected away or cleaned up by response crews.

If an oil spill occurs at depth in deep water and the oil is ejected under pressure, some oil would rise to the surface, but some oil droplets may become entrained deep in the water column (Boehm and Fiest, 1982), creating a subsurface plume (Adcroft et al., 2010). If this plume was to come in contact with the benthic organisms on a topographic feature, the impacts could range from **negligible** to **severe**, including mortality; loss of habitat, biodiversity, and live coverage; change in community structure; and failed reproductive success (Reimer, 1975; Guzmán and Holst, 1993; Negri and Heyward, 2000; Silva et al., 2015). Impacts would depend on the location and weathering of the oil and the hydrographic characteristics of the area (Bright and Rezak, 1978; Rezak et al., 1983; McGrail, 1982; Le Henáff et al., 2012). Because all of the topographic features are located on the shelf and because upwelling events are limited to hurricanes, eddy formations, or when certain meteorological conditions exist (Walker, 2001; Collard and Lugo-Fernandez, 1999; Zavala-Hidalgo et al., 2006), contact of a small subsurface plume with a topographic feature would only occur under the most ideal and unlikely conditions (Silva et al., 2015). There is a possibility that, if a subsurface plume becomes entrained into the nepheloid layer, organisms in this layer could be greatly impacted. In shallow waters, this layer is typically restricted to the bottom 66 ft (20 m) of the water column (Bright et al., 1976; Bright and Rezak, 1978).

If dispersants are used on a larger spill (refer to **Chapter 3.2.7.2.3**), they would enable oil to mix into the water column and possibly impact organisms on the topographic features. However, dispersant use is not anticipated except on the largest spills. For a surface spill, dispersed oil is not expected to reach the topographic feature (Guo et al., 2014; Lange, 1985; Tkalich and Chan, 2002); however, for a subsurface plume where dispersants were applied, any dispersed oil in the water column that comes in contact with corals may evoke short-term negative responses by the organisms, such as reduced feeding and photosynthesis or altered behavior (Wyers et al., 1986; Cook and Knap, 1983; Dodge et al., 1984; Ross and Hallock, 2014). For larvae, the response may be more profound (Goodbody-Gringley et al., 2013). As such, the use of dispersants during coral spawning season should only be used under the most dire circumstances (Negri and Heyward, 2000; Goodbody-Gringley et al., 2013). However, outside of the spawning season, dispersant-treated areas may recover more rapidly than areas where oil is allowed to decay naturally (Lessard and Demarco, 2000).

For any accident, it is also expected that a certain quantity of oil may settle on the seafloor due to a binding process with suspended sediment particles or after being consumed and excreted by phytoplankton (International Tanker Owners Pollution Federation Limited, 2002; Passow et al., 2012). It is anticipated that the greatest amount of oil adsorbed to sediment particles would occur close to the spill, with reduced concentrations farther from the source. If the spill occurs close to a topographic feature, the underlying benthic communities may become smothered by the particles and exposed to hydrocarbons. Beyond that area, impacts are expected to be **negligible** to **minor** as particles are biodegraded and become more widely dispersed. Sublethal impacts to benthic organisms from such exposure may include reduced recruitment success, reduced growth, and reduced coral cover as a result of impaired recruitment (Rogers, 1990; Kushmaro et al., 1997).

During a response operation, drilling muds may be pumped into a well to stop a loss of well control. It is possible that during this process this mud may be forced out of the well and deposited on the seafloor near the well site. If this occurs, the impacts would be severe for the organisms buried; however, the impact beyond the immediate area would be limited.

Without adherence to the distancing requirements of the Topographic Features Stipulation, impacts to topographic features could be severe and long lasting due to oiling, cleanup activities, toxins from dispersants, or bottom-disturbing activities. However, if the requirements of the Topographic Features Stipulation are applied, impacts would be **negligible** to **minor**, short in duration, and limited to the topographic feature where the accident occurs.

Cumulative Impacts

The cumulative impact of OCS oil- and gas-related routine activities and accidental events considered include bottom-disturbing activities (e.g., anchoring, structure emplacement and removal, muds and cuttings discharges) and accidental events (e.g., bottom disturbance, the discharge of oil, or spill cleanup). Any bottom-disturbing activities would be considered to be a catastrophic threat to the biota of topographic features. However the proposed Topographic Features Stipulation has been in effect for decades and is expected to remain in effect; it is therefore assumed to be in effect for this analysis. Adherence to these restrictions would prevent adverse impacts on benthic communities of topographic features (refer to **Chapter 2.2.4.1**).

Potential non-OCS oil- and gas-related cumulative impact factors include anchoring, fishing, recreational diving, the presence of invasive species, and natural events (e.g., hurricanes). However, because of the spatial extent of the topographic features and the management activities of other agencies, the only reasonably foreseeable effect on topographic features could be the effect of anchoring on the features.

OCS Oil- and Gas-Related Impacts

Bottom-disturbing activities could result in the physical destruction of benthic habitat and organisms or the disturbance of the sediments within the environment, resulting in burial or increased stress. Given adherence to the siting restrictions of the Topographic Features Stipulation, the cumulative impacts of OCS Oil and Gas Program operations have been **negligible** to date. An example of this is the continued high degree of coral coverage and biodiversity documented by the long-term monitoring program at the Flower Garden Banks National Marine Sanctuary (Johnston et al., 2015). The area in the vicinity of the Sanctuary has seen a substantial amount of oil and gas production for decades, and coverage by benthic organisms has remained stable.

Impacts on the topographic features could occur as a result of OCS oil spills. To date, previous noncatastrophic spills have not had any identifiable impact (cumulative or otherwise) on any topographic features. Because of the Topographic Features Stipulation, siting restrictions facilitate spills reaching the surface before contacting the features. For oil on the surface, the depths of the crests of the topographic features are deep enough (>49 ft; >15 m) that surface oil should not reach topographic features in sufficient concentrations to cause impacts. Deep mixing of oil is possible during extreme weather events and could result in negative impacts on deep habitats (Silva et al., 2015). Excluding these events, dispersed surface oil that may reach the benthic communities of topographic features in the GOM would be expected to be at a low enough concentration to not have any discernable long-term impacts (Lewis, 1971; Elgershuizen and De Kruijf, 1976; Dodge et al., 1984; Wyers et al., 1986). In total, it is expected that, given adherence to the proposed stipulations, the cumulative impact would remain **negligible**.

Non-OCS Oil- and Gas-Related Impacts

The potential impacts to topographic features from non-OCS oil- and gas-related sources include anchoring, fishing, hurricanes, damage by recreational scuba diving, and the presence of invasive species. Most of these features are deep enough that scuba diving activities are limited. In most areas where diving is possible, that activity is managed by other Federal agencies that protect habitats from modification or destruction.

Hurricanes are considered a rare event at any given location (refer to **Chapter 3.3.2.9.3**); however, they are a natural event within the environment, and these habitats have adapted to deal with these storms over millennia. As such, hurricanes may alter the environment and kill organisms; however, they are not considered “impacts” because they remain a normal part of the life cycle of a topographic feature.

Because many of the topographic features are found near established shipping fairways and are well-known fishing areas, vessel anchoring at a topographic feature could and has damaged the biota (refer to **Chapter 3.1.3.3.1**). The degree of damage is dependent on the size of the anchor and chain (Lissner et al., 1991). Anchor damages incurred by benthic organisms may take more than 10 years to recover, depending on the extent of the damage (Fucik et al., 1984; Rogers and Garrison, 2001). The combined impact of anchoring activities on topographic features is unknown, but anchoring is only prohibited at four of the recognized topographic features. Three of these features are included in the Flower Garden Banks National Marine Sanctuary and the other (McGrail Bank) is designated a coral HAPC. Within the Flower Garden Banks National Marine Sanctuary, all anchoring is prohibited; in the coral HAPC, anchoring is only restricted to fishing vessels.

Fishing pressure could alter fish community structure and potentially have a top-down trophic impact on fish populations, ultimately impacting the benthic community. This could occur though unsustainable harvest practices; however, most managed fish populations in the GOM are stable or recovering. Harvest activities are managed and monitored by other government agencies, and populations are not expected to be depleted to a point where benthic populations are impacted. The recent invasion by lionfish may alter fish and invertebrate populations on topographic features (Johnston et al., 2015). The predatory nature of this fish, combined with the lack of natural predators, suggests that a population explosion of lionfish could result in a top-down impact of benthic organisms. The result would be a decrease in biodiversity and abundance of many of the smaller organisms that use the benthic habitats found on topographic features. Given the spread of reported lionfish sightings across the GOM, it is possible that they are present on all of the topographic features. The impacts are still unknown as populations are still increasing exponentially (Switzer et al., 2015).

Given that all OCS oil- and gas-related anchoring activities have been and remain prohibited or regulated on and around topographic features, and that citing restrictions minimize the potential for an accidental oil spill to contact topographic features, the probability of an OCS oil- and gas-related activity increasing the impact of any non-OCS oil- and gas-related activities is low. In addition, the same restrictions on proposed activities reduce the probability of any OCS oil- and gas-related activity associated with a proposed action, increasing the effects of previous OCS oil- and gas-related activities. In contrast, non-OCS oil- and gas-related impacts could potentially damage and disrupt topographic features because many of the effects are highly variable and unpredictable. Overall, impacts of non-OCS oil- and gas-related activities are expected to range between **negligible** to **moderate** depending on the amount of activity in the vicinity of the features, impacts of fishing regulations, and the continued presence of pollution in the GOM. As such, the incremental contribution of a proposed lease sale is negligible, as the overall cumulative impacts of a proposed lease sale, combined with non-OCS oil- and gas-related activities, is expected to be **negligible**.

Incomplete or Unavailable Information

After evaluating the information above, BOEM has determined that a substantial amount of information remains unknown about these features; however, the information that is known is adequate to come to a reasonable determination with respect to the impact-producing factors associated with a proposed action. Research in deep marine systems is complex and requires substantial resources; as such, research on these features has been limited. For example, our understanding of the possible impacts of surface oil spills to topographic features in the GOM was determined by combining research on the depth and concentration of the physical mixing of surface oil with the known depths of topographic features. These results suggest that, although oil measurements were not collected at every feature under every condition, topographic features exist at depths deeper than lethal concentrations of oil would be expected (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Rezak et al., 1983; Wyers et al., 1986). Mixing to depth might occur, but it would be limited to when tropical storms pass in close proximity to the spill (Silva et al., 2015). Additionally, continuous monitoring of the Flower Garden Banks since the 1970's for impacts related to OCS oil- and gas-related development suggests that BOEM's Topographic Features Stipulation may achieve the stated objective of minimizing damage to topographic features from OCS oil- and gas-related activities (refer to Johnston et al., 2015, and references therein). At the Flower Garden Banks, corals have flourished while OCS oil- and gas-related development has occurred and, in some cases, activities have taken place just outside the No Activity Zone. Since corals are generally considered to be more fragile than most other organisms found on topographic features, it is reasonable to conclude that topographic features with more resilient organisms than the Flower Garden Banks have not been negatively affected by OCS oil- and gas-related development in the GOM.

With respect to unavailable information in relation to the *Deepwater Horizon* explosion, oil spill, and response, much of this information cannot be obtained because it has not been released. Relevant data on the status of topographic features may take years to acquire and analyze. This unavailable information may be relevant to adverse effects because the *Deepwater Horizon* explosion, oil spill, and response may have caused changes to baseline conditions for topographic features in the GOM. While outstanding reports are not expected to reveal reasonably foreseeable significant effects, BOEM nonetheless determined that additional information could not be timely acquired and incorporated into the current analysis. BOEM has used existing information and reasonably accepted scientific methodologies to extrapolate from available information in completing this analysis and formulating the conclusions presented here. However, until this information is made available, it is impossible to make this determination. Although the body of available information is incomplete, the currently available evidence supports past analyses and does not indicate severe adverse impacts directly linked to the *Deepwater Horizon* explosion, oil, spill, and response for topographic features. Therefore, BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among alternatives.

4.6.1.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Adherence to the proposed Topographic Features Stipulation would prevent most of the potential impacts on topographic feature communities from loss of well control, surface and subsurface oil spills, and routine activities by increasing the distance of such events from the topographic features. During an accidental event, it would be expected that the majority of oil would rise to the surface and that the most heavily oiled sediments would likely be deposited before reaching the topographic features. Any contact with spilled oil would likely cause sublethal effects to benthic organisms because the distance of activity would prevent contact with concentrated oil. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal and impacts would be at the community level. Most turbidity, sedimentation, and oil adsorbed to sediment particles would also be at low concentrations by the time the topographic features were reached, also likely resulting in primarily sublethal impacts. Impacts from an oil spill on topographic features are also lessened by the depth of the features and the currents that surround the features. This alternative would also do little to reduce the cumulative impacts to topographic features as many blocks near the features are already leased and non-OCS oil- and gas-related activities are not expected to decrease. Overall, any impacts to topographic features from routine activities and accidental events or the cumulative impact of a proposed action in the GOM is expected to be **negligible** or **moderate** and isolated. The size and scope of the impacts would be directly proportional to the size of an accident and the efforts to remedy the effects. However, because topographic features are spread across the GOM, localized impacts at one topographic feature does not preclude that impacts would occur at other topographic features.

4.6.1.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Under Alternative B, the impacts of routine activities to topographic features would remain the same in the CPA as under the Alternative A, while most features in the WPA would not be directly impacted. Overall, there are 16 topographic features in the CPA and 0 in the EPA. Any impacts resulting from accidental events in the CPA and/or EPA would remain localized, and the number of features affected would be directly proportional to the size of the accident. An accident along the CPA/WPA border has the possibility to impact features in either planning area. This alternative would do little to reduce the cumulative impacts to topographic features as many blocks near the features are already leased and non-OCS oil- and gas-related activities are not expected to decrease. Overall, any impacts to topographic features from routine activities and accidental events or the cumulative impact of a proposed lease sale in the GOM is dependent on the extent of the activity but is expected to be **negligible** or **moderate** without adherence to the Topographic Features Stipulation, but the impacts should remain **negligible** with adherence to the stipulation. While the CPA/EPA has the greatest potential for OCS oil- and gas-related activity, topographic features are dispersed across the shelf area. As such, any localized impacts would not result in impacts across the entire shelf area, resulting in no population-level impacts.

4.6.1.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Under Alternative C, the impacts of routine activities to topographic features would remain the same in the WPA while features in the CPA would not be directly impacted. Any impacts resulting from accidental events in the WPA would remain localized, and the number of features affected would be directly proportional to the size of the accident. An accident along the CPA/WPA border has the possibility to impact features in either planning area. This alternative would do little to reduce the cumulative impacts to topographic features as many blocks near the features are already leased and non-OCS oil- and gas-related activities are not expected to decrease. Overall, any impacts to topographic features from routine activities and accidental events or the cumulative impact of a proposed action in the GOM would be directly related to the extent of the activity, but is expected to be **negligible** or **moderate** without adherence to the Topographic Features Stipulation, but the impacts should remain **negligible** with adherence to the stipulation. While the WPA has less potential for OCS oil- and gas-related activity than the CPA, topographic features are dispersed across the shelf area. As such, any localized impacts would not result in impacts across the entire shelf area, resulting in no population-level impacts.

4.6.1.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Under Alternative D, topographic features could be further protected by distancing OCS oil- and gas-related activities farther from these habitats, reducing the probability of impacts. An accidental spill may still reach a feature, but it is expected that the increased distance would provide more dispersal time as the spill travels the additional distance across unleased blocks. This alternative would do little to reduce the cumulative impacts to topographic features as many blocks near the features are already leased and non-OCS oil- and gas-related activities are not expected to decrease. Overall, any impacts to topographic features from routine activities and accidental events or the cumulative impact of a proposed action in the GOM is expected to be **negligible**. Blocks subject to the Topographic Features Stipulation include any available unleased block in which a No Activity Zone or Shunting Zone may be applied. A total of 207 blocks within the CPA and 160 blocks in the WPA are affected by the Topographic Features Stipulation. For additional information related to the specific blocks that would be excluded, refer to **Chapter 2**. The exclusion of any of the other blocks subject to either the Live Bottom (Pinnacle Trend) and/or Blocks South of Baldwin County, Alabama, Stipulations is not expected to change the impacts to topographic features because of the small number of blocks and their distance from identified topographic features.

4.6.1.2.5 Alternative E—No Action

Under Alternative E, there would be no impacts to topographic features; however, the impacts would be limited to cumulative impacts associated with previous OCS oil- and gas-related development and non-OCS oil- and gas-related activities.

4.6.2 Pinnacles and Low-Relief Features

Impact Analysis Process and Scope

This analysis considers the impacts of routine activities, accidental events, and a proposed action's incremental contribution to cumulative impacts on GOM live bottom habitats a 50-year period. This analysis is not exhaustive of all possible impacts of routine activities and accidental events; rather, it focuses on those related to a proposed action. Because a catastrophic oil spill is not reasonably foreseeable, those potential impacts (including long-term recovery) are addressed in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c). The impact significance criteria and resulting conclusions presented here (**Table 4-9**) focus on the overall functioning, resilience, and ecosystem level importance of live bottom pinnacles and other live bottom low-relief features throughout U.S. waters of the GOM. Postlease, site-specific analyses would focus more on the potential localized impacts of individual development activities (e.g., proposed drilling of a specific well) to individuals, discrete communities, and small patches of live bottom habitat. Those analyses would also detail site-specific protective mitigations required prior to approval of such activities.

Table 4-9. Pinnacles and Low-Relief Features Impact-Producing Factors.

Pinnacles and Low-Relief Features	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Bottom-Disturbing Activities and Drilling-related Sediment and Waste Discharges					
Without Mitigation	Minor to Major	Minor to Moderate	Negligible to Minor	Negligible to Minor	None
With Mitigation	Negligible	Negligible	Negligible	Negligible	None
Accidental Impacts					
Bottom-Disturbing Activities and Drilling-Related Sediment and Operational Waste Discharges					
Without Mitigation	Minor to Major	Minor to Moderate	Negligible to Moderate	Negligible to Moderate	None
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Oil Spills					
Without Mitigation	Minor to Major	Minor to Moderate	Negligible to Moderate	Negligible to Moderate	None
With Mitigation	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Cumulative Impacts					
OCS Oil and Gas					
With Mitigation	Negligible	Negligible	Negligible	Negligible	Negligible
Non-OCS Oil and Gas					
All Combined Non-OCS Impact-Producing Factors	Minor to Major	Minor to Major	Minor to Major	Minor to Major	Minor to Major

Impact-Level Definitions

For this analysis, the definitions below were used to categorize impacts to pinnacles and low-relief features.

- **Negligible** – Impacts to live bottom communities are largely undetectable. There is some potential for even undetectable impacts to cause slight changes to a local community's species abundance and composition, community structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not alter the overall status of GOM live bottom communities.
- **Minor** – Impacts to live bottom communities are detectable but cannot be clearly distinguished from natural variation. Such impacts could result in noticeable changes to a local community's species abundance and composition, community

structure, and/or ecological functioning, but any such changes would be spatially localized, short term in duration, and would not alter the overall status of GOM live bottom communities.

- **Moderate** – Impacts to live bottom communities detectably cause substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive, but they are expected to only temporarily alter the overall status of GOM live bottom communities such that long-term recovery to pre-impact levels is likely.
- **Major** – Impacts to live bottom communities detectably cause substantial, population-level changes in species composition, community structure, and/or ecological functioning. These impacts would be expected to be spatially extensive and to noticeably alter the overall status of GOM live bottom communities such that long-term recovery to pre-impact levels is unlikely.

The primary relevant, reasonably foreseeable impacts of routine activities and accidental events to live bottom habitats described in this chapter can be grouped into the following three general categories:

(1) bottom-disturbing activities (routine and accidental);

(2) drilling-related sediment and waste discharges (routine and accidental); and

(3) oil spills (accidental).

These impacts are analyzed in detail under the "Routine Activities" and "Accidental Events" sections below. Cumulative Impacts were also considered in two steps: cumulative impacts resulting from OCS oil- and gas-related activities and impacts resulting from non-OCS oil- and gas-related activities.

Some impact-producing factors relevant to live bottom communities are analyzed in detail in other chapters and need only be briefly summarized here. **Chapter 4.7** (Fishes and Invertebrate Resources) details impacts from anthropogenic noise. Note that despite the growing body of information available for fishes, there is comparatively little information available on sound detection and sound-mediated behaviors for marine invertebrates. That said, the overall impacts on live bottom communities from anthropogenic noise are expected to be **negligible**. **Chapter 4.7** also details the impacts of routine activities and the cumulative impacts from OCS oil- and gas-related infrastructure presence, subsequent removal, and/or conversion to artificial reefs. While the total contribution of OCS infrastructure is still only a small percentage of natural hard bottoms (Gallaway et al., 2009) and is projected to further decrease throughout the period covered by this analysis (**Chapter 3.3.1.5**), the presence, removal, and/or conversion of artificial hard substrates colonized by sessile invertebrates are likely to result in localized community changes, such as changes in species diversity in an area (Schroeder and Love, 2004). While individual presence, removal, or conversion actions at specific locations do not cause more than negligible impacts when considered against the broader scope of this analysis, when the sum of such actions are considered cumulatively for all planning areas and over 50 years, such impacts could be greater for individual species. This is because select species commonly associated with OCS oil and gas platforms could be noticeably influenced over time by the overall presence (or removal) of OCS infrastructure. For example, a particular hermatypic coral species' Gulfwide spatial distribution may shift over time because of the presence or removal of structures in otherwise soft bottom-dominated areas. Such a change (were it to occur) could be considered a moderate level impact (for that species) if it represented a detectable change in the species' spatial distribution; such a range shift might have potential long-term effects related to dispersal and genetic connectivity to other populations of that species. Such potential impacts are not necessarily either positive or negative; that would be dependent on the species and a number of complex ecological factors. Some evidence of these types of changes (in particular, range expansion) has been documented for some shallow-water hermatypic species (Sammarco et al., 2012). More peer-reviewed literature about this topic is available for fish resources, as detailed in **Chapter 4.7** (Fishes and Invertebrate Resources).

Several additional impact-producing factors described in **Chapters 3.1 and 3.2** were evaluated for potential impacts on live bottom communities. These impact-producing factors were not carried forward for full analysis because any potential effects were judged to be either not reasonably foreseeable or having such a miniscule impact that they would not rise to the level of **negligible** impact. These impact-producing factors include surface oil-spill response efforts (refer to **Chapter 4.6.1**, Topographic Features), impacts from G&G activities other than bottom disturbance (bottom disturbance is covered below), and potential impacts from a sinking vessel. A sinking vessel settling on a live bottom community is not a reasonably foreseeable impact-producing factor. Even if such an incident did occur, it would not have a population-level impact despite likely crushing or smothering live bottom organisms in the area of direct contact.

Some potential impact-producing factors are already regulated by other Federal agencies and/or international treaties. For example, the discharge of marine debris is subject to a number of laws and treaties. These include the Marine Debris Research, Prevention, and Reduction Act; the Marine Plastic Pollution Research and Control Act; and the MARPOL-Annex V Treaty. Regulation and enforcement of these laws is conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. To further reduce potential impacts, the BSEE provides information on marine debris and requires training of all OCS personnel through the "Marine Trash and Debris Awareness and Elimination" NTL (NTL 2015-BSEE-G03). Historically, this NTL has been made a binding part of leases through application of the Protected Species Stipulation. This NTL instructs OCS operators to post informational placards that outline the legal consequences and potential ecological harm of discharging marine debris. This NTL also states that OCS workers should complete annual marine debris prevention training; operators are also instructed to develop a certification process for the completion of this training by their workers. These various laws, regulations, and NTL would likely minimize any potential damage to live bottom resources from the discharge of marine debris related to OCS oil- and gas-related operations. Nonetheless, some accidental release of marine debris is still likely to occur as a result of OCS oil-and gas-related operations and could theoretically have limited effects on live bottom organisms (e.g., physical damage caused by strong currents pushing debris into fragile organisms or ingestion of plastics by invertebrates). However, the amount of debris in question would not suffice to cause even negligible impacts when considered at the scale of the overall population of live bottom communities in the GOM. One possible exception would be frequent accidental losses of very large items such as pipeline segments with the potential to crush or smother live bottoms. That impact-producing factor is briefly discussed under "Bottom-Disturbing Activities" in the "Accidental Events" section below, even though any such losses are expected to be very rare. In all cases, the likelihood of spatial overlap with debris from OCS vessels or infrastructure is inherently small due to the relatively rare and patchy distribution of live bottom communities in the GOM, particularly in areas of the western and northern GOM, which have the greatest amount of OCS oil- and gas-related operations.

Another potential impact-producing factor that is largely governed by (and potential impacts reduced by) external regulations is the potential presence of toxins in drilling muds and cuttings and/or produced waters. Because of the regulations issued by the USEPA and/or international treaties designed to keep toxins below harmful levels, hazardous levels of toxins are generally not expected to reach live bottom communities. Nonetheless, potential impacts from toxins are briefly discussed in the "Routine Activities" section below.

Historical Protections of Live Bottom Features

Protective measures have been developed over time based on the nature and sensitivity of various live bottom habitats and their associated communities, as understood from decades of BOEM-funded and other environmental studies. These protections were developed into stipulations historically applied to OCS leases in areas with known concentrations of live bottom features. The Pinnacle Trend is a specific series of high- and low-relief hard bottom features occurring just east of the Mississippi River. BOEM has consistently applied the Live Bottom Stipulation to 74 OCS lease blocks covering this area. The CPA blocks directly adjacent to low-relief blocks are included in a proposed action and some of the alternatives; therefore, potential impacts of routine activities and accidental events originating in those adjoining blocks are analyzed here. A full list of the proposed stipulation blocks can be found in **Appendix D**.

Live bottom habitats are found outside the blocks where the Topographic Features and Live Bottom Stipulations have been historically applied. Such habitats are not specifically included in those stipulations but are still routinely given protections during NEPA reviews of site-specific development plans, as described in NTL 2009-G39, "Biologically-Sensitive Underwater Features and Areas." That NTL provides information and consolidates guidance to help operators understand BOEM's requirements related to sensitive benthic habitats.

Lessees must provide site-specific seafloor survey data and interpretive information (including about hard bottom features) with each EP, DOCD, and DPP. Site-specific NEPA reviews are conducted on these plans by BOEM's subject-matter experts on a case-by-case basis to determine whether a proposed operation could impact a live bottom feature. If an impact is judged likely based on site-specific information derived from BOEM's studies/databases, other published research, geohazard survey data, or another creditable source, the operator may be required to distance/relocate the proposed operation or undertake other mitigations to prevent an impact. This analysis assumes continuation of the protective measures outlined in NTL 2009-G39, as they are routinely applied (where appropriate) during all site-specific plan reviews. The Live Bottom Stipulation is applied to individual lease sales at the discretion of the Secretary and has been consistently applied to the same lease blocks for decades. The types of potential impacts to live bottom communities described in this chapter would become more likely and more severe without the continued application of these stipulations.

4.6.2.1 Description of the Affected Environment

The terms live bottom and hard bottom are often used interchangeably, but they are actually distinct since it is possible to have hard bottom that is not live bottom. Hard substrates can form crusts, pavements, pinnacles, ledges, outcrops, and other reefal features (Jenkins, 2011). These harder substrates may or may not be covered by a thin veneer of muddy or sandy sediments that can be deposited and removed over time by currents and storms. Hard substrates with the lowest vertical relief are the most likely to be routinely buried and exposed. Encrusting algae and sessile invertebrates regularly attach to and cover exposed hard substrates, creating live bottoms. For the purposes of the Live Bottom Stipulation, "live bottom areas" have been defined as communities or areas that contain biological assemblages consisting of sessile invertebrates such 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 (substrate type) favors the accumulation of turtles, fishes, and other fauna.

Distribution of Hard/Live Bottoms in the Gulf of Mexico

The distribution of hard bottoms in the GOM is not fully known, due in part to the patchy and ephemeral (temporary) nature of hard bottoms that do not have sufficient vertical relief to avoid intermittent sediment burial (Parker et al., 1983; Jenkins, 2011; Simmons et al., 2014; Jaap, 2015). Although accurate quantification is challenging and can quickly become outdated, Parker et al. (1983) illustrates a reasonable overall proportion and distribution of hard bottoms in U.S. portions of the GOM. The study extrapolated from 732 visual sampling stations to roughly approximate the amount of hard bottom habitat in a band of relatively shallow waters (18-91 m; 59-299 ft), estimating that about 94 percent (44,946 km^2; 17,354 mi^2) of the total lies between Key West and Pensacola, Florida, on the broad West Florida Shelf, and only about 6 percent (2,780 km^2; 1,073 mi^2) lies between Pensacola, Florida, and the Rio Grande River, where the continental shelf break is closer to shore. More recently, Jenkins (2011) interpolated a Gulfwide estimate of dominant surficial seafloor sediments.

Beyond direct sampling and visual observations, an evolving variety of geophysical techniques such as sidescan- and multibeam echo sounder-sonar (Hine et al., 2008; Mueller et al., 2014) and 3D seismic (USDOI, BOEM, 2015c; **Chapter 4.4**, Deepwater Benthic Communities) can also be used to estimate and map the distribution of hard bottom habitats. In the eastern GOM, far from the proposed EPA lease sale area and in parts of the EPA currently under a lease moratorium, there are several areas (including the Florida Middle Grounds, Madison-Swanson Marine Reserve, Steamboat Lumps, the Dry Tortugas Ecological Reserves, and Pulley Ridge, as shown in **Figure 4-17**) containing high concentrations of low-relief live bottom habitat. These and other areas have been designated by the NMFS and GMFMC as marine reserves and/or EFH Habitat Areas of Particular Concern in recognition of the high ecological and socioeconomic (i.e., fisheries) value of live bottom habitat (Simmons et al., 2014; **Figure 4-17**). Designation is intended to encourage additional research and (in some but not all cases) implement fisheries management measures such as restrictions on gear types (Simmons et al., 2014). However, HAPC designation does not have direct bearing on nonfishing activities such as those regulated by BOEM. BOEM does consult with the NMFS on EFH and HAPCs, including the above-named areas (*Essential Fish Habitat Assessment* white paper, USDOI, DOEM, 2016d).

Live Bottom Ecology

Live bottom communities are controlled by interconnected abiotic and biotic factors (Brooks, 1991; Weaver et al., 2002; Jaap, 2015). Physical conditions (e.g., light, sedimentation/turbidity, substrate type, temperature, salinity, prevailing currents, and the frequency and intensity of severe weather events) affect biological variables such as larval transport, settlement, and growth. For example, Lugo-Fernández et al. (2001) reported blockage of coral larval dispersal from the Flower Garden Bank area to the eastern GOM by the Mississippi River plume. In addition, biological controls, such as predation and trophic interactions, can affect epibenthic community development and disturbance response. The relative importance of each controlling factor varies for different types of epibenthos (Jaap, 2015).

A persistent nepheloid layer (a layer of sediment-laden water above the seafloor) can be a controlling factor for live bottom species sensitive to turbidity (Rezak et al., 1990) and thus is also relevant to impact-producing factors of some OCS oil- and gas-related activities. This layer reduces the light reaching hard bottoms, resulting in decreased species richness and abundance below 262 ft (80 m) (Dennis and Bright, 1988; Rezak et al., 1990). Some studies suggest that the Mississippi River plume influences the distribution and abundance of sessile invertebrates within 43 mi (70 km) of the river delta and may affect turbidity and sedimentation throughout the Pinnacle Trend (Gittings et al., 1992a; CSA and GERG, 2001). Nepheloid layers are less frequent in the eastern GOM, but they can occur when the Mississippi River plume and upwelling affect the area (CSA and GERG, 2001).

Large, shallow-water coral reefs created via biogenic deposition of calcium carbonate over time by hermatypic coral species (refer to Schumacher and Zibrowius [1985] for more information about theoretical and practical definitions of "hermatypic") are present only at the southern end of the EPA and on a few topographic features in the WPA and CPA (refer to **Chapter 4.6.1**, Topographic Features, for the impact analysis). While the general public often thinks of such biogenic coral reefs as the only natural habitat for corals, Jaap (2015) illustrates that, for most of their geological history, corals have existed in less elaborate epibenthic communities that are not built upon large biogenic reefs (Veron, 1995 and 2000). These types of corals and epibenthic communities are the focus of this chapter on pinnacles and low-relief features.

The Pinnacle Trend Area

Physical Characteristics

The Pinnacle Trend is an approximately 64 x 16 mi (103 x 26 km) area in water depths of about 200-650 ft (60-200 m). It is in the northeastern portion of the CPA at the outer edge of the Mississippi-Alabama shelf, between the Mississippi River and De Soto Canyon (**Figures 4-17 and 4-19A**).

Live bottoms within the Pinnacle Trend consist of both high-relief outcroppings at the edge of the Mississippi-Alabama Shelf and low-relief hard bottoms on the inner and middle shelf. BOEM has sponsored numerous studies providing information about these features (Brooks, 1991; CSA, 1992; Thompson et al., 1999; CSA and GERG, 2001). A 2002 bathymetric survey by the USGS (Gardner et al., 2002) provided high-quality seafloor imagery that has become the baseline for this area (**Figure 4-19B**).

The eastern part of the Pinnacle Trend is covered with a thin, well-sorted layer of fine- to medium-grained quartzose sand originating from eastern continental rivers. The western portion is covered with fine silts, sands, and clays deposited by the Mississippi River (CSA, 1992). The linear orientation and distribution of some features correspond with depth contours and may represent historic shorelines and drowned calcareous biogenic reefs that developed prior to the most recent sea-level rise (Ludwick and Walton, 1957; Sager et al., 1992; Thompson et al., 1999).

The high-relief features are complex in shape and structure (e.g., **Figure 4-19C**) and provide varied zones of microhabitat for attached organisms. High-relief features consist of pinnacles, flat-top reefs, reef-like mounds, patch reefs, and ridges and scarps. Tall spire-like mounds are the historical “pinnacles” for which the region is named. The pinnacles rise up to 66 ft (20 m) in height and can be over 1,640 ft (500 m) in diameter (Thompson et al., 1999; Brooks, 1991). Other features in this area are smaller and have less vertical relief, but they are more numerous. Low-relief features include fields of small seafloor mounds that rise only a meter or two above the seafloor but still provide hard surfaces for attached epifauna. Fields of shallow depressions about 3-20 ft (1-6 m) across also add habitat complexity to the overall character of the Pinnacle Trend area.

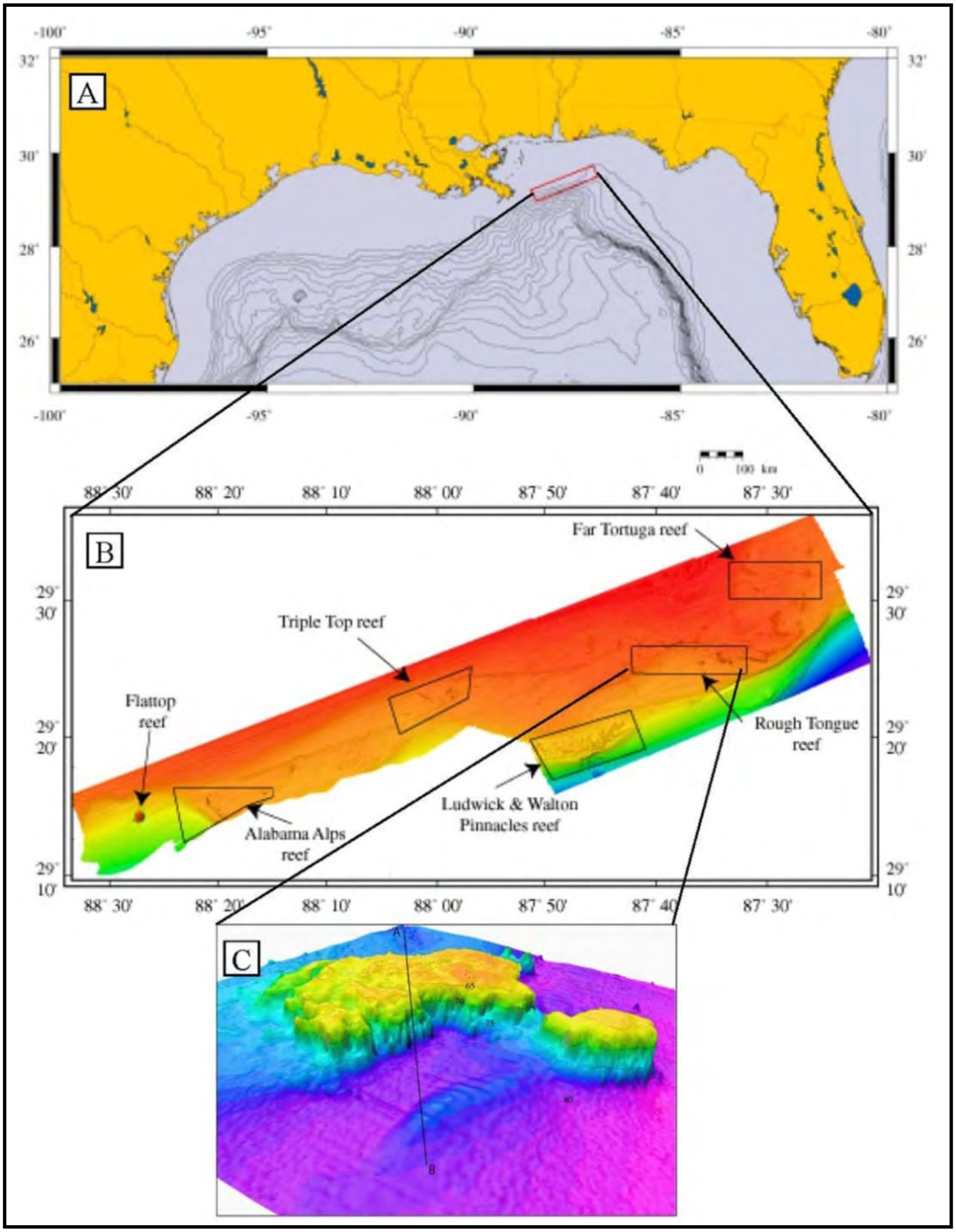

Figure 4-19. General Location of the Pinnacle Trend (A), Multibeam Bathymetry and Named Reef Areas (B), and an Exaggerated Vertical Relief Profile of Rough Tongue Reef (C). (Figure parts were excerpted and rearranged from Gardner et al., 2002.)

Ecology of Live Bottom Communities in the Pinnacle Trend

The substantial amount of hard substrate in the Pinnacle Trend supports colonization by large numbers of suspension-feeding invertebrates, including octocorals, black corals, and sponges, and over 70 species of fish (Weaver et al., 2002). The Pinnacle Trend features are composed of carbonate reef material (Ludwick and Walton, 1957) and vary in shape, size, vertical relief, and overall complexity. These physical characteristics affect the composition (e.g., biodiversity, density, etc.) of the community associated with the substrate. Generally, the more complex the topographic shape of the substrate, the greater the variety of habitats for organisms and thus greater abundance and diversity of organisms.

Assemblages of coralline algae, sponges, octocorals, crinoids, and bryozoans are present at the tops of the shallowest features in water depths of less than 230 ft (70 m) (CSA, 1992). On the deeper features, as well as along the sides of the shallower pinnacles, ahermatypic corals may be locally abundant, along with octocorals, crinoids, and basket stars. The diversity and abundance of the associated species appear to be related to the size and complexity of the features, with the lower-relief outcrops typically having lower faunal densities and higher relief features having more diverse faunal communities (Gittings et al., 1992a; Thompson et al., 1999).

Low-Relief Live Bottoms

Outside of the Pinnacle Trend, low-relief live bottom features can and do occur in isolated locations in shallow waters (<984 ft; 300 m) throughout the GOM, wherever there is suitable hard substrate and other physical conditions (depth, turbidity, etc.) allow for epibenthic community development (Rezak et al., 1990). However, they are primarily known to be present in some locations on the Mississippi-Alabama Shelf and many more locations on the West Florida Shelf (**Figure 4-17**), far east of the proposed EPA lease sale area. None of the blocks with known concentrations of live bottom low-relief habitat are expected to be offered for lease; however, several live bottom low-relief areas are adjacent to blocks that would be offered for lease under a proposed action and could potentially be affected by impacts of routine activities and accidental events. Therefore, an analysis of the potential impacts is included in this Multisale EIS.

Ecology of Inner- and Middle-Shelf Live Bottoms of the Mississippi-Alabama Shelf

These nearshore, hard bottom areas are located in 60-130 ft (18-40 m) of water. A fine-grained quartz sand sheet covers most of the Mississippi-Alabama Shelf; however, numerous hard bottoms that are formed of sedimentary rock occur off the Mississippi River Delta and seaward of the Chandeleur Islands (Schroeder, 2000). These features include isolated low-relief, reef-like structures; rubble fields; low-relief flat rocks; limestone ledges; rocky outcrops off Mobile Bay; and clustered reefs (Schroeder et al., 1988; Schroeder, 2000). Hard bottom features on the Mississippi-Alabama-Florida Shelf typically provide reef habitat for tropical organisms, including sessile epifauna (i.e., soft corals, ahermatypic hard corals, sponges, bryozoans, and crinoids) and fish.

Various live bottom areas of the Mississippi-Alabama Shelf have been described in literature (Shipp and Hopkins, 1978, Schroeder et al., 1988; Schroeder et al., 1989, Brooks, 1991). These areas support a number of foundational species (including hard and soft corals, coralline algaes, and sponges) that are associated with larger, diverse communities of mobile invertebrates and fishes.

Ecology of Inner- and Middle-Shelf Live Bottoms of the West Florida Shelf

The majority of low-relief live bottom habitats in the GOM are found on the West Florida Shelf. The shelf is a relatively flat table of carbonate limestone that is largely covered with carbonate sand sheets. BOEM has designated blocks on the West Florida Shelf out to the 100-m (328-ft) isobath as Live Bottom (Low-Relief) Stipulation blocks (**Figure 4-17**) because live bottom communities are widely scattered across the West Florida Shelf on limestone ledges and outcrops (Jaap, 2015). In many places, the sand frequently shifts due to seasonal storms, occasionally uncovering patches of hard bottom. The nepheloid layer found throughout much of the northern CPA is not present to the same degree on the West Florida Shelf.

In addition to the smaller, widely distributed low-relief hard bottoms, there are also areas with permanently exposed, higher relief hard bottoms. In the southeastern portion of the GOM, shallow-water hermatypic corals are common throughout the Florida Keys reef tract, the Dry Tortugas, and Pulley Ridge (Jaap, 2015). To the north along the West Florida Shelf are several other important areas recognized by the NMFS/GMFMC (Simmons et al., 2014). Some of these areas are thought to be relic reef formations that were "drowned" with historic sea-level rises.

Various sessile fauna and flora develop on exposed surfaces of low-relief hard substrates (Jaap, 2015). Some fauna, such as gorgonian soft corals, are flexible and tall enough to survive partial sediment burial. Many of the formations have deep reef communities with soft corals, black corals, sponges, sea whips/sea fans, anemones, and associated mobile echinoderms and crustaceans. Habitats that are sufficiently close to the water surface can support some hermatypic corals. Scleractinian and milleporian corals are common on rocky outcrops throughout the eastern GOM (Jaap, 2015).

Consultations

In 2014, 20 new coral species were listed as "threatened" under the ESA; all but 7 of these are found only in Indo-Pacific waters (*Federal Register*, 2014b). Three of the new species and two others that were previously listed (elkhorn and staghorn) are found in shallow waters of the GOM. Some are found on a few topographic features in the WPA/CPA and others in the Dry Tortugas and Florida reef tract. These coral species are further described in **Chapter 4.9.5**. The OCS lease blocks in the EPA near these areas are not being offered in a proposed lease sale due to the current leasing moratorium and are therefore too distant to be reasonably affected by routine activities or accidental events occurring in leased areas. Currently, only staghorn and elkhorn coral have had critical habitat areas defined off the Florida Keys and Florida reef tract. For ESA-listed coral found in the WPA and CPA where accidental impacts might be possible, these coral species would be expected to experience the same impacts as other live bottom organisms. However, due to their relatively low population sizes, any impacts from accidental events on ESA-listed corals would have a magnified effect on each of those species. BOEM consults on listed corals as part of the Section 7 consultation with the NMFS. Adherence to recommendations resulting from this consultation and application of the Live Bottom Stipulation should decrease any impacts to these species.

4.6.2.2 Environmental Consequences

Routine Activities

A number of routine OCS oil- and gas-related impact-producing factors may cause adverse impacts on live bottom communities. As noted above, some factors with minimal impacts are presented in greater detail in other chapters and are not repeated here. The potential routine impact-producing factors on live bottom habitats analyzed here are grouped into two main categories having similar impacts: (1) bottom-disturbing activities (e.g., anchoring, infrastructure emplacement and removal, and core sampling); and (2) drilling-related sediment and waste discharges (e.g., drilling muds and cuttings, and produced waters). These impact-producing factors have the potential to damage live bottom habitats and disrupt associated communities if not sufficiently distanced via mitigations.

Bottom-disturbing activities can be described as any activities that result in the physical disturbance of the seafloor during the exploration, production, or decommissioning phase of OCS oil- and gas-related operations. Anchoring, operational wastes produced during drilling, trenching, pipe-laying, and structure emplacement and removal are examples of OCS oil- and gas-related activities that disturb the seafloor (refer to **Chapter 3.1**). The spatial extent of the seafloor disturbance and the magnitude of the effect on benthic organisms would depend on the specific activity, local environmental conditions (e.g., currents, water depth, etc.), and species-specific behaviors and habitat preferences.

Drilling of new wells is one of the activities with the greatest impact potential, due to the associated sedimentation/turbidity caused by the drilling process and from the release of drilling cuttings and discharges. As noted in Chapter 3, drilling an exploratory well produces approximately 2,000 metric tons of combined drilling fluid and cuttings, though the total mass may vary widely for different wells (Neff, 2005). Cuttings discharged at the surface tend to disperse in the water column and are distributed at low concentrations (CSA, 2004). In deep water, the majority of cuttings discharged at the sea surface are likely to be deposited within 820 ft (250 m) of the well (CSA, 2006). Cuttings shunted to the seafloor forms piles concentrated within a smaller area than when sediments are discharged at the sea surface (Neff, 2005).

Turbidity from suspended sediments, along with sediment displacement resulting from routine, bottom-disturbing OCS oil- and gas-related activities generally have localized effects. In general, impacts to live bottoms could include any or all of the following: reduced settlement and growth due to loss of available hard substrate; inhibited feeding leading to reduced reproductive fitness; and mortality of individuals (e.g., coral polyps) and groups (e.g., a coral colony). Reductions in overall biological cover could have secondary ecological effects on organisms that were using the complex structural microhabitats. Some mobile invertebrates (e.g., star fish) are expected to be able to move to avoid the heaviest sedimentation and highest suspended sediment loads within 33 ft (10 m) of a disturbance, while sessile invertebrates (e.g., corals) cannot. Both sessile and mobile invertebrate species adapted to living in turbid environments, such as those commonly found in the persistent nepheloid layer or otherwise adapted to occasional sediment inundation, may be less affected by increased turbidity. Such organisms may be adapted to remove some covering sediment via tentacle motion and mucus secretion (Shinn et al., 1980; Hudson and Robbin, 1980). Other species that typically inhabit less turbid waters would suffer greater impacts (Rogers, 1990; Gittings et al., 1992a). For example, zooxanthellate coral species are dependent on a continuous, unobscured light source to support the symbiotic photosynthetic algae (zooxanthellae) and may suffer coral bleaching if the water column becomes overly turbid. Solitary octocorals and gorgonians are generally more tolerant of sedimentation, partly because they grow tall and are flexible, reducing sediment accumulation and allowing for easier removal (Marszalek, 1981; Torres et al., 2001; Gittings et al., 1992a). Apart from turbidity and sedimentation, the chemical content of drilling muds and cuttings, and to a lesser extent produced waters, is another potential impact-producing factor since these may contain hydrocarbons, trace metals including heavy metals, elemental sulfur, and radionuclides (Kendall and Rainey, 1991; Trefry et al., 1995). Substances containing heavy metals and other potentially toxic compounds would have the potential to be moderately toxic to live bottom organisms, but only if they were to come into contact in undiluted strengths (CSA, 2004). Although the literature has not reported impacts corals as a result of exposure to contaminants in cuttings, infauna have shown effects at distances <330 ft (<100 m) from the discharge. These include reduced reproductive fitness, altered populations, and acute toxicity (Montagna and Harper, 1996; Carr et al., 1996; Kennicutt et al., 1996; Hart et al., 1989; Chapman et al., 1991; CSA, 2004). Because of BOEM's distancing requirements for new wells, contact with concentrated (and potentially harmful) levels of any such toxins is not expected. Produced waters (refer to **Chapter 3.1.5.1.2** for more detail) are rapidly diluted with distance, and impacts are generally only observed within very close proximity of the discharge point (Gittings et al., 1992a; Neff, 2005). In addition to the protection offered by BOEM's distancing requirements, releases of toxic discharges are regulated by the USEPA through the issuance of NPDES permits. Adherence to these regulations would help ensure that water quality is maintained at nontoxic levels.

In addition to drilling activities, the process of installing and removing OCS oil- and gas-related infrastructure (i.e., pipelines, platforms, and subsea systems including cables) also has the potential to displace large volumes of sediment. The resulting localized increases in turbidity and sedimentation would have the same indirect impacts as those caused by drilling-related sediment discharges.

The OCS oil- and gas-related infrastructure/equipment also has the potential to damage or kill benthic organisms should the equipment itself make direct contact. Any object placed on or through a live bottom feature can cause partial or complete breakage, crushing, or smothering. In addition to mortality, there could be any or all of the potential sublethal impacts already described above in relation to sedimentation. The severity of impacts from direct physical contact would vary in direct proportion to the surface area and mass of the specific equipment. For example, the placement of a large bottom-founded platform on a live bottom would have a much greater impact than the placement of a small umbilical cable.

Similarly, anchor damage is one of the greatest threats to the biota of the offshore banks in the GOM (Rezak and Bright, 1979; Rezak et al., 1985; Gittings et al., 1992a; Hudson et al., 1982). Anchors may break, fragment, or overturn corals, sponges, and other benthic organisms, and the anchor chain or cable may drag across and shear organisms off the substrate (Dinsdale and Harriott, 2004). This would result in negative consequences ranging from increased stress to mortality (Dinsdale and Harriott, 2004). The impact of dragging an anchor across a live bottom would depend on the distance and duration of bottom contact, but it could be considerable due to the forces involved. Dragged anchors often leave seafloor scars noticeable on sidescan-sonar imagery years later. Damage to a coral community may take 10 or more years to recover (Fucik et al., 1984; Rogers and Garrison, 2001).

As further detailed in other chapters, explosive severance methods used during decommissioning activities could result in damage or death to any organisms within the vicinity of the blast or associated sediment plume, although long-term turbidity is not expected from platform removal operations. The shockwave from the blast could also damage or destroy the underlying hard substrates required to support live bottoms. The BSEE Interim Policy Document 2013-07, “Rigs-to-Reefs Policy,” specifies that the use of explosive severance methods will not be approved if analysis determines they would cause harm to established artificial reef sites and/or natural live bottoms.

Potential impacts resulting from all of the above routine activities are mitigated through the Live Bottom Stipulation and the protective measures summarized above and detailed in NTL 2009-G39. The site-specific survey information and distancing requirements described in NTL 2009-G39 would allow BOEM to identify and protect live bottom features from harm by proposed OCS oil- and gas-related activities during postlease reviews. If those protective measures are applied to identified live bottom habitats as expected, at the scope of this analysis, impacts of routine activities would be expected to be **negligible**.

Without adherence to the requirements of the stipulation and external regulatory restrictions on discharges, impacts to live bottom communities from the above routine activities could rise to minor, moderate, or even major, depending on the number and locations of specific activities. The highest impact levels are possible in the improbable (but theoretically possible) case that a large number of routine activity disturbances were to physically impact a large number of live bottom habitats. Even without mitigations, the likelihood is very low that a large number of OCS oil- and gas-related activities would occur in close proximity because the hard substrate habitats supporting live bottom communities are patchily distributed throughout the GOM and are relatively rare compared with soft bottom substrates. But this possibility cannot be definitively ruled out without knowing the precise spatial distribution of both future OCS oil- and gas-related activities and live bottom communities.

Accidental Events

The primary accidental impact-producing factors on live bottoms analyzed here are grouped into two categories: (1) bottom-disturbing activities (e.g., anchoring and infrastructure emplacement and removal); and (2) oil spills (surface and subsurface) and associated cleanup responses. These impact-producing factors have the potential to damage live bottom habitats and disrupt associated communities if not sufficiently distanced or otherwise mitigated.

Bottom-Disturbing Activities

Impacts resulting from bottom-disturbing activities were detailed under “Routine Activities” and are largely the same for accidental events. There are only slight differences that need to be considered here; these differences are related to mechanisms and potential severity. The primary, accidental bottom-disturbing activity is the inadvertent deposition or placement of equipment on live bottoms. Accidental loss of equipment could occur during transfer operations between vessels and platforms, during vessel transit, during an “on deck” accident, as a consequence of a severe storm, or if a structure, drill, or anchor is unintentionally placed in the wrong location during operations. During routine operations, distancing mitigations offer some protections against these types of impact, but those protections do not apply to accidents, other than to reduce the likelihood of routine activities occurring in live bottom areas in the first place. Any object placed on or through a live bottom feature can cause partial or complete breakage, crushing, or smothering of both substrate and organisms, and/or could cause increased sedimentation as equipment disturbs the seafloor. In addition to mortality, live bottom communities could experience any or all of the potential sublethal impacts already described in the “Routine Activities” section above. The severity of impacts from direct physical contact would vary in direct proportion to the surface area and mass of the specific equipment. Given the relative rarity of live bottom habitats and communities in the GOM, impacts from accidental bottom-disturbing equipment are expected to be infrequent and highly localized, with the likelihood of accidental contact further reduced by the expected distancing mitigations. However, because of the unplanned and potentially uncontrolled nature of accidental bottom-disturbing events, there exists greater uncertainty about their potential impact severity than exists for planned routine activities. Therefore, at the scale of this analysis, impacts to deepwater benthic communities could range from **negligible** to **minor**, depending on their overall frequency and severity and whether or not community-level impacts as a result of accidental events can be clearly distinguished from natural variation.

Without the protective measures provided by the Live Bottom Stipulation and by postlease reviews and distancing, the potential impacts of accidental bottom disturbances could rise to moderate or even major levels, in the improbable (but theoretically possible) case that a large number of accidental disturbances were to physically impact a large number of deepwater benthic communities. Even without mitigations, the likelihood is very low that a large number of OCS oil- and gas-related activities would occur in close proximity to the relatively rare hard substrate habitats supporting live bottom communities, but this possibility cannot be definitively ruled out without knowing the precise spatial distribution of both future OCS oil- and gas-related activities and live bottom communities.

Oil Spills and Associated Impacts

Oil spills, historic trends, the characteristics of oil, and factors affecting the fate of oil released into the marine environment are discussed in detail in **Chapter 3.2.1**, and the potential effects on water quality are analyzed in **Chapter 4.2** (Water Quality). For information on impacts specifically resulting from a catastrophic oil spill (beyond the scope of this analysis), refer to the *Catastrophic Spill Events Analysis* white paper (USDOI, BOEM, 2016c).

Impacts related to an accidental release of oil or other contaminants could adversely affect live bottom communities. Potential impacts related to an accidental spill would depend on the combination of these various components: surface oil; subsurface oil; chemical dispersants and dispersed oil; sedimented oil (oil adsorbed to sediment particles, also known as “marine snow”); sedimentation caused by a loss of well control; and certain spill-response activities. Adherence to well-distancing requirements should serve to reduce such impacts.

Biological impacts resulting from exposure to accidentally released oil droplets and/or chemical dispersants are anticipated to be mostly sublethal. Sublethal impacts that may occur to exposed corals and similar benthic invertebrates may include reduced feeding, reduced photosynthesis, reduced reproduction and growth, physical tissue damage, and altered behavior. For example, short-term (24 hours) sublethal responses of one coral species included mesenterial filament extrusion, extreme tissue contraction, tentacle retraction, and localized tissue rupture after exposure to dispersed oil at a concentration of 20 ppm (Knap et al., 1983; Wyers et al., 1986). It is important to note that, generally, laboratory experimental concentrations are designed to discover toxicity thresholds (e.g., DeLeo et al., 2015) that exceed probable exposure concentrations in the field.

Oil spills originating at the surface, such as from a vessel or platform, have some potential to impact live bottom features. The depth of OCS live bottom features helps to buffer and protect such features from most surface spills because their crests are generally deeper than the physical mixing ability of surface oil (Lange, 1985; McAuliffe et al., 1975 and 1981a; Tkalich and Chan, 2002; Thompson et al., 1999; Schroeder, 2000). Oil becomes diluted as it physically mixes with the surrounding water column. The shallowest known concentrations of live bottom features occur in the Live Bottom (Low Relief) Stipulation blocks, which are not expected to be offered for lease. In the Pinnacle Trend area, the largest features rise to within 130 ft (40 m) of the sea surface, but other live bottom features (except for named topographic features) have less relief or are found in deeper waters. In very unusual conditions, surface oil could contact Pinnacle Trend features. Silva et al. (2015) documented acute lethal and sublethal impacts to gorgonians on Pinnacle Trend features caused by large amounts of *Deepwater Horizon*-sourced surface oil. A large volume of oil/dispersant mixture was submerged by unusually strong wave action associated with a tropical storm that passed directly over the oil. As a result, sizable amounts of the relatively undiluted oil/dispersant reached live bottom features. This contact, though demonstrably possible, required an unusual combination of atypical conditions, making it generally unlikely outside of a catastrophic spill situation, which is not part of a proposed action and not likely expected to occur.

In a subsurface spill or loss of well control situation, it is expected that the majority of released oil would rise quickly to the surface due the characteristics of northern GOM oil reserves, meaning most impacts would be similar to a surface-originating spill. However, if an oil spill/loss of well control occurs at great depths and released oil is subjected to higher water pressures, some oil droplets may emulsify and become entrained deep in the water column (Boehm and Fiest, 1982), creating a subsurface plume (Adcroft et al., 2010). Such plumes were documented following the *Deepwater Horizon* oil spill. If a concentrated plume came into contact with live bottom organisms, impacts could include mortality, failed reproductive success, reduced biodiversity, reduced coverage of fauna and flora on hard substrates, and changes in community structure (Reimer, 1975; Guzmán and Holst, 1993; Negri and Heyward, 2000; Silva et al., 2015). Exact impacts would depend on the location, age of the spill, and the hydrographic characteristics of the area (Bright and Rezak, 1978; Rezak et al., 1983; McGrail, 1982; Le Henáff et al., 2012). However, because shallow-water live bottom features are located on the shelf and upwelling events are limited to hurricanes, eddy formations, or when certain metrological conditions exist (Walker, 2001; Collard and Lugo-Fernandez, 1999; Zavala-Hidalgo et al., 2006), contact of a subsurface plume with a live bottom feature would only occur under the most ideal conditions (e.g., Silva et al., 2015).

The USCG may allow the use of chemical dispersants in certain spill situations. Chemical dispersion of oil can help to break up concentrations of oil and accelerate natural weathering processes and bacterial biodegradation. Use of dispersants may, however, allow surface oil to penetrate to greater depths than normally expected from typical physical mixing, and dispersed oil might tend to remain further below the water's surface than undispersed oil (McAuliffe et al., 1981b; Lewis and Aurand, 1997). Reports about dispersant usage on surface plumes indicate that a majority of the dispersed oil remains in the top 33 ft (10 m) of the water column, which is generally shallower than the crests of OCS live bottom features; therefore, contact is generally not expected apart from unusually ideal conditions such as those seen in Silva et al. (2015). If contact is made, impacts may differ somewhat between oil, oil/dispersant mixtures, and dispersant alone. DeLeo et al. (2015) demonstrated that concentrated amounts of dispersant and oil/dispersant mixtures caused more severe health declines to live bottom organisms than oil-only mixtures. One field study (Yender and Michel, 2010) indicated less severe impacts, possibly due to that study's (more realistic) application of dispersants in an open field system, although during the *Deepwater Horizon* oil spill, dispersants were applied subsea at the source of the blowout. Stratified density layers of water allowed the oil/dispersant plume to remain at depth instead of dispersing up into the water column (Joint Analysis Group, 2010), and these concentrated plumes are thought to have caused serious but fairly localized damage to deepwater corals on the continental slope (White et al., 2012; Hsing et al., 2013; Fisher et al., 2014a). It is unlikely that concentrated oil/dispersant mixtures would be found near shallow-water live bottom features; therefore, lethal exposures to large numbers of shallow-water live bottom organisms are not anticipated.

For any accidental spill, it is expected that a certain quantity of oil may eventually settle on the seafloor through a binding process with suspended sediment particles (adsorption) or after being consumed and excreted by phytoplankton (Passow et al., 2012). The product of these processes is sometimes referred to as "marine snow." It is expected that the greatest amount of adsorbed oil particles would occur close to the spill, with the concentration reducing over distance. If the spill occurs close to a live bottom feature, some underlying live bottom organisms may become smothered by the particles and experience long-term exposure to hydrocarbons. This was seen for some deepwater corals following the *Deepwater Horizon* oil spill and response (White et al., 2012; Hsing et al., 2013; Fisher et al., 2014a). Beyond the localized area of impact in that case, particles would become increasingly biodegraded and dispersed. Localized impacts to live bottom organisms would be expected to be largely sublethal and could include reduced recruitment success, reduced growth, and reduced biological cover as a result of impaired recruitment (Rogers, 1990; Kushmaro et al., 1997).

Sediments suspended or displaced as a result of a loss of well control could also impact live bottom organisms. These impacts would be largely identical to those caused by sedimentation stirred up by bottom-disturbing equipment, with the possible addition of toxic hydrocarbons or drilling muds in the sediments (refer to “Routine Activities”). Because OCS-permitted wells would have been distanced from live bottom features before installation, it is expected that the heaviest sediment concentrations would fall out of suspension and disperse before reaching sensitive live bottom features, preventing most impacts. Some live bottom organisms, such as flexible sea fans, are naturally adapted to turbid conditions and may not be as negatively affected. Outside of a catastrophic spill situation, a very substantial amount of sediment burial of organisms during an accidental spill event is not reasonably foreseeable (refer to the *Catastrophic Spill Events Analysis* white paper, USDOI, BOEM, 2016c).

Finally, spill cleanup/response activities could themselves have negative. During a response operation, the risk of accidental impacts of bottom-disturbing equipment is increased. There could be unplanned or emergency anchoring on live bottom features or accidental losses of heavy equipment from responding vessels. Response-related equipment such as seafloor-anchored booms may be used and could inadvertently contact live bottom organisms. In addition, drilling muds may be pumped into a well to prevent a loss of well control. It is possible that during this process, some of this mud may be forced out of the well and deposited on the seafloor near the well site. If this occurs, the impacts would be severe for any organisms buried; however, the impact beyond the immediate area would be limited and adherence to the original distancing requirements would prevent or reduce most impacts.

Accidental spills have historically been small and are low-probability events (**Table 3-12**). While the total amount of hard/live bottoms in the GOM is small compared with soft bottoms, the habitats are widely distributed and a localized impact from one noncatastrophic accidental event would only impact a small portion of the overall resource (McEachran, 2009).

All of the above impact-producing factors could lead to lethal or sublethal impacts on individual live bottom communities, with the range of impacts dependent on the quantity of spilled oil and proximity to habitats. While a spill resulting from a catastrophic-level blowout in deep water (such as the *Deepwater Horizon* oil spill) has the potential to seriously impact individual live bottom communities over a long time period, such a spill is not reasonably foreseeable as a result of a proposed action. Impacts from individual routine activities and reasonably foreseeable accidental events are usually temporary, highly localized, and expected to impact only small numbers of organisms and substrates at a time. Some live bottom species possess natural adaptations to high-turbidity environments that could help remove spill-related sediments. Moreover, use of the expected site-specific plan reviews/mitigations would distance activities from identified live bottom communities, greatly diminishing the likelihood and severity of potential effects. Therefore, at the scale of this analysis, and with application of the expected mitigation practices, impacts on live bottom communities from accidental spills and associated impact-producing factors are expected to range from **negligible** to **minor**. This range of potential impact levels reflects the relative uncertainty associated with unplanned and potentially uncontrolled accidental spills. The exact impact would depend on the overall frequency and severity of accidental spills, their proximity to live bottoms, and whether or not community-level impacts as a result of accidental events can be clearly distinguished from natural variation.

Without the protective measures provided by the Live Bottom Stipulation and associated postlease reviews and distancing, the potential impacts of accidental spills could rise to moderate or even major levels, in the improbable (but theoretically possible) case that a large number of accidental spills were to occur at wells in close proximity to a large number of live bottom communities. Even without mitigations, the likelihood is very low that a large number of accidental spills would occur in close proximity to the relatively rare hard substrate habitats supporting live bottom communities, but this possibility cannot be definitively ruled out without knowing both the precise distribution of such spills and live bottom communities.

Cumulative Impacts

The following analysis considers whether the incremental impacts of routine activities and accidental events associated with the proposed OCS Oil and Gas Program-related operations, when added to or acting synergistically with existing non-OCS oil- and gas- related impact sources from the cumulative impacts scenario, may result in a significant collective impact.

OCS Oil- and Gas-Related Impacts

The OCS oil- and gas Program-related impacts include the long-term, incremental contribution of the routine and accidental bottom-disturbing activities outlined above: (1) bottom-disturbing activities (e.g., drilling, anchoring, infrastructure installation/removal, and associated sedimentation); (2) sediment and waste discharges (e.g., drilling muds and cuttings, and produced waters); and (3) oil spills (surface and subsurface and associated cleanup responses). As already detailed, these impact-producing factors have the potential to damage individual live bottom habitats and disrupt associated benthic communities, if insufficiently distanced or otherwise mitigated. Bottom-disturbing activities could result in the physical destruction of benthic habitat and organisms or the disturbance of sediments within the environment, resulting in burial and/or increased turbidity. Routine and accidental waste discharges could be toxic if contacted in undiluted form near the source. Oil spills and dispersants are known to have negative, acute effects on benthic organisms, and the cumulative, long term effects of persistent, low-level exposure to oil are not yet fully understood. All of these activities could lead to lethal or sublethal impacts on individual live bottom communities. However, impacts from individual events are usually temporary, highly localized, and expected to impact only small numbers of organisms and substrates at a time, particularly since live bottom habitats are relatively rare and distributed in only small patches of the OCS areas that are anticipated to be leased. Also, adherence to the expected Live Bottom Stipulation and site-specific plan reviews/mitigations would distance many of these activities, greatly diminishing potential effects. Therefore, the incremental cumulative contribution of these proposed OCS oil- and gas-related activities is expected to have only **negligible** impacts.

Non-OCS Oil- and Gas-Related Impacts

The cumulative, long-term impact of reasonably foreseeable, non-OCS oil- and gas-related anthropogenic activities and influential environmental conditions on live bottoms could be considerable, although they are difficult to precisely quantify when projecting future conditions over the next 50 years. The primary anthropogenic activities with impact producing factors are vessel anchoring and fishing. The primary environmental factors are invasive species, hypoxia, severe weather, and climate change. There is extensive scientific literature available about all of these subjects; only a brief summary analysis is provided here. It should be noted that BOEM's stipulations and site-specific plan reviews/mitigations are designed to protect live bottom resources from OCS oil- and gas-related activities within BOEM's jurisdiction and to mitigate against a proposed action's incremental cumulative impact contribution to the overall OCS and non-OCS cumulative impacts

Certain fishing gear and overfishing can have long-term effects on benthic species and habitats. These effects can be caused both by the gear and through indirect trophic effects. Bottom-tending gear such as bottom trawls and bottom-contacting long lines could destroy or disturb hard/live bottoms such that species diversity and abundance are negatively affected (Wells et al., 2008; NRC, 2014; Pusceddu et al., 2014; Secor et al., 2014). This impact may dislodge, entangle, or otherwise damage organisms inhabiting live bottoms. Large emergent sponges and corals may be particularly vulnerable to trawling activity, as these organisms grow above the substrate and can be caught and removed by trawling activity (Freese et al., 1999, Hourigan 2014). Because many hook-and-line fishermen target live bottom-associated reef fish, they may use bottom-contacting gear that can damage the tissues of benthic organisms, particularly when the line is snagged and abandoned. In addition, fishing pressure could selectively alter fish community structure and, over the long term, have a top-down trophic impact on fish populations that interact with live bottoms.

The impacts of vessel anchoring on live bottoms are similar to the other bottom-disturbing impacts described above. Of note in this section is that smaller vessels such as recreational fishing and diving boats are also included. Such vessels are more numerous than large vessels, though their individual anchors are much smaller and most recreational activities occur close to shore. The degree of potential damage is dependent on the size of the anchor and chain (Lissner et al., 1991). Anchor damages to benthic organisms such as corals may take more than 10 years to recover (Fucik et al., 1984; Rogers and Garrison, 2001).

The lionfish (*Pterois volitans/miles*) is an invasive species of concern that has been reported throughout the GOM (USDOI, GS, 2010 and 2015; Johnston et al., 2013; Aguilar-Perera and Tuz-Sulub, 2010). This fish is thought to drive down diversity and abundance of benthic organisms, especially crabs, demersal fishes, and shrimps (Green et al., 2012). The cumulative impact of invasive species on GOM live bottom features is unknown at this time, but it is projected that negative impacts are likely to worsen over time as lionfish populations are increasing exponentially in both abundance and distribution (Switzer et al., 2015).

Depleted dissolved oxygen occurs seasonally in shelf waters of the northern GOM, including in areas with live bottoms. Dissolved oxygen depletion is caused primarily by the decomposition of algae whose production is stimulated by excess nutrients delivered by the Mississippi River and other coastal rivers, the source of which can be traced back to onshore human activities such as fertilizer use. Hypoxic (dissolved oxygen ≤2.0 mg/L) conditions can have lethal and sublethal effects on aquatic organisms (refer to **Chapter 3.3.2.12** for more information on hypoxia). Although hypoxic conditions are mainly a characteristic of Louisiana-Texas shelf waters, negative effects could reach some live bottom (low-relief) communities in the northeast portion of the CPA. Dramatic changes in natural levels of dissolved oxygen over time could alter the composition and distribution of live bottom communities.

Severe weather events of sufficient magnitude (e.g., hurricanes) may also cause impacts. The force of currents and wave action can directly disturb sediments (Brooks, 1991; CSA, 1992), increasing turbidity and associated impacts. Severe weather can also have secondary impacts, such as causing movement of abandoned fishing gear and causing accidental losses of equipment overboard or even the toppling of entire platforms. In general, live bottom communities have adapted over millennia to deal with natural levels of severe weather, but changing climatic conditions that alter the frequency and/or severity of severe weather events could impact live bottom resources in unforeseen ways to which live bottoms may not be able to adapt.

Climate change-related effects have the potential to alter baseline environmental conditions throughout the GOM. An additional review of climate change is presented in the Five-Year Program EIS (USDOI, BOEM, 2016b). Of particular note for live bottom communities are the potential negative consequences that may be caused by the dual mechanisms of increasing ocean temperatures and ocean acidification and associated reductions in the bioavailability of calcium carbonate. Sustained, unusually high water temperatures are documented to cause coral bleaching, in which symbiotic zooxanthellae are expelled from coral polyps. Ocean acidification can inhibit normal rates of calcification by exoskeleton-building corals and other calcifying marine organisms, and decreased calcification rates have been observed in numerous shallow-water, zooxanthellate corals (refer to Hofmann et al., 2010). Both mechanisms can inhibit growth and reproductive fitness.

The cumulative impact level of each of these individual factors is difficult to accurately estimate since the spatial and temporal characteristics of some factors are rapidly changing and necessary baseline information is still being collected. However, at present, the overall impact of these non-OCS oil- and gas-related factors is estimated to be minor to moderate, with individual species affected to different degrees by each factor. Over the next 50 years, the impact level from these non-OCS oil- and gas-related factors could potentially rise to as great as major for some species, should current trends of these factors continue or worsen.

Weighed against these potential non-OCS oil- and gas-related impacts, the cumulative impact of a proposed lease sale is expected to contribute only a **negligible** amount to the more serious expected impacts of non-OCS oil- and gas-related activities.

Incomplete or Unavailable Information

BOEM recognizes that there is incomplete or unavailable information related to GOM live bottom habitats in general and specifically in relation to routine activities, accidental events, and cumulative impacts for OCS oil- and gas-related activities and cumulative non-OCS oil- and gas-related activities. However, the information that is known is adequate to come to a determination with respect to reasonably foreseeable impact-producing factors associated with a proposed action.

Research in offshore marine systems is logistically complex and requires substantial resources to conduct. The total amount of research on live bottom habitats has therefore been limited, although BOEM and its predecessor agencies have funded numerous studies over the past 40 years. An example of incomplete knowledge about this resource would be that the exact distribution of GOM live bottom habitats at any given time is not perfectly understood. This is due in part to limits on data collection but also due to the frequent burial and exposure of low-relief hard bottoms. To help address this knowledge gap, BOEM requires operators to provide detailed, updated, site-specific survey information about potential live bottom habitats; this information is reviewed by subject-matter experts prior to approval of individual proposed activities, and appropriate protective mitigations are applied where appropriate.

Although BOEM has acquired and applies a good deal of knowledge about possible impacts to live bottom habitats, a perfect understanding of all conceivable impacts is unattainable. For example, only recently did a study (Silva et al., 2015) provide compelling evidence that mixing of a surface oil/dispersant mixture to the depths of the Pinnacle Trend live bottom features can occur given an unusual combination of conditions and could then have a localized impact. Given the geographic and temporal scope of a proposed action, it is believed that even impacts resulting from that particular scenario would still only have a slight impact on the overall status of GOM live bottom habitats, and the amount of oil/dispersant mixture in that catastrophic situation greatly exceeded the amounts considered in the "Accidental Events" analysis. However, the example demonstrates the point that the body of literature supporting impact analysis is still growing and requires continual review by BOEM.

Known information about potential impacts of a theoretical catastrophic spill is detailed in the *Catastrophic Spill Events Analysis* white paper (USDOI, BOEM, 2016c). However, a great deal of information related to impacts specific to the *Deepwater Horizon* explosion, oil, spill, and response is still incomplete or unavailable. BOEM has determined that such additional information could not be timely acquired and incorporated into the current analysis. However, based on the currently available evidence, outstanding reports are not expected to reveal additional significant effects that would alter the overall conclusions about reasonably foreseeable impact-producing factors associated with a proposed action.

BOEM will continue to analyze and support collection and analysis of the best available scientific information related to live bottom habitats. BOEM used reasonably accepted scientific methodologies to extrapolate from existing information in completing this analysis and formulating the conclusions presented here. BOEM has determined that the incomplete information is not essential to a reasoned choice among alternatives.

4.6.2.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

The activities proposed under Alternative A could directly impact live bottom pinnacle and low-relief features within the GOM. The primary, reasonably foreseeable, impact-producing factors for deepwater benthic habitats can be grouped into three main categories: (1) bottom-disturbing activities; (2) sediment and waste discharges; and (3) oil spills. The proposed Live Bottom Stipulation, along with site-specific reviews of permit applications and associated distancing requirements, would mitigate potential impacts to live bottom communities as a result of both routine activities and accidental disturbances. Assuming adherence to all expected lease stipulations and other postlease protective restrictions and mitigations, the routine activities are expected to have mostly short-term, localized, and temporary effects on live bottom communities that may not be clearly detectable. Therefore, at the regional, population-level scope of this analysis, the impacts of routine activities would be expected to be **negligible**.

Accidental events (below the threshold of a catastrophic spill, which is detailed in the *Catastrophic Spill Event Analysis* white paper [USDOI, BOEM, 2016c]) have the potential to cause detectable, severe damage to specific live bottom communities. However, the number of such events is expected to be very small and localized, and impacts might not be clearly distinguishable from natural variation. Therefore, at the regional, population-level scope of this analysis, impacts from reasonably foreseeable accidental events are expected to be **negligible** to **minor**.

Proposed and existing OCS oil- and gas-related activities would also contribute incrementally to the overall OCS oil- and gas-related and non-OCS oil- and gas-related cumulative effects experienced by live bottom habitats. A variety of non-OCS oil- and gas-related activities, including fishing and anchoring, along with shifting natural conditions such as invasive species and climate change-related factors, may have a considerable impact on live bottom communities over the next 50 years. Weighed against these potential non-OCS oil- and gas-related impacts, the cumulative impact of a proposed action under Alternative A is expected to contribute only a negligible amount to the more serious expected impacts of non-OCS oil- and gas-related activities.

4.6.2.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Under Alternative B, BOEM would hold a lease sale excluding the available unleased WPA blocks and would offer all available unleased blocks in the CPA and a portion of the EPA. Alternative B would not fundamentally alter the conclusions reached under Alternative A, but it would reduce the potential impacts of a proposed sale in the available unleased WPA blocks. The impacts from proposed activities to live bottom communities would remain the same in leased portions of the CPA/EPA. Impacts resulting from accidental events should remain relatively localized, with the number of features affected being directly proportional to the size of the accident. An accident along the CPA/WPA border has the possibility to impact features in either planning area. Live bottom communities are found throughout the GOM, and therefore, the impacts associated with Alternative B could still potentially cause some population-level effects.

At the regional, population-level scope of this analysis, the overall impact to live bottom communities as a result of the activities proposed under Alternative B are expected to be the same as Alternative A, i.e., negligible to minor, assuming the application of the Live Bottom (Pinnacle Trend) Stipulation and continuation of expected mitigation practices. BOEM's mitigation practices would reduce the potential impacts as a result of routine activities and accidental events, and OCS oil- and gas-related cumulative impacts of a proposed sale under Alternative B to the range of **negligible** to **minor**. Absent these mitigations, the impacts resulting from routine activities and accidental events of a proposed sale under Alternative B could be greater; the overall population-level impact could range from minor to moderate (in a theoretical, if improbable, worst-case scenario). This impact level is less than the potential major level impact that would be possible (absent mitigations) under Alternative A. This difference is due to the reduced area available for new leasing under Alternative B, which would somewhat limit the number of potentially affected live bottom communities (including concentrations of known live bottom communities in the South Texas Banks) and increase the likelihood of long-term recovery to pre-impact levels. However, it is believed that existing mitigation practices would continue to be applied to the proposed activities under all action alternatives, reducing the expected level of OCS oil- and gas-related impacts.

The incremental cumulative impacts of proposed and existing OCS oil- and gas-related activities under Alternative B are considered to add only a negligible contribution to the overall cumulative impact, which includes the relatively greater influence of non-OCS oil-and gas-related cumulative impacts occurring throughout the GOM over the 50-year analysis period.

4.6.2.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Under Alternative C, BOEM would hold a lease sale excluding the CPA/EPA available unleased blocks and would offer all available unleased blocks in the WPA. Alternative C would not fundamentally alter the conclusions reached under Alternative A, but it would reduce the potential impacts of a proposed lease sale of the available unleased CPA/EPA blocks, including known concentrations of live bottoms in the Pinnacle Trend blocks and other portions of the northeastern

CPA (**Figure 4-17**). The impacts from proposed activities to live bottom communities would remain the same in leased portions of the WPA. Impacts resulting from accidental events should remain relatively localized, with the number of features affected being directly proportional to the size of the accident. An accident along the CPA/WPA border has the possibility to impact features in either planning area. Live bottom communities are found throughout the GOM, not just in the CPA/EPA, and therefore, the impacts associated with Alternative C could still potentially cause some population-level effects.

At the regional, population-level scope of this analysis, the overall impact to live bottom communities as a result of the activities proposed under Alternative C are expected to be the same as Alternative A, i.e., negligible to minor, assuming the application of the Live Bottom (Pinnacle Trend) Stipulation and continuation of expected mitigation practices. BOEM's mitigation practices would reduce the potential impacts as a result of routine activities and accidental events, and OCS oil- and gas-related cumulative impacts of a proposed lease sale under Alternative C to the range of **negligible** to **minor**. Absent these mitigations, the impacts resulting from routine activities and accidental events of a proposed lease sale under Alternative C could be greater; the overall population-level impact could range from negligible to moderate (in a theoretical, if improbable, worst-case scenario). This impact level is less than the potential major level impact that would be possible (absent mitigations) under Alternative A. This difference is due to the reduced area available for new leasing under Alternative C, which would somewhat limit the number of potentially affected live bottom communities (including large concentrations of known live bottom communities in the live bottom Pinnacle Trend blocks and other portions of the northeastern CPA, i.e., higher concentrations than are known to occur in the WPA and thus a different impact range than under Alternative B) and increase the likelihood of long term recovery to pre-impact levels. However, it is believed that existing mitigation practices would continue to be applied to the proposed activities under all action alternatives, reducing the expected level of OCS oil- and gas-related impacts.

The incremental cumulative impacts of proposed and existing OCS oil- and gas-related activities under Alternative C are considered to add only a negligible contribution to the overall cumulative impact, which includes the relatively greater influence of non-OCS oil-and gas-related cumulative impacts occurring throughout the GOM over the 50-year analysis period.

4.6.2.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Under Alternative D, BOEM could hold a lease sale excluding leasing on any and/or all blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations. Known live bottom features in the Pinnacle Trend area would be further protected by the increased distancing of OCS oil- and gas-related activities. An accidental spill may still reach some Pinnacle Trend features, but if so, it is expected that such a spill would be more dispersed and diluted from having to travel the additional distance across the unleased blocks.

The impacts from the proposed activities to live bottom communities would remain the same in all other leased portions of the OCS. Impacts resulting from accidental events should remain relatively localized, with the number of features affected being directly proportional to the size of the accident. An accident along the border of available unleased blocks subject to the Topographic Features and Live Bottom (Pinnacle Trend) Stipulations still has the possibility to impact features within those unleased blocks. Live bottom communities are found throughout the GOM, not just in the blocks subject to the Topographic Features and Live Bottom (Pinnacle Trend) Stipulations, and therefore, the impacts associated with Alternative D could still potentially cause some population-level effects. The exclusion of blocks subject to the Blocks South of Baldwin County, Alabama Stipulations is not expected to change the impacts to pinnacles and/or low-relief features because of the small number of blocks and their distance from identified features.

At the regional, population-level scope of this analysis, the overall impact to live bottom communities as a result of the activities proposed under Alternative D are expected to be the same as Alternative A, i.e., negligible to minor, assuming the application of the Live Bottom (Pinnacle Trend) Stipulation and continuation of expected mitigation practices. BOEM's mitigation practices would reduce the potential impacts as a result of routine activities and accidental events, and OCS oil- and gas-related cumulative impacts of a proposed lease sale under Alternative D to the range of **negligible** to **minor**. Absent these mitigations, the impacts resulting from routine activities and accidental events of proposed lease sale under Alternative D could be greater; the overall population-level impact could range from negligible to moderate (in a theoretical, if improbable, worst-case scenario). This impact level is less than the potential major level impact that would be possible (absent mitigations) under Alternative A. This difference is due to the reduced area available for new leasing under Alternative D, which would somewhat limit the number of potentially affected live bottom communities (including large concentrations of known live bottom communities in the topographic features blocks and live bottom blocks, i.e., higher concentrations than are known to occur in the WPA and thus a different impact range than under Alternative B) and increase the likelihood of long-term recovery to pre-impact levels. However, it is believed that existing mitigation practices would continue to be applied to the proposed activities under all action alternatives, reducing the expected level of OCS oil- and gas-related impacts.

The incremental cumulative impacts of proposed and existing OCS oil- and gas-related activities under Alternative D are considered to add only a negligible contribution to the overall cumulative impact, which includes the relatively greater influence of non-OCS oil-and gas-related cumulative impacts occurring throughout the GOM over the 50-year analysis period.

4.6.2.2.5 Alternative E—No Action

Under Alternative E, a proposed lease sale would be cancelled. Therefore, the potential for impacts would be **none** because new impacts to live bottom communities related to the cancelled lease sale would be avoided entirely. Continuing impacts to the communities would be limited to existing impacts resulting from routine activities and accidental events, and cumulative impacts associated with previous OCS lease sales and development. BOEM's current Live Bottom

Stipulation and mitigation practices already regulate these activities and should continue to limit associated new impacts to the **negligible** to **minor** range.

Development of oil and gas would, in all likelihood, be proposed again in a future lease sale; in that case, the overall level of OCS oil- and gas-related activity would only be delayed, not reduced, at least in the short term.

Ongoing non-OCS oil- and gas-related activities are difficult to accurately estimate since the spatial and temporal characteristics of some factors are rapidly changing, and necessary baseline information is still being collected; however, at present, these non-OCS oil- and gas-related activities are having minor to moderate cumulative impacts on live bottom communities. These could potentially become greater for some species, even rising to major over the next 50 years, should current trends of these factors continue or worsen.

4.7 FISHES AND INVERTEBRATE RESOURCES

Fish and invertebrate resources of the GOM comprise a large and diverse group of species (Felder et al., 2009). The distribution of fishes and invertebrates vary widely and species may be associated with different habitats at various life stages. This analysis highlights behaviors and habitat preferences, but it does not attempt to provide a comprehensive list of all potentially impacted fauna. For purposes of this analysis, habitat preferences can be divided into three broad categories: estuarine; coastal; and oceanic. Exposure to specific impact-producing factors generated by OCS oil- and gas-related routine activities and accidental events can vary among these categories. Coastal and oceanic resources are further broken into benthic and pelagic zones to address differences in potential exposure to impact-producing factors within a given habitat category. Ichthyoplankton bridges all three categories. Egg and larval stages of most fishes and invertebrates can be found in the upper layer of the water column, exposing these species' early life stages to similar impact-producing factors. For these reasons, the description of the affected environment for fish and invertebrate resources is broken into estuarine, coastal, and oceanic habitats, and the surface waters occupied by ichthyoplankton are described separately. A brief discussion of the federally managed species is provided at the end of the "Description of the Affected Environment" below (**Chapter 4.7.1**).

A full analysis of the "Environmental Consequences" is presented in **Chapter 4.7.2.1**. Analyses of the specific alternatives do not restate the full analysis of the impact-producing factors potentially affecting fishes and invertebrate resources; the analyses identify the potential impacts as a result of routine activities, accidental events, and cumulative impacts. This avoids excessive replication of the discussion of similar if not identical impacts for each alternative.

Preliminary analysis of routine OCS oil- and gas-related activities and reasonably foreseeable accidental events identified nine impact-producing factors with the potential to affect marine fishes and invertebrates and/or their habitat. Many OCS oil- and gas-related activities affect the environment similarly. For example, vessel traffic, exploratory drilling, geophysical activities, and offshore construction all produce sound. The impact-producing factor, "anthropogenic sound," was analyzed taking all sound-producing OCS activities into consideration. The following are impact-producing factors that were considered and analyzed in this resource analysis:

- anthropogenic sound (**Chapter 3.3.2.7**);
- bottom-disturbing activity (**Chapter 3.1.3.3.1**);
- habitat modification; and
- oil spills (**Chapter 3.2.1**).

Two impact-producing factors that were considered for fishes and invertebrate resources but determined to be insignificant under all reasonably foreseeable circumstances due to the limited exposure and/or response expected for fish and invertebrate resources are not included in this chapter. These impact-producing factors are entrainment (**Chapter 3.1.5.1.6**) and offshore lighting (**Chapter 3.1.3.4.4**). Analyses of two additional impact-producing factors that could potentially impact resources ecologically important to fishes and invertebrates were found to sufficiently address the potential for adverse impacts to the respective habitats and are not duplicated in this chapter. These impact-producing factors are onshore construction and manufacturing (**Chapters 3.7 and 4.3**, Coastal Habitats) and regulated discharges (**Chapters 3.1.5 and 4.2**, Water Quality).

Analysis of potential impacts considered the estimated scale of source activities and used the best available science to evaluate how specific impact-producing factors could affect resources within the expected environment. Cumulative impacts (**Chapter 4.7.3**) were analyzed for OCS oil- and gas-related activities and for other sources that could affect fishes and invertebrates (e.g., coastal development, commercial shipping, fisheries, and environmental). Because of the diversity of fishes and invertebrates, detailed criteria for potential impact levels are not reasonable.

Impact-Level Definitions

For this analysis, the potential impact-level criteria can be described in terms of population-level effects.

- **Negligible** – localized and temporary impacts that are expected to be indistinguishable from natural variations in population distribution and abundance.
- **Minor** – localized and temporary impacts that are expected to be indistinguishable from natural variations in population distribution and abundance. Community-level variations may be locally detectable, such as species mix and relative abundance following the removal of OCS oil- and gas-related infrastructure.
- **Moderate** – Impacts would be expected to exceed natural variations in population abundance or distribution, but not result in a long-term decline.

- **Major** – Impacts would be expected to exceed natural variations and inherently result in a long-term decline in populations.

Though two protected fish species (Gulf sturgeon [*Acipenser oxyrhynchus desotoi*] and smalltooth sawfish [*Pristis pectinata*]) are found near the area of interest, they inhabit and have critical habitat in onshore waters. These species are not considered to be impacted by a proposed action because they are found away from activities that could cause an impact. The impact-producing factors analyzed and the impact-level conclusions reached from the analysis in this chapter are presented in **Table 4-10**.

Table 4-10. Fish and Invertebrate Resources Impact-Producing Factors.

Fish and Invertebrate Resources	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Anthropogenic Sound	Minor	Minor	Minor	Minor	None
Bottom-Disturbing Activity	Negligible	Negligible	Negligible	Negligible	None
Habitat Modification	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Accidental Impacts					
Oil Spills	Negligible	Negligible	Negligible	Negligible	None
Cumulative Impacts					
OCS Oil and Gas					
Anthropogenic Sound	Minor	Minor	Minor	Minor	Minor
Bottom-Disturbing Activity	Negligible	Negligible	Negligible	Negligible	Negligible
Habitat Modification	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Non-OCS Oil and Gas					
Anthropogenic Sound	Moderate	Moderate	Moderate	Moderate	Moderate
Fisheries	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate
Habitat Modification	Minor	Minor	Minor	Minor	Minor

4.7.1 Description of the Affected Environment

The ecological factors influencing the distribution of fish and invertebrate species include salinity, temperature, depth, primary productivity, and bottom type. These factors vary widely across the Gulf of Mexico and between inshore and offshore waters. Fish and invertebrate resources are associated with the various environments and are not randomly distributed. High densities of fish and invertebrate resources can be associated with particular habitat types; for detailed habitat information, distribution, potential impacts, and mitigations, refer to **Chapters 4.3** (Coastal Habitats), **4.5** (Deepwater Benthic Communities), **4.5** (*Sargassum* and Associated Communities), and **4.6** (Live Bottom Habitats), and to the *Essential Fish Habitat Assessment* white paper (USDOI, BOEM, 2016d). Because wide variations in habitat usage can occur throughout a species' life history, potential impacts have been analyzed in three broad habitat categories (i.e., estuarine, coastal, and oceanic) and one life history category (i.e., ichthyoplankton). These categories are not divided by fixed boundaries but by generalized conditions and characteristics typical of the habitat where a fish or invertebrate may spend the bulk of its life.

Estuarine

Estuaries are typically semi-enclosed areas where marine saltwater is diluted by freshwater and where salinity may vary widely from day to day. The freshwater input (e.g., bayou, stream, or river) delivers sediment and nutrients that result in turbid, productive environments. Estuaries include many important habitat types (e.g., wetlands, seagrasses, and mudflats) and are frequently areas with high biomass. However, these environments can also have high energetic costs for resident organisms due to the fluctuating conditions. Many of the fishes and invertebrates found in mid- or near-shelf waters are dependent on or opportunistically make use of estuaries at some point in their life cycle. For example, estuaries provide nursery habitat for Gulf menhaden (*Brevoortia patronus*), spotted sea trout (*Cynoscion nebulosus*), blue crab (*Callinectes sapidus*), brown shrimp (*Farfantepenaeus aztecus*), and gag (*Mycteroperca microlepis*). The eastern oyster (*Crassostrea viginica*) is an example of a species that both benefits from the environmental conditions in estuarine habitat and serves as an important substrate. Bull sharks (*Carcharhinus leucas*) opportunistically make use of estuarine habitat and are common in estuaries and coastal waters. Estuaries may be subject to extreme tidal exchange, strong currents, water-column stratification, and/or rapid fluctuations in dissolved oxygen.

Coastal

Coastal waters are defined here as those waters extending from the shoreline seaward over the continental shelf. These waters are enriched by organic material exported from the estuaries and rivers of the GOM and support the greatest biomass of the three categories. Many species in the coastal waters of the GOM exploit the entire water column; the following subcategories are used to distinguish between zones in which species are predominantly found.

Coastal Pelagics

Pelagic fishes are primarily found in waters associated with neither the shore nor the seafloor. Commercial fishery landings are one of the best sources of information for coastal pelagic fishes because these species are an important component of regional fisheries. Coastal pelagic species traverse shelf waters of the region throughout the year. Major coastal pelagic families occurring in the region include

- Carcarhinidae (requiem sharks),
- Elopidae (ladyfish),
- Engraulidae (anchovies),
- Clupeidae (herrings),
- Scombridae (mackerels and tunas),
- Carangidae (jacks and scads),
- Mugilidae (mullets),
- Pomatomidae (bluefish), and
- Rachycentridae (cobia).

The distribution of most species depends upon water-column characteristics that vary spatiotemporally. Coastal pelagic species with an affinity for vertical structure are often observed around topographic features and offshore platforms, where they are best classified as transients rather than resident fishes. Spawning typically occurs over the mid- or inner-continental shelf, eggs and larvae are pelagic, and juveniles are common in estuaries and coastal waters. Coastal pelagic fishes can be divided into two general groups: large predatory species (e.g., Spanish mackerel, cobia, and coastal sharks); and smaller, omnivorous and herbivorous species, such as Gulf menhaden (*Brevoortia patronus*) and striped mullet (*Mugil cephalus*). Members of both groups may form large schools. The predatory species typically undergo migrations, grow rapidly, mature early, and exhibit the ability to produce a large number of eggs, while the latter group includes many estuarine-dependent species that are frequently preyed upon by members of the first group. These fishes are ecologically important to energy transfer in the nearshore environment and, in many cases, are subject to significant fishing pressure. Large schools of squid (e.g., *Doryteuthis pealeii* and *Lolliguncula brevis*) can also be found over the continental shelf, and many less well-known cephalopods inhabit the GOM, ranging from nearshore waters to oceanic waters (Voss and Brakoneicki, 1985; Felder et al., 2009).

Coastal Demersal

Most of the benthic habitat in the northern GOM can be described as low-relief soft bottom habitat (i.e., mud, clay, and sand). Demersal fish and benthic invertebrates live and forage at the seafloor. White shrimp (*Litopenaeus setiferus*), hardhead catfish (*Arius felis*), Atlantic croaker (*Micropogonias undulatus*), and cownose rays (*Rhinoptera bonasus*) are common to inshore soft bottom habitat. Over the inner- and mid-shelf, and in association with deeper topographic features, red snapper (*Lutjanus campechanus*) provide an example of an opportunistic fish. This species feeds on the bottom and throughout the water column. Older and larger fish inhabit open bottom and habitat with vertical structure, whereas young adults tend to recruit to habitat with vertical structure (Gallaway et al., 2009). Scattered low-relief hard bottom features and several significant higher relief features are located on the shelf. Thirteen banks have been identified by the Gulf of Mexico Fisheries Management Council (GMFMC) as being important features in the northwestern GOM, and these banks are designated as habitat areas of particular concern (HAPCs). Where hard bottom occurs, demersal species and opportunistic reef fish species more commonly associated with the mid- or inner-shelf may also be found. Species particularly adapted for deeper hard bottom areas include snowy grouper (*Epinephelus niveatus*), yellowedge grouper (*Epinephelus flavolimbatus*), and gag (*Mycteroperca microlepis*). Outer shelf demersal assemblages (approximately 656- to 984-ft [200- to 300-m] water depth) might include three-eye flounder (*Ancylopsetta dilecta*), deepbody boarfish (*Antigonia capros*), and armored searobins (*Peristedion miniatum*).

Oceanic

For purposes of this impact analysis, oceanic waters are generally defined as those waters seaward of the continental shelf, although oceanographic features and storms can cause these waters to intrude over the mid- or inner-shelf. Information on the distribution and abundance of oceanic species comes from commercial longline catches, recreational fishing surveys, and relatively few independent research efforts. Pelagic fishes occur throughout the water column in the open ocean. Within this vast habitat, water-column structure (i.e., temperature, salinity, and turbidity) is the primary means of partitioning for analyses. In general, pelagic fishes recognize different watermasses based upon physical and biological characteristics. The following subcategories are used to distinguish among assemblages based on predominant depth inhabited: epipelagic – extends from the surface to a depth of 656 ft (200 m); mesopelagic – extends from 656 to 3,281 ft (200 to 1,000 m); and bathypelagic – includes depths greater than 3,281 ft (1,000 m). The demersal category is also included and encompasses those species associated with the deep seafloor.

Epipelagic

Oceanic epipelagic species occur throughout the GOM, especially at or beyond the shelf edge. Epipelagics are reportedly associated with mesoscale hydrographic features such as fronts, eddies, and discontinuities. Many of the oceanic fishes also associate with drifting *Sargassum*, which provides forage areas and/or nursery refugia (**Chapter 4.5,** *Sargassum* and Associated Communities). Common fishes in this zone include halfbeaks and flying fishes (Exocoetidae), and early life stage driftfishes (Ariommatidae). Several well-known large predators are also epipelagic species, including bluefin tuna (*Thunnus thynnus*), swordfish (*Xiphias gladius*), dolphinfish (*Coryphaena hippurus*), wahoo (*Acanthocybium solanderi*), and shortfin mako (*Isurus oxyrinchus*). The lower section of this epipelagic zone has a distinct fauna, consisting of the poorly known oarfishes and its relatives, in addition to fishes with great depth ranges such as tunas (Scombridae) and swordfishes (Xiphiidae) (McEachran and Fechhelm, 1998). Adult driftfishes are generally found at depths bridging the lower epipelagic and upper mesopelagic zones.

Mesopelagics

The mesopelagic realm is below the photic zone and below the permanent thermocline. Mesopelagic fish assemblages in the GOM 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; 656-3,281 ft) to feed in higher, food rich layers of the water column (McEachran and Fechhelm, 1998). Mesopelagic fishes are ecologically important because they transfer substantial amounts of energy between mesopelagic and epipelagic zones over each diel cycle.

Bathypelagics

The deeper dwelling bathypelagic fishes inhabit the water column at depths >1,000 m (3,281 ft) and seldom migrate into shallower waters. This zone receives no sunlight and temperatures range from 4 °C to 10 °C (39 °F to 50 °F). Numerous species of gonostomatids (bristlemouths or lightfishes) and scaleless black dragonfishes (Melanostomiidae) are found in the bathypelagic of the GOM. Like mesopelagic fishes, most species are capable of producing and emitting light (bioluminescence) to aid in communication in an environment devoid of sunlight (Snyder, 2000).

Demersal

Three major deep-sea studies have collected demersal fish throughout the depth range of the GOM's continental slope between the 1960's and as recently as 2003. The families Macrouridae (grenadiers or rattails), Ophidiidae (cuskeels), and Alepocephalidae (slickheads) dominated the samples (Rowe and Kennicutt, 2009). Analysis of the data suggested an upper slope assemblage between 1,033 and 2,575 ft (315 and 785 m), a mid-slope assemblage between 2,251 and 4,491 ft (686 and 1,369 m), and a deep assemblage between 5,030 and 10,089 ft (1,533 and 3,075 m) (Rowe and Kennicutt, 2009). Shelf edge and upper slope species include tilefish (*Lopholatilus chamaeleonticeps*) and snowy grouper (*Epinephelus niveatus*).

Ichthyoplankton

Most fishes inhabiting the GOM, whether benthic or pelagic as adults, have pelagic larval stages. For the duration of this stage, these 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). In general, the distribution of fish larvae depends on the spawning behavior of adults, hydrographic structure and transport at a variety of scales, duration of the pelagic period, behavior of larvae, larval mortality, and growth (Leis, 1991). Larval fishes are highly dependent on zooplankton until they can feed on larger prey.

Two important hydrographic features in the GOM are the Mississippi River discharge plume and the Loop Current. Combined with wind regimes in the region, these features strongly influence the transport and distribution of pelagic eggs and larvae. Water from the Mississippi River exits from several passes, delivering approximately one-third its volume to the Mississippi-Alabama shelf and two-thirds to the Texas-Louisiana shelf. The convergence and mixing of this many plumes is associated with continually reforming turbidity fronts and an accumulation of larvae at the plume boundary (Wiseman and Sturges, 1999). Planktonic eggs and larvae also become concentrated at the frontal boundaries of the Loop Current, shed rings, and gyres. Entrained *Sargassum* provides nursery habitat and refuge for many of these early life stage fish, and upwelling at the edges of the Loop Current and rings delivers nutrient-enriched waters to the surface, increasing primary production. Frontal waters of both the river plume and eddy boundaries provide feeding and growth opportunities for larvae.

Managed Species

For purposes of this analysis, managed species are those identified in a fishery management plan by a regional fishery management council or as a federally managed species. These species are subject to monitoring and management regulations. Fish species currently managed in the GOM are listed in Table D-1 of the *Essential Fish Habitat Assessment* white paper (USDOI, BOEM, 2016d). Detailed descriptions 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) and updated in the “Essential Fish Habitat Generic Amendment 3” (GMFMC, 2005). Information on federally managed species and EFH is provided in the Consolidated Atlantic Highly Migratory Species Fishery Management Plan and amendments. These fishes and invertebrates are included in the preceding categories and are considered in the respective analyses for impacts below. Increased susceptibility to potential impacts as a result of fishing pressures will be discussed in the “Cumulative Impacts” section below.

4.7.2 Environmental Consequences

This chapter provides detailed information regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts described in **Chapter 3** and their potential effects on fish and invertebrate resources that would potentially result from a proposed action or the alternatives. This analysis applies to all considered alternatives. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), the distribution of fishes and invertebrate species is nonrandom and generally even throughout their range of habitat within the planning areas. As such, the potential for impacts to populations is independent of the planning area(s) analyzed. Differences in the specific populations potentially exposed to impact-producing factors and the potential impacts may be more easily estimated as specific sites and activities become known. Therefore, because of the diversity and distribution of species in the Area of Interest, the level of impacts would be the same for Alternatives A, B, C, and D. However, Alternative E would have no impacts as a proposed action would not be implemented; therefore, the only impacts would be those associated with the continuing effects from past lease sales and non-OCS oil- and gas-related activities. Following this environmental consequences chapter, there will be a summary of the potential impacts as they relate to the action alternatives.

Routine Activities

Routine OCS oil- and gas-related activities that take place on the OCS as a result of a proposed action and that produce sound, disturb the seafloor, or otherwise modify the habitat, could impact fish and invertebrate resources. A full list of impact-producing factors and scenarios for routine activities can be found in **Chapter 3.1**.

Anthropogenic Sound

Natural background noise in a marine environment is the result of physical processes (i.e., wind, wave action, tidal movement, and geological activity) and bioacoustic signals (Wysocki and Ladich, 2005; Hildebrand, 2009; Radford et al., 2010; Ladich, 2013). Acoustic signaling in the marine environment is extremely efficient, so marine species have evolved several mechanisms for producing and receiving sound. Important sound-mediated behaviors can include spawning aggregations, larval settlement, territorial disputes, and predator-prey detection (Radford et al., 2010 and 2014; Slabbekoorn et al., 2010). Despite the growing body of information on fishes, there is comparatively little information available on sound detection and sound-mediated behaviors for marine invertebrates (Mooney et al., 2012; Normandeau Associates, 2012; de Soto et al., 2013; Popper et al., 2014; Samson et al., 2014). The diversity of marine fishes and invertebrates suggests the small number of studied species may not be representative of the full range of auditory sensory mechanisms and hearing capabilities. Therefore, caution was used in extrapolating potential impacts to fishes and invertebrate resources from documented behavioral responses and physiological impacts resulting from exposure to anthropogenic sound sources. For purposes of this analysis, it was deemed reasonable to use observed results as an indication of the types of impacts that may occur as a result of expected discreet and cumulative exposures to anthropogenic sound produced by routine OCS oil- and gas-related activities.

All routine OCS oil- and gas-related activities have some element of sound generation. Common sound sources include propeller cavitation, rotating machinery, and reciprocating machinery, which are associated with routine OCS oil- and gas-related activities such as vessel traffic, drilling, construction, and oil and gas production, processing, and transport. Sound introduced into the marine environment as a result of human activities has the potential to affect marine organisms by stimulating behavioral response, masking biologically important signals, causing temporary or permanent hearing loss (Popper et al., 2005; Popper et al., 2014), or causing physiological injury (e.g., barotrauma) resulting in mortality (Popper and Hastings, 2009). The potential for anthropogenic sound to affect any individual organism is dependent on the proximity to the source, signal characteristics, received peak pressures relative to the static pressure, cumulative sound exposure, species, motivation, and the receiver’s prior experience. In addition, environmental conditions (e.g., temperature, water depth, and substrate) affect sound speed, propagation paths, and attenuation, resulting in temporal and spatial variations in the received signal for organisms throughout the ensonified area (Hildebrand, 2009).

Sound detection capabilities among fishes vary. All fishes are able to detect low-frequency particle motion at short ranges by means of the otolith and lateral line organs (Popper et al., 2003).

Detection of the particle velocity and the ability to determine the position of the source is only possible over distances of 1-2 body lengths, but it is important for orientation in flowing water and maneuvering in close proximity to other organisms (Popper et al., 2014). Species with a swim bladder or accessory structure close to or in contact with the inner ear have increased hearing sensitivity and a wider range of detectable frequencies than do fishes with a swim bladder only or fishes with no gas-filled structure (Popper et al., 2003). For most fish species, it is reasonable to assume hearing sensitivity to frequencies below 500 Hertz (Hz) (Popper et al., 2003 and 2014; Popper and Hastings, 2009; Slabbekoorn et al., 2010; Radford et al., 2014). Ambient noise may be divided into three general frequency bands (i.e., low, medium, and high), each dominated by different sound sources (Hildebrand, 2009). The band of greatest interest to this analysis, low-frequency sound (30-500 Hz), has come to be dominated by anthropogenic sources and includes the frequencies most likely to be detected by most fish species. For example, the noise generated by large vessel traffic typically results from propeller cavitation and falls within 40-150 Hz (Hildebrand, 2009; McKenna et al., 2012). This range is similar to that of fish vocalizations and hearing, and could result in a masking effect.

Masking occurs when background noise increases the threshold for a sound to be detected; masking can be partial or complete. If detection thresholds are raised for biologically relevant signals, there is a potential for increased predation, reduced foraging success, reduced reproductive success, or other effects. However, fish hearing and sound production may be adapted to a noisy environment (Wysocki and Ladich, 2005). There is evidence that fishes are able to efficiently discriminate between signals, extracting important sounds from background noise (Popper et al., 2003; Wysocki and Ladich, 2005). Sophisticated sound processing capabilities and filtering by the sound sensing organs essentially narrows the band of masking frequencies, potentially decreasing masking effects. In addition, the low-frequency sounds of interest propagate over very long distances in deep water, but these frequencies are quickly lost in water depths between ½ and ¼ the wavelength (Ladich, 2013). This would suggest that the potential for a masking effect from low-frequency noise on behaviors occurring in shallow coastal waters may be reduced by the receiver's distance from sound sources, such as busy ports or construction activities.

Pulsed sounds generated by OCS oil- and gas-related activities (e.g., impact-driven piles and airguns) can potentially cause behavioral response, reduce hearing sensitivity, or result in physiological injury to fishes and invertebrate resources. Impact pile-driving during OCS construction and on-lease seismic activity are both temporally and spatially limited activities. The effects of these sound-producing activities would extend only to communities of fishes and invertebrates within a relatively small area. Benthic fishes and invertebrates could receive sound waves propagated through the water and sound waves propagated through the substrate. However, Wardle et al. (2001) found that, although fishes and invertebrates associated with a reef exhibited a brief startle response when exposed to pulsed low-frequency signals, disruption of diurnal patterns was not observed. Fishes disturbed by the noise were observed to resume their previous activity within 1-2 seconds and only exhibited flight response if the airguns were visible when discharged (Wardle et al., 2001). Other studies of fishes exposed to pulsed anthropogenic sound signals in natural environments have produced a wide range of results suggesting that species, experience, and motivation are very important factors, and indicating that habituation may occur (Engås et al., 1996; Løkkeborg et al., 2012; Popper et al., 2014). Organisms in close proximity to a pulsed sound source are at increased risk of barotrauma. A signal with a very rapid rise and peak pressures that vary substantially from the static pressure at the receiver's location can cause physiological injury or mortality (Popper et al., 2014). However, the range at which physiological injury may occur is short (<10 m; <33 ft) and, given fish avoidance behavior, the potential for widespread impacts to populations as a result of physiological injury is **negligible**.

Despite the importance of many sound-mediated behaviors and the potential biological costs associated with behavioral response to anthropogenic sounds, many environmental and biological factors limit potential exposure and the effects that OCS oil- and gas-related sounds have on fishes and invertebrate resources. The overall impact to fishes and invertebrate resources due to anthropogenic sound introduced into the marine environment by OCS oil- and gas-related routine activities is expected to be **minor**.

Bottom-Disturbing Activities

For the purpose of this analysis, bottom-disturbing activities are distinguished from habitat modification by the relatively short period of time over which disturbances occur. Anchoring, drilling, trenching, pipe-laying, and structure emplacement are examples of OCS oil- and gas-related activities that disturb the seafloor. The specific activity, ocean currents, and water depth can affect the extent of the water column and seafloor disturbance, and the magnitude of the effect. For example, drilling an exploratory well produces approximately 2,000 metric tons (2,205 tons) of combined drilling fluid and cuttings, though the total mass may vary widely for different wells (Neff, 2005). Cuttings discharged at the surface tend to disperse in the water column and are distributed at low concentrations (CSA, 2004b). In deep water, cuttings discharged at the sea surface may spread 3,280 ft (1,000 m) from the source, with the majority of the sediment deposited within 820 ft (250 m) of the well (CSA, 2006). Drilling mud plumes may be visible 0.6 mi (1 km) from the discharge point, but the plumes rapidly become diluted (Shinn et al., 1980; Hudson et al., 1982; Neff, 2005). Cuttings shunted to the seafloor form piles concentrated within a smaller area than that affected by sediments discharged at the sea surface (Neff, 2005). Emplacement of infrastructure (i.e., pipelines, platforms, and subsea systems) can also displace large volumes of sediment, resulting in increased turbidity and sedimentation (**Chapter 3.1.3.3**).

Turbidity and sedimentation resulting from routine OCS oil- and gas-related activities are short term and have localized effects (**Chapter 3.1.3.3.2**). The potential impacts to fishes and invertebrates (e.g., reduced feeding efficiency, decreased predator avoidance, and behavioral responses) may be related to species-specific behaviors and habitat preference (Minello et al., 1987; Benfield and Minello, 1996; Chesney et al., 2000; de Robertis et al., 2003; Jönsson et al., 2013; Lunt and Smee, 2014). Mobile fishes and invertebrates are expected to avoid the heaviest sedimentation and highest suspended sediment loads within 33 ft (10 m) of a disturbance. Icthyoplankton cannot avoid sediment plumes at or near the surface and may be exposed for longer durations than adults. However, evidence suggesting increased turbidity, which may reduce hatching success or delay larval development, is limited, and other studies have shown larval foraging success and growth may benefit from nutrient-rich plumes (Wenger et al., 2014; Gray et al., 2012). Coastal fishes and invertebrate species adapted to turbid environments, such as shallow bays, estuaries, and coastal habitat influenced by the Mississippi River plume, may be less affected by increased turbidity than species typically inhabiting less turbid environments.

Due to a combination of the spatiotemporally limited nature of suspended sediment plumes resulting from bottom-disturbing activities, avoidance behaviors, and a range of tolerances for various environmental conditions, the overall impact to fishes and invertebrate resources as a result of bottom disturbances associated with OCS oil- and gas-related routine activities is expected to be **negligible**.

Habitat Modification

For purposes of this analysis, the installation of platforms, pipelines, and subsea systems, or the construction of other facilities within a marine environment constitutes habitat modification. Although these structures are temporary (refer to **Chapter 3.1.6**, Decommissioning and Removal Operations; **Chapter 3.1.6.2**, Rigs-to-Reefs Policy; and **Chapter 3.3.2.1.2**, Artificial Reefs, for more information), the operational life is long term and may impact the distribution of species in an area (Carr and Hixon, 1997; Gallaway et al., 2009; Shipp and Bortone, 2009). It is generally assumed that artificial structures serve as both fish-attracting and production-enhancing devices, depending upon the species (Carr and Hixon, 1997; Gallaway et al., 2009; Shipp and Bortone, 2009). The resulting assemblages frequently include commercially and recreationally valuable coastal and oceanic fishes. The well-known association with OCS oil- and gas-related structures attracts fishermen targeting these species and may subject some fishes to locally increased fishing pressure (Dance et al., 2011; Addis et al., 2013). However, infrastructure or pipeline removal also impacts fishes and invertebrates associated with the substrate. Removal of the structure is necessary to restore the seafloor to the original soft bottom habitat, but it would likely result in an altered community as the restored site is recolonized. The removal of hard substrate may result in community-level changes, such as an overall reduction in species diversity of epifaunal organisms, fishes, and invertebrates (Schroeder and Love, 2004).

Fish mortality can occur as a result of decommissioning operations using explosive severance methods; however, a study of the associated mortality for three commercially important fishes indicated that the level of explosive severance activity in the GOM did not significantly alter stock assessments (Gitschlag et al., 2001). To account for inherent variations in species composition and abundance among platforms (e.g., Stanley and Wilson, 1997; Gitschlag et al., 2001; Stanley and Wilson, 2000; Wilson et al., 2003), mortality estimates were doubled and stock estimates were recalculated. Although the study was limited and cannot be directly applied to all species or habitats, it is reasonable to assume that other represented fish populations would respond similarly. Impacts to sessile benthic organisms (e.g., barnacles and bivalves) and many mobile invertebrates (e.g., shrimp and crabs) that do not possess swim bladders are expected to be minimal (Keevin and Hempen, 1997; Schroeder and Love, 2004). Larvae and small juvenile fishes have been found to be more susceptible to injury from shock waves than large juveniles or adults (Govoni et al., 2008). At the projected rate of removal, these activities are not expected to have a substantial negative impact on stocks of managed fishes or other fishes and invertebrates associated with OCS oil- and gas-related infrastructure.

Some structures may be converted to artificial reefs. If portions of a platform were permitted to be reefed in place, the hard substrate and encrusting communities would remain part of the benthic habitat. The diversity of the community would change due to the reduced presence in the water column, but some associated fish species would be expected to continue use of the structure. Structures removed and redeployed as artificial reef substrate at another location may support substantially different communities, depending on the environmental characteristics of the reef site and other factors. The plugging of wells and other decommissioning activities that disturb the seafloor would impact benthic communities as discussed above.

Some ichthyoplankton studies have been conducted, focusing specifically on the influence of offshore platforms. The first of these projects investigated the potential role of platforms as nursery habitat for larvae or refugia for postlarval and juvenile fish (Hernandez et al., 2001). A follow-up study by Shaw et al. (2002) used data collected at several platforms both east and west of the Mississippi River Delta to examine the significance of platforms to larval and juvenile fishes. Both Hernandez et al. (2001) and Shaw et al. (2002) found highest taxonomic richness and diversity at mid-shelf platforms. Results indicated the distribution of larval and juvenile life stages is influenced by across-shelf gradients of increasing depth, similar to the distribution of adult fishes. Differences observed in the abundance of certain taxa in larval and juvenile fish assemblages across longitudinal gradients may reflect differences in the hydrographic conditions and/or habitat availability (Shaw et al., 2002). These results indicate the predominant factors influencing the distribution of larvae and juvenile life stages are environmental conditions and the distribution of adult conspecifics. Therefore, emplacement and/or removal of OCS oil- and gas-related infrastructure as the result of a proposed action is expected to have a **negligible** impact on the distribution or abundance of ichthyoplankton.

Although fish and invertebrate resources may be affected by habitat modifications due to routine OCS oil- and gas-related activities, there is no evidence suggesting that population-level impacts would occur as a result of a proposed activity. Due to the localized nature of the effects and limited number of structure installations and removals anticipated, impacts to fishes and invertebrate resources as a result of routine OCS oil- and gas-related activities are expected to range from **negligible** for most species to **minor** for species most commonly associated with OCS oil- and gas-related platforms (e.g., sharpnose puffer [*Canthigaster rostrate*], gray triggerfish [*Balistes capriscus*], great barracuda [*Sphyraena barracuda*], and red snapper [*Lutjanus campechanus*]).

Accidental Events

Accidental events resulting in a release of oil or other contaminants (“spills”) could adversely affect fish and invertebrate resources. Although an unlikely occurrence, a subsea loss of well control would also suspend large amounts of sediment. For the reasons stated above ("Bottom-Disturbing Activities"), the potential effects of suspended sediments would be **negligible**. This section will address the potential effects to fishes and invertebrate resources resulting from direct and indirect exposure to spilled oil. Oil spills, historic trends, the characteristics of oil, and factors affecting the fate of oil released into the marine environment are discussed in **Chapter 3.2.1**, and the potential effects on water quality are analyzed in **Chapter 4.2** (Water Quality).

The effects of spills in open waters of the OCS proximate to mobile adult fishes would likely be sublethal; potential effects would be reduced because adult fish have the ability to avoid adverse conditions, metabolize hydrocarbons, and excrete metabolites and parent compounds. However, dispersal and emulsification of spilled oil can increase bioavailability to fishes and invertebrates throughout the water column. Some filter feeders, such as Gulf menhaden, may have an increased risk of exposure due to the likelihood of ingesting high levels of dispersed oil. Increased contaminant exposure could result in a higher incidence of chronic sublethal impacts (Millemann et al., 2015). Similarly, adsorption of oil to suspended particulate matter and subsequent sedimentation increases the potential for chronic exposure of demersal fishes and benthic invertebrates to oil (Murawski et al., 2014; Baguley et al., 2015; Snyder et al., 2015). Long-term impacts to fish and invertebrate populations in the GOM have not been identified, but studies suggest short-term impacts, including increased metabolic costs, immunosuppression, and histological lesions (Carls et al., 1998; Brewton et al., 2013). As a result of these effects, fitness and productivity of affected individuals may be decreased.

Oil floating on the surface could directly contact ichthyoplankton found at or near the surface, coating eggs and larvae. Most ichthyoplankton would be unable to avoid spills and the affected individuals may be at risk of death, delayed development, abnormalities, endocrine disruption, or other effects, resulting in decreased fitness and reduced survival rates (Incardona et al., 2014; Mager et al., 2014; Brown-Peterson et al., 2015; Snyder et al., 2015). In general, early life stages are more sensitive to acute oil exposure than adults, but some research indicates that embryos, depending on the developmental stage, may be less sensitive to acute exposure than larval stages (Fucik et al., 1995). Spills reaching estuarine habitat or overlapping spatiotemporally with a spawning event have the greatest potential for affecting the early life stages of fishes and invertebrates.

Effects from an accidental event would be expected to be localized; accidental spills have historically been small and are low-probability events (**Tables 3-12 and 3-17**). Most fishes and invertebrates in the GOM are broadly distributed throughout one or more regions of the GOM and, typically, only a small portion of a population would be impacted (McEachran, 2009). Studies indicate that the impacts of previous accidental spills have not resulted in population-level effects (Fodrie and Heck, 2011; Moody et al., 2013; Rooker et al., 2013; Murawski et al., 2014; Fry and Anderson, 2014). However, long-term impacts could be masked by many factors (e.g., natural population variability, natural and anthropogenic disturbances, and compensatory processes) and may not be observed for several years (Fodrie et al., 2014). Therefore, the overall impact to fishes and invertebrate resources due to reasonably foreseeable accidental spills resulting from routine OCS oil- and gas-related activities is expected to be **negligible**.

Cumulative Impacts

The OCS oil- and gas-related activities resulting from a lease sale are assumed to occur over a period of 50 years. However, available information is insufficient to conduct an analysis of impact-producing factors potentially affecting fish and invertebrate resources over the same period. The unknown influence of changing environmental, biological, and anthropogenic factors over such an extended period could exceed that of analyzed impact-producing factors. Therefore, this section assumes an analysis of reasonably foreseeable cumulative impacts to encompass a period of approximately 20 years. This cumulative analysis considers the effects on fishes and invertebrate resources of the Gulf of Mexico as a result of the OCS Program, State oil and gas activity, recreational and commercial fishing (**Chapters 4.11 and 4.10**, respectively), and habitat availability. Potential degradation of specific habitats is analyzed in **Chapters 4.3** (Coastal Habitats), **4.4** (Deepwater Benthic Communities), **4.5** (*Sargassum* and Associated Communities), and **4.6** (Live Bottom Habitats). The direct and/or indirect impacts from cumulative OCS oil- and gas-related and non-OCS oil- and gas-related activities on essential fish habitat are considered and summarized in the *Essential Fish Habitat Assessment* white paper (USDOI, BOEM, 2016d).

OCS Oil- and Gas-Related Impacts

As discussed in the analysis of routine activities, OCS oil- and gas-related activities produce some level of anthropogenic sound, though signal characteristics vary widely. Geological and geophysical surveys, construction of new facilities, and decommissioning are episodic acoustic events and do not contribute to long-term changes in the soundscape. The OCS oil- and gas-related support vessel traffic, drilling, production facilities, and other sources of continuous sounds contribute to a chronic increase in background noise, with varying areas of effect that may be influenced by the sound level, frequencies, and environmental factors (Hildebrand, 2009; Slabbekoorn et al., 2010; McKenna et al., 2012). These sources have a low potential for causing physiological injury or injuring hearing in fishes and invertebrates (Popper et al., 2014). However, continuous sounds have an increased potential for masking biologically relevant sounds than do pulsed signals. The potential effects of masking on fishes and invertebrates are unknown, but evidence indicates that the increase to background noise as a result of the OCS Program would be relatively minor. Therefore, it is expected that the cumulative impact to fishes and invertebrate resources in the GOM would be **minor** and would not extend beyond localized disturbances or behavioral modification. The incremental impact of a single lease sale would be **negligible**.

Sediment suspended by bottom-disturbing activities settles rapidly to the seafloor. Impacts from individual events are temporary, highly localized, and expected to impact small numbers of organisms. In nearshore and estuarine waters, the effects of temporarily increased turbidity would be indistinguishable from background conditions. Bottom-disturbing activities in outer-shelf and oceanic waters may temporarily affect fishes and invertebrates in the water column or bury sessile benthic organisms near the disturbance. The cumulative contribution to adverse impacts on these resources would be **negligible** due to the transient nature of the disturbance and the limited area affected. The incremental impact of a single lease sale would be **negligible**.

Cumulative habitat modification as a result of OCS oil- and gas-related activities is spatially extensive and long term in nature. It has been hypothesized that the network of OCS oil- and gas-related infrastructure has resulted in changes in the distribution of some species (Shipp and Bortone, 2009; Gallaway et al., 2009). However, the total contribution of OCS oil- and gas-related infrastructure to hard substrate in the Gulf is small and is projected to decrease throughout the period covered by this analysis (Gallaway et al., 2009). Exceptions to the removal requirement may be permitted under specific circumstances; for more information, refer to **Chapter 3.1.6.2** (Rigs-to-Reefs Policy) and **Chapter 3.3.2.1.2** (Artificial Reefs). The cumulative impact of OCS oil- and gas-related habitat modification on fishes and invertebrate resources may be extensive for some species; therefore, cumulative impacts may range from **negligible** for most species to **moderate** for those species associated with OCS oil- and gas-related platforms (i.e., distribution and abundance may vary from historical values). The incremental impact of a single lease sale would be **minor**.

Non-OCS Oil- and Gas-Related Activities

Commercial shipping is the greatest anthropogenic source of low-frequency sound in the marine environment and, combined with many other sources (e.g., State oil- and gas-related activities, coastal construction, and recreational boating), contributes to increased background noise levels; Hildebrand, 2009; McKenna et al., 2012; Hawkins et al., 2014). As a result of increasing background noise, fishes and invertebrates may modify behaviors and biologically relevant sounds could be masked, but the effects are unknown. Marine organisms evolved in a noisy environment and available information suggests that at least some fishes and invertebrates may have the capacity to adapt to increasing noise levels (Wardle et al., 2001; Wysocki and Ladich, 2005; Purser and Radford, 2011; Radford et al., 2014). However, even organisms adapted to increasing background noise could incur consequences from remaining in an environment continuously exposed to sound energy from anthropogenic sources. Potential effects would vary among species and across a range of environmental factors but may include reduced hatching rates, delayed development, or decreased reproductive potential (Slabbekoorn et al., 2010; Hawkins et al., 2014). The overall contribution of non-OCS oil- and gas-related anthropogenic sound sources to increasing background noise levels in the marine environment is expected to **moderately** impact fishes and invertebrate resources because increased background noise levels affect broad areas and can be reasonably assumed to have limited population-level impacts, but they would not be expected to result in a long-term decline in population.

The NMFS is responsible for implementing fisheries regulations and managing commercial and recreational fisheries, with advice from the regional fisheries management councils. Commercial and recreational fishing have been a factor in the decline of several fish populations in the GOM (Shipp, 1999; USDOC, NMFS, 2015a; NRC, 2014). Although several stocks are rebuilding or have been rebuilt, certain fishing practices and overfishing can have long-term effects on target species and the ecosystem. For example, the structure of a rebuilt stock may differ from historic demographics, resulting in a less resilient population, or habitat could be altered such that species diversity and abundance are affected (Wells et al., 2008; NRC, 2014; Pusceddu et al., 2014; Secor et al., 2015). The cumulative impact of long-term, large-scale fisheries activity on fishes and invertebrate resources in the GOM is not known, but NMFS has determined that assessed fish stocks are predominantly healthy (USDOC, NMFS, 2015a). Thus, it is expected that impacts to fishes and invertebrate resources as a result of commercial and recreational fisheries would range from **negligible** for most nontargeted species to **moderate** for species that are overfished or experiencing overfishing (e.g., hogfish spp., gray triggerfish, and greater amber jack [*Seriola dumerili*]).

The conversion or modification of wetlands as a result of agricultural, residential, and commercial development in the GOM has been substantial (USEPA, 2012b; Greene et al., 2014). The trend for coastal development is projected to continue into the future, although at a slower rate because of regulatory pressures (refer to **Chapter 4.3**, Coastal Habitats, for detailed information on these habitats, potential impacts, and mitigations). The conversion of habitat from one form to another (e.g., wetlands to open water) would typically result in community-level changes in biodiversity and abundance compared with communities in unmodified habitat (Lowe and Peterson, 2014; USDOC, NMFS, 2010a). Although changes to habitat may benefit some species while adversely impacting others, it is generally accepted that the quality (i.e., the ecological services provided) of modified habitat is not equivalent to natural habitat (Peterson and Lowe, 2009; Scyphers et al., 2015). Therefore, the continued loss or modification of wetlands could ultimately result in decreased recruitment for some estuarine-dependent species, adversely impacting stocks within the region (Levin and Stunz, 2005; Jordan et al., 2012). The current lack of a meaningful baseline makes it extremely difficult to estimate cumulative impacts to fishes and invertebrate resources at a regional scale. However, coastal zone management efforts increasingly incorporate the responses of fishes and invertebrates into analyses of development activities (Peterson and Lowe, 2009; Greene et al., 2014). The Federal, State, and local agencies jointly responsible for managing estuarine habitats, permitting development, and mitigating impacts ensure that sustainable development practices are implemented. Therefore, the cumulative adverse impact of coastal development on fishes and invertebrate resources is expected to be **minor**.

Additional pressures potentially contributing to cumulative effects on fishes and invertebrate resources in the GOM include increasing invasive species populations and climate change. These factors are currently negligible but could have increasingly substantial impacts in the future. Invasive species, such as the lionfish, have the potential to out-compete and displace some indigenous species of ecological, commercial, and/or recreational importance (Morris and Akin, 2009; Dahl and Patterson, 2014; Raymond et al., 2014). Although severe weather events are part of the natural environment and are not considered in an analysis of impact-producing factors, changing conditions that alter the frequency and/or severity of weather events or that accelerate sea-level rise could impact fishes and invertebrate resources in an unforeseen manner. A review of climate change is presented in Chapter 4.2.1 of the Five-Year Program EIS (USDOI, BOEM, 2016b).

The cumulative effect of combined past, present, and reasonably foreseeable future OCS oil- and gas-related activities and non-OCS oil- and gas-related activities on fishes and invertebrate resources of the Gulf of Mexico is expected to vary spatiotemporally. The incremental contribution of OCS oil- and gas-related activities to the combined cumulative impacts is generally **minor** in comparison with all other human activities affecting the resources. Impacts to fish and invertebrate populations are expected to be in proportion to the fraction of a population exposed to an impact-producing factor. Therefore, OCS oil- and gas-related habitat modification is likely to have a greater impact than other oil- and gas-related impact-producing factors of a more limited scale and duration. However, impacts are not universally adverse and some habitat modification may benefit particular species or communities. Commercial and recreational fishing are expected to have the greatest direct impact on fishes and invertebrate resources. Although the NMFS manages fisheries, populations are affected by many biological and environmental factors. Fluctuations in populations of fisheries-affected species are expected. Increased background noise levels due to anthropogenic sources, such as commercial shipping, are also likely to affect deep waters of the GOM (Hildebrand, 2009). Although the effects are currently unknown, no impacts to fish and invertebrate populations in the GOM have been quantified. International efforts to develop and implement ship-quieting technologies may mitigate future increases in shipping capacity. As a result of these impact-producing factors, the overall cumulative impact on fishes and invertebrate resources may range from **negligible** to **moderate** for different species throughout the period analyzed.

Incomplete or Unavailable Information

BOEM identified incomplete or unavailable information related to impacts to fishes and invertebrate resources resulting from OCS oil- and gas-related activities and non-OCS oil- and gas-related activities in the GOM. Anthropogenic sound and habitat modification directly or indirectly affect large areas of the GOM and potentially impact thousands of species. However, the response of individuals, groups of conspecifics (members of the same species), and communities are highly variable and inconsistent. In addition, BOEM recognizes that there is incomplete information with respect to potential long-term effects resulting from exposure to spilled oil. Although additional information on these impact-producing factors may be relevant to the evaluation of impacts to fishes and invertebrate resources, BOEM has determined that the incomplete information is not essential to a reasoned choice among alternatives. Analyses of routine activities, accidental events, and cumulative impacts drew upon the most current and best available research to assess the potential effects on many species and habitats. The findings collectively indicate that impacts are likely, but limited, and are not expected to induce a population-level response. BOEM recognizes the potential that populations with spatially limited distributions or increased sensitivity to an impact-producing factor may be more severely impacted than current research suggests. However, sufficient data to conduct a thorough assessment of all potentially affected species are not available or obtainable within the timeline contemplated in the NEPA analysis of this Multisale EIS. BOEM used the best available science to determine the range of reasonably foreseeable impacts and applied accepted scientific methodologies to integrate existing information and extrapolate potential outcomes in completing this analysis and formulating the conclusions presented here.

4.7.2.1 Alternatives A, B, C, and D

With respect to fishes and invertebrate resources, the effects associated with selection of any of the proposed action alternatives would be equivalent because of the diversity and distribution of fish and invertebrate species throughout the potential area of interest. The preceding analyses assumed a nonrandom distribution of species and considered impacts to fishes and invertebrate resources occurring in a wide range of habitats across all planning areas. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), the distribution of fishes and invertebrate species is nonrandom and generally even throughout their range of habitat within the planning areas. As such, the potential for impacts to populations is independent of the planning area(s) analyzed. Differences in the specific populations potentially exposed to impact-producing factors and the potential impacts may be more easily estimated as specific sites and activities become known. Therefore, at a planning area scale, it is expected that a similar mix of species would be exposed to the analyzed impact-producing factors, regardless of the specific action alternative selected. The activities proposed under Alternatives A, B, C, and D would directly impact fishes and invertebrate resources within the GOM and would contribute incrementally to the cumulative effects on these resources. Routine activities, excluding infrastructure emplacement, would be expected to have short-term and/or localized effects. The installation of OCS oil- and gas-related infrastructure constitutes a long-term modification of the local habitat. Individually, these modifications have small-scale (e.g., community-level) effects on the distribution and abundance of species; cumulatively, OCS oil- and gas-related infrastructure is hypothesized to have moderately impacted the distribution of some fishes and invertebrates, exceeding natural variations. Although this effect is not necessarily adverse and infrastructure is expected to be decommissioned and sites restored to natural habitat, the cumulative impact over the life of the OCS Program is spatiotemporally extensive with species-specific effects. Accidental spills are considered low-probability events, but they have the potential to produce localized impacts on fishes and invertebrate resources if coinciding with a spawning event. Mobile adults are expected to avoid adverse conditions, limiting exposure to spilled oil. The cumulative, long-term effects of exposure to oil are unknown, but available information suggests that the effects have been minor. The cumulative effects of habitat loss and increasing background noise levels are unknown, but the OCS oil- and gas-related contribution is small, relative to non-OCS oil- and gas-related impact-producing factors. Therefore, the analysis of routine OCS oil- and gas-related activities, accidental events, and the cumulative impacts of OCS oil- and gas-related and non-OCS oil- and gas-related activities indicates the expected overall impact to fishes and invertebrate resources, depending upon the affected species, would range from **negligible** to **moderate** for the period analyzed. For example, muds and cuttings discharged at the surface for a well drilled at a water depth of 5,000 ft (1,524 m) would have a negligible impact on coastal species, such as menhaden, whereas a small spill in coastal waters and subsequent response activities could disrupt a spawning event or temporarily displace coastal fishes from the affected area (minor). Moderate impacts would only be expected if impact-producing factors affected habitat or populations to an extent that would be expected to exceed natural variations in population abundance or distribution but not result in a long-term decline.

4.7.2.2 Alternative E—No Action

Under Alternative E impacts on fishes and invertebrate resources within the Gulf of Mexico would be **none**. However, cumulative impacts would be unchanged from the conclusions reached for the other alternatives.

4.8 BIRDS

The analyses of the potential impacts of routine activities and accidental events associated with a GOM proposed action and a proposed action's incremental contribution to the cumulative impacts to coastal and migratory birds are presented in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define the impact levels for each impact-producing factor (**Table 4-11**). The impact-producing factors considered and analyzed include discharges and wastes, noise, platform severance with explosives, geophysical surveys with airguns, platform presence and lighting, emergency air emissions, platform or pipeline oil spills, spill response, oil- and gas-related activities in State waters, the hypoxic "dead zone" of the Mississippi River, net coastal wetland gain or loss, a large tanker spill, military activities, recreation, boat traffic, impacts on bird habitat, collisions with manmade structures, predation by domestic cats, commercial fishing, climate change, and wetland subsidence.

Impact-producing factors considered but not analyzed include obstruction lighting, which is under the jurisdiction of the USCG. Other impact-producing factors that were not analyzed because they do not apply to birds include geological ancillary activities, all onshore infrastructure emplacement and presence, offshore platform emplacement, other commissioning activities, and onshore waste disposal.

Seven species found in the area of interest are listed under the ESA, and BOEM has initiated formal consultation with the FWS for those species. Those species have life histories that are similar to those of the birds covered in this chapter, but the cumulative impact could be greater. BOEM recognizes this, consults on these species, and requires mitigations that would decrease the potential for greater impacts due to small population size. For more information on the listed bird species, refer to **Chapter 4.9.4** (Protected Birds).

Table 4-11. Birds Impact-Producing Factors.

Birds	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Discharges and Wastes	Negligible	Negligible	Negligible	Negligible	None
OCS Oil- and Gas-Related Noise and Disturbance	Negligible	Negligible	Negligible	Negligible	None
Platform Severance and Rigs-to-Reefs	Minor	Minor	Minor	Minor	None
Geophysical Surveys with Airguns	Minor	Minor	Minor	Minor	None
Platform Presence and Lighting	Minor	Minor	Minor	Minor	None
Accidental Impacts					
Oil Spills	Moderate	Moderate	Moderate	Moderate	None
Oil-Spill Response	Minor	Minor	Minor	Minor	None
Emergency Air Emissions	Minor	Minor	Minor	Minor	None
Cumulative Impacts					
OCS Oil- and Gas-Related	Moderate	Moderate	Moderate	Moderate	Moderate
Non-OCS Oil- and Gas-Related	Major	Major	Major	Major	Major

Impact-Level Definitions

In ecology, the size of a population is often defined by the number of individuals with similar genes (i.e., species, subspecies, and races). However, a population can also be somewhat more arbitrarily defined as individuals in a geographic area. That area is sometimes of arbitrary location or size. Birds species described in this chapter are considered to have large populations because they are not endangered or threatened and because each species, taken as a whole, is widely distributed and abundant. The impact-level definitions for birds are as follows:

- **Negligible** – Overall, there would be little to no impacts that are measured or measurable for a population. No mortality of a flock or large population would occur, and no overall disturbance-causing changes in behavioral patterns would be expected.
- **Minor** – One of the two following conditions are met: (1) flocks or large populations of birds would experience stimuli or impact-producing factors and would be disturbed or otherwise affected overall, resulting in acute behavioral changes; however, these impacts would be short-term and reversible; and (2) one or more incidents where one or more individuals experience injury or

mortality may occur, but with no measured or measurable impact on a large population.

- **Moderate** – A large population of birds would experience stimuli or impact-producing factors and overall would be chronically disturbed or affected, which could result in chronic behavioral changes. Impacts would affect substantial numbers of individuals but would not affect estimates of continued population viability, including predicted annual rates of recruitment or survival. Sublethal impacts would be irreversible at this impact level.
- **Major** – A large population of birds would experience stimuli or impact-producing factors that would result in a reduction in the estimates of continued viability of the population. Major impacts could include sufficiently high numbers such that the estimated continued viability of a large population is diminished, including predicted massive reductions in the annual rates of recruitment or survival. Major impacts could also include permanent disruption of behavioral patterns that would affect at least one whole species.

4.8.1 Description of the Affected Environment

This description of birds focuses on the factors that control the relative vulnerability of different bird groups to impacts. Passerines, or songbirds, represent many of the breeding and wintering birds within the Gulf Coast States. They are only found offshore when migrating across the Gulf of Mexico, and they cannot stop and rest or feed on the water. Some species of birds (some seabirds) live primarily offshore except when breeding and, therefore, are rarely observed in the nearshore environment. The remaining species are found within coastal and inshore habitats and may be more susceptible to potential deleterious effects resulting from OCS oil- and gas-related activities because many of these species largely overlap spatially and temporally with OCS oil- and gas-related activities because of their abundance or density, and because of the potential of oil impacting their habitat or food resources. A detailed analysis of the impacts to birds is presented in the chapters below.

Feeding Habits

A bird's feeding method is one of the important determinants of a bird's habitat choice. Bird species feed either in the water (aquatic feeders) or terrestrially. Aquatic bird species that feed by wading include some shorebirds and other waders such as herons. Some species wade in relatively shallow water to feed and others feed on beaches and have relatively short legs; other species feed in relatively deeper water as well as relatively shallow water and have relatively longer legs. Shorebirds are adapted to take advantage of tidally-influenced habitat. Their diurnal movements and habitat use appears to be closely linked to tidal advances and recessions, i.e., lunar, solar, or wind-driven tides. Shorebirds and other wading species feed on invertebrates and fish. Aquatic bird species, including some ducks, may feed by dabbling at the water surface. Many aquatic bird species, including some ducks and many seabirds, feed by diving into the water from the air or water surface for either plant or animal food. Some seabirds aggregate at patches of floating macroalgae *Sargassum* to feed or rest, at least in tropical waters (Haney, 1986).

Oil from reasonably foreseeable spills is not expected to be very commonly encountered by birds. Still, birds are a relatively vulnerable resource because feeding habits may result in encounters between birds and OCS oil- and gas-related activity. For example, waders feed in shallow water, which is important because oil from previous spills that happened to reach the sediment may accumulate in the sediment, where birds may encounter it. Diving birds can encounter an oil slick either if they begin their dive in the air and pass across the water surface or if they begin their dive floating on the water surface. Birds may feed and roost in the water or at or near the water's edge, where they may be impacted by oil spill. Marsh birds feed in or at the water's edge of marshes, where oil may accumulate in the sediment. Also, platforms may represent profitable foraging areas for seabirds, raptors, and potentially passerines (Wiese et al., 2001; Russell, 2005).

Habitat

The open Gulf (including blue water [off the continental shelf], shelf, and inshore open water) is used by terrestrial birds (including passerines), shorebirds, long-legged wading birds, and raptors for trans-Gulf migration (Russell, 2005). This habitat is used by seabirds for feeding and roosting, and some seabirds never come ashore in the Gulf of Mexico. Wetlands (consisting of trees, shrubs, marshes, and/or unvegetated flats) (refer to **Chapter 4.3**, Coastal Habitats) are used by waterfowl, shorebirds, long-legged wading birds, secretive marsh birds (e.g., rails), raptors, and terrestrial birds (including passerines) for feeding, roosting, and/or nesting (Portnoy, 1978 and 1981; Hunter et al., 2006; Brown et al., 2001; and North American Waterfowl Management Plan, 2004). Beaches and dunes are used by seabirds and shorebirds for feeding, roosting, and/or nesting (Portnoy, 1978 and 1981; Hunter et al., 2006). Coastal forests are used by trans-Gulf migrant terrestrial birds for feeding, roosting, and/or nesting. Several species breed along the coastline of the Gulf of Mexico (where spilled oil may travel and persist) and, therefore, may be especially vulnerable to the impacts of an oil spill. Previous surveys indicate that Louisiana, Texas, and Florida are among the primary states in the southern and southeastern U.S. for both nesting colonies and the total number of breeding coastal and marine birds (Portnoy, 1978 and 1981; Hunter et al., 2006). All avian species show varying levels of fidelity to both breeding and wintering areas.

Population Ecology

The level of any impact to different species of birds depends on its population ecology, including the age or life stages and sex that are impacted. For example, relevant population ecology information for seabirds includes delayed maturity, low reproductive potential, periodic nonbreeding, low first-year survival, and small clutch size. These factors can make them the most vulnerable to impacts. Relevant population ecology is not always available to explain oiling mortality from an oil spill because the sex and life stage of recovered oiled birds is not always known or recorded. For example, for the *Deepwater Horizon* explosion, oil spill, and response, only the species information was available, not the age, life stage, or sex of oiled birds. The location, magnitude, and other conditions of an impact-producing factor that may seem to have relatively low contact with and relatively reduced mortality for one species may in fact cause other bird species increased mortality and long-term impacts. Populations appear to be most sensitive to changes (even small decreases) in adult survival, particularly female survival because adult female survival appears to be the driver for these populations (Russell, 1999).

Migration

Some birds that utilize the GOM are year-round resident species. These species may be exposed to impacts during any time of the year. However, most of the bird species that utilize the GOM are migratory. They may breed, overwinter, or stop over in the GOM while migrating on the northern Gulf Coast. For example, some birds may breed on the coast and depart during the winter months. However, some birds breed in the northern United States or the Caribbean and overwinter offshore the GOM and never come ashore. All avian species show varying levels of fidelity to both breeding and wintering areas. Birds may be present only during one or two of the following seasons: breeding and/or overwintering and/or migrating. Therefore, seasonal timing of an impact helps determine which species would be affected.

Each spring, vast numbers of birds migrate northward across the GOM enroute to breeding habitats in the United States and Canada from their wintering quarters in the neotropics. They depart in large numbers from the Yucatan Peninsula and the Isthmus of Tehuantepec (Russell, 2005). The path they take depends on supporting tail wind direction, which depends, in turn, on the presence of an East Continental High Pressure synaptic weather pattern over the continental United States or a Bermuda High Pressure synaptic weather pattern over the Atlantic Ocean around Bermuda (Russell, 2005). The East Continental Highs move east and become Bermuda Highs. During an East Continental High, the birds may migrate especially from the east-southeast to the northwest Gulf of Mexico (**Figure 4-20**). During a Bermuda High, the birds may migrate especially from the south-southeast to the northcentral Gulf of Mexico (**Figure 4-21**). They are mostly seed eaters and insectivores and, therefore, may stop over and feed on available insects but mostly not on aquatic organisms. Following a short breeding season in the north, most of these birds return southward across the GOM; their numbers are then augmented by offspring produced over the summer (Russell, 2005). An example of a fall migration route that could initiate in the north central Gulf of Mexico and terminate on the eastern Bay of Campeche, the Yucatan Peninsula, western Cuba, and northern Honduras is shown in **Figure 4-20**. Migrating songbirds may stop over on offshore platforms. Platform density with respect to migratory routes is shown in **Figure 4-22**, and its high spatial variability at a large scale suggests that the probability of a bird encountering one or more platforms is also highly variable of routes at a large scale. Migratory birds may also stop over on boats, other vessels, and coastal terrestrial habitat when crossing the GOM in the spring or fall. Three of the four migratory flyways in the United States depend on the GOM as part of their route. Executive Order 13186 protects migratory birds and emphasizes species of conservation concern. It requires analyses of birds in NEPA documents and a Memorandum of Understanding between the action agency (BOEM and BSEE) and the FWS. Also, all migratory birds are protected under the

Migratory Bird Treaty Act. The Act provides limits on when migratory birds can be taken, killed, possessed, transported, or imported.

For some bird species, both spring and fall migrations take place in a series of stops among various staging areas. At these staging areas, birds spend time primarily feeding to recover reserves necessary for the sustained flight to the next staging area (Norris, 2005; Krapu et al., 2006; Skagen, 2006). Many coastal habitats along the GOM are critical for such purposes.

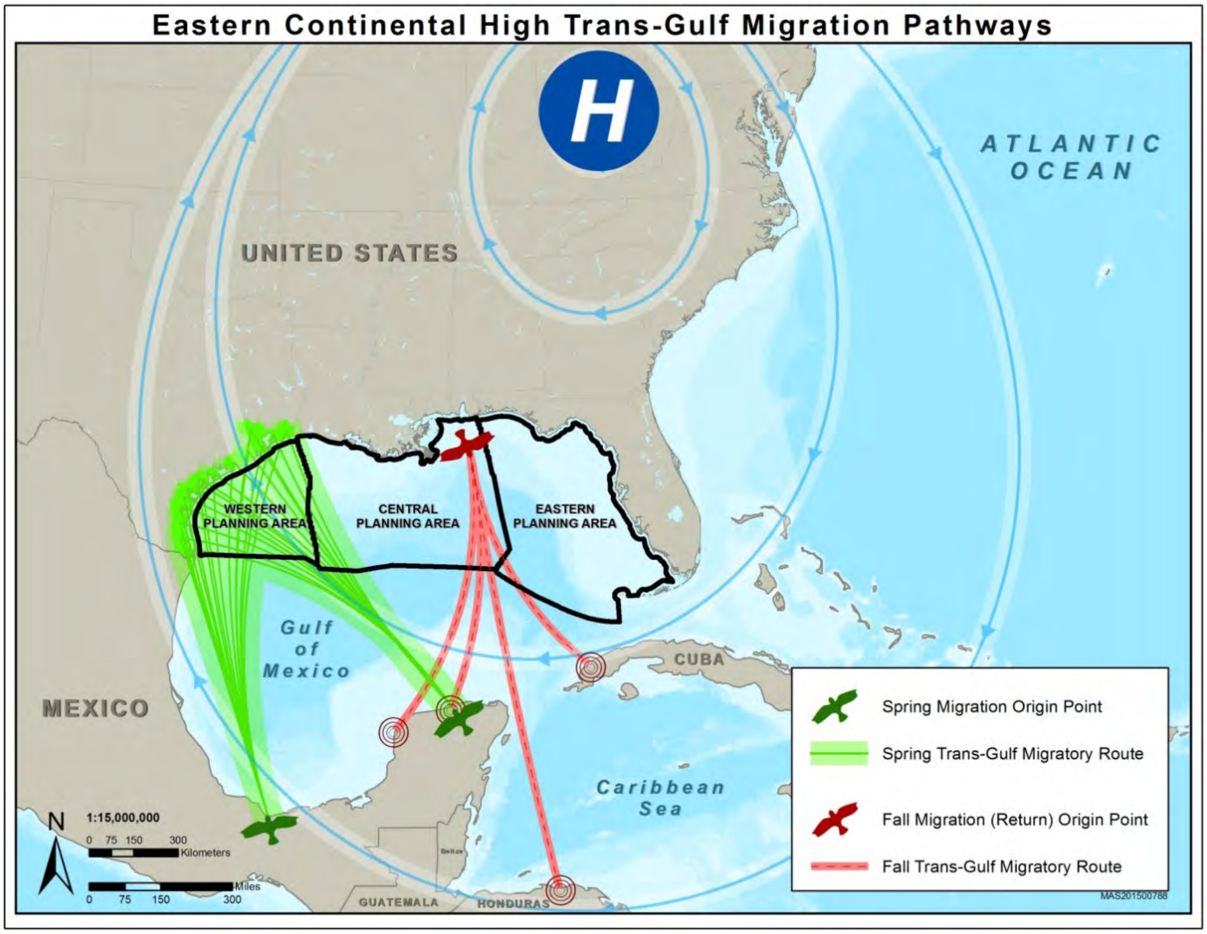

Figure 4-20. Migration Routes for Trans-Gulf Migratory Birds in the Presence of an Eastern Continental High. (The Eastern Continental High is indicated by the letter "H," and the corresponding clockwise somewhat concentric synaptic wind patterns are indicated by lines and arrows.)

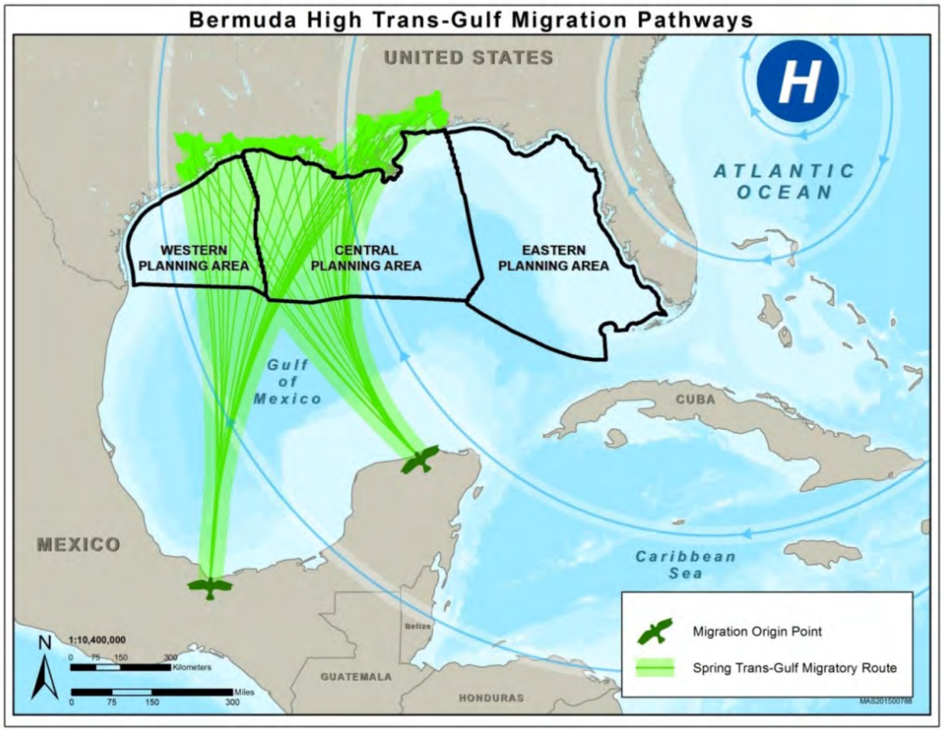

Figure 4-21. Migration Routes for Trans-Gulf Migratory Birds in the Presence of a Bermuda High. (The Bermuda High is indicated by the letter "H," and clockwise somewhat concentric synaptic wind patterns are indicated by lines and arrows.)

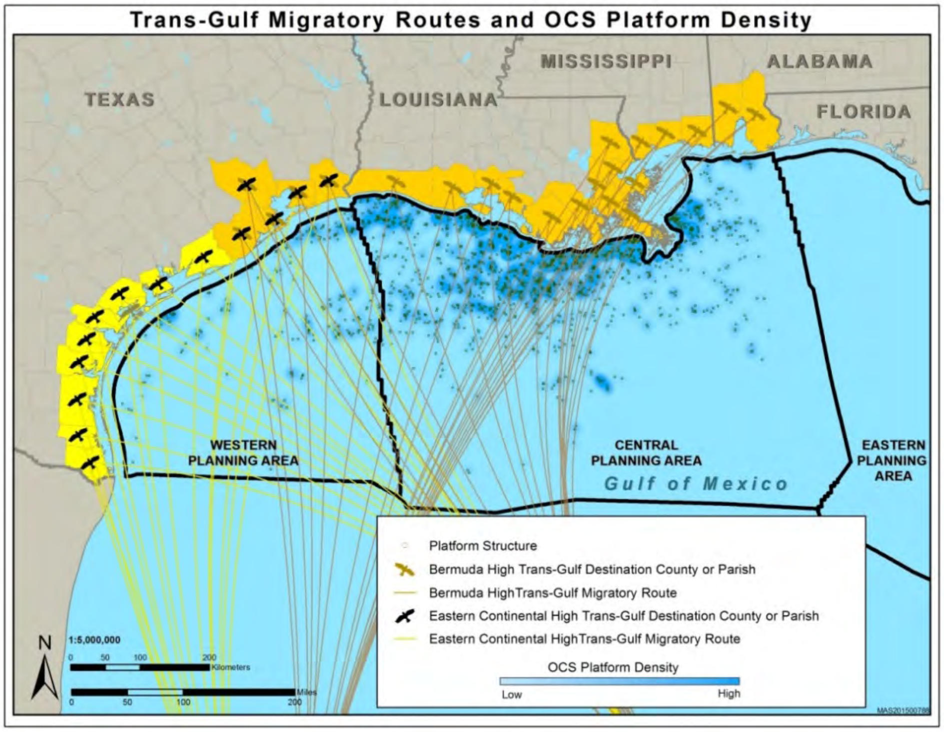

Figure 4-22. Platform Density and Spring Migration Routes for Trans-Gulf Migratory Birds.

Baseline Populations

Baseline populations of birds have been affected by recent events, including hurricanes and the *Deepwater Horizon* explosion, oil spill, and response. However, no species or subspecies of birds that has been listed as federally endangered or threatened, of conservation concern to the U.S. Fish and Wildlife Service, State listed, or of State conservation concern has been reported in sharp decline or otherwise harmed by either recent hurricanes or the *Deepwater Horizon* explosion, oil spill, and response. Most populations are not listed of conservation concern and, therefore, the populations are probably, but not absolutely, low or in sharp decline. No hurricanes have made baseline changes since the 2012-2017 WPA/CPA Multisale EIS, which was published in 2012 (USDOI, BOEM, 2012b). There is new information on baseline changes resulting from the *Deepwater Horizon* explosion, oil spill, and response.

Hurricane-related flooding can drown nests, and associated winds can kill birds due to impact with objects like trees. In addition, hurricane impacts to coastal ecosystems can have deleterious effects to foraging and nesting birds that utilize those habitats. However, no surveys of mortality from such impacts related to Hurricane Katrina and other storms were located.

Mortality from the *Deepwater Horizon* explosion, oil spill, and response was sufficient to cause a small negative shift in baseline abundances for seabirds. Total seabird mortality seaward of 25 mi (40 km) from shore due to the *Deepwater Horizon* explosion, oil spill, and response was estimated at 200,000 birds (Haney et al., 2014a). Estimates of breeding population sizes were 60,000-15,000,000 for four procellariiform (shearwaters and related) species, 9,000 for one pelecaniform (pelican and related) species, and 96,000-500,000 for three charadriiform (gulls and related) species (Haney et al., 2014a). Total bird mortality landward of 25 mi (40 km) from shore was estimated as 600,000 birds using one model and 800,000 birds using another (Haney et al., 2014b). In perspective, in three analyzed species of seabirds, estimated losses due to the *Deepwater Horizon* explosion, oil spill, and response were 12 percent or more of the total population estimated present in the northern GOM (Haney et al., 2014b). This new information estimates a small negative shift in baseline numbers. No recovery data have become available since the analyses by Haney et al. (2014a and 2014b). Incremental impacts caused by the negative shift in baseline numbers were not sufficient to change the conclusions for the impact analysis of a proposed action. The shift was extrapolated from the increased mortality due to the *Deepwater Horizon* explosion, oil spill, and response. However, these changes to the baseline did not identify any species whose population was likely to be impacted by a proposed action or alternatives. Mortality can indicate substantial impacts from an oil spill even when sharp declines or other impacts on population size have not been measured. No reports of the impact of hurricane levels or the impact of the *Deepwater Horizon* explosion, oil spill, and response on the rates of population decline or any other impacts on population size were located.

4.8.2 Environmental Consequences

This chapter provides detailed information regarding the impact-producing factors from the routine activities, accidental events, and cumulative impacts described in **Chapter 3** and their potential effects on birds that would potentially be impacted by a proposed action or the alternatives. This analysis would apply to all alternatives considered; however, the level of impacts would be different for each alternative, as discussed below in **Chapters 4.8.2.1-5**.

Routine Activities

Impacts from routine activities to coastal, marine, and migratory birds include impacts from routine discharges and wastes, noise, platform severance with explosives (barotrauma), geophysical surveys with airguns, platform presence and lighting, construction of OCS-related onshore facilities, and pipeline landfalls.

Discharges and wastes (**Chapter 3.1.5**) include produced waters, drilling muds and cuttings, and routine air emissions. Routine discharges and wastes affecting air and water quality (**Chapter 4.1**, Air Quality, and **Chapter 4.2**, Water Quality) are under the jurisdiction of the USEPA or BOEM, and regulation assures that impacts are negligible. For air quality, mandated timetables and other requirements necessary for attaining and maintaining healthful air quality in the U.S. are imposed based on the seriousness of the regional air quality problem detected by monitoring. BOEM is characterizing OCS oil- and gas-related operational discharges and wastes as having a **negligible** impact on birds because of regulations on air emissions and also because effluents into water are regulated under the NPDES with discharge limits that are risk-based and supported by toxicity testing.

The OCS oil- and gas-related helicopters and vessels have the potential to cause noise and disturbance. However, flight altitude restrictions over sensitive habitat, including that of birds, may make serious disturbance unlikely. Birds are also known to habituate to noises, including airport noise. The OCS oil- and gas-related vessel traffic would follow regular routes so seabirds would find the noise to be familiar. Therefore, the impact of OCS oil- and gas-related noise from helicopters and vessels to birds would be expected to be **negligible**.

Platform severance and Rigs-to-Reefs are discussed in *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf: Programmatic Environmental Assessment* (USDOI, MMS, 2005). Refer to **Chapter 3.1.6** for more information on platform removal. Platform severance with explosives may potentially kill one or more birds from barotrauma if a bird (or several birds because birds may occur in a flock) is present at the location of the severance. For the impact of underwater sound, a threshold of 202 dB sound exposure level (SEL) for injury and 208 dB SEL for barotrauma was recommended for the *Brahyramphus marmoratus*, a diving seabird (USDOI, FWS, 2011). Platform relocation in the Rigs-to-Reefs program would potentially provide foraging habitat for birds, which would be a positive impact. The overall impact of severance and rigs-to-reefs would be **minor**.

Geological and geophysical (G&G) surveys are discussed in the *Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas; Final Programmatic Environmental Impact Statement* (USDOI, BOEM, 2014a). Refer to **Chapter 3.1.2.1** for more information on G&G information in the GOM. Geological and geophysical surveys with airguns may kill one bird (or a small number of individuals occurring in a flock) from barotrauma in one or more incident. This impact would be **minor**.

Potential impacts of platform lighting can be dependent on spectra, intensity, and weather conditions (refer to **Chapter 3.1.3.4.3** for more information on platform lighting). Obstruction lighting is considered under cumulative impacts because it is under the jurisdiction of the USCG and not likely subject to change. Birds may have the following behaviors in any combination, any order, any frequency, and any duration at platforms: resting; feeding; collision with platforms; and nocturnal circulation (Russell, 2005). Seabirds are attracted to structures and may benefit from underwater reef organisms associated with the structure. Nocturnal circulation happens to some birds stopping at platforms. At night, birds circulate around the lit platforms, sometimes for extended periods. Nocturnal circulation may be brief with little impact or may be long term and burn up energy reserves (Russell, 2005). Song birds become restless to migrate at dusk and lose migratory restlessness when they stop to feed. Therefore, if they stop and feed, they may not continue on until dusk happens again. If they just stop and do not feed, they may continue on soon after stopping. The number of times a bird stops at platforms is unknown. Birds would likely stop over on platforms with lights with spectral red or with high intensity during overcast, rainy, or foggy conditions at night (Marquenie et al., 2013). Also, they might stop over if they encounter head winds that slow their trans-Gulf migration past dawn. The cause-and-effect processes of possible impacts from lights to migratory birds and migration are being investigated; however, no determinations have been made. This is because the bird optical magnetic compass, which may be key to birds' response to lights, has been very difficult to study; its properties are mostly conjecture at this time (Wiltschko and Wiltschko, 2014; Ramirez et al., 2014) and have been investigated by wildlife biologists teamed with quantum chemists. Birds suffering from exhaustion would typically be sick or weak and their mortality would be a case of natural selection where the populations would be strengthened (i.e., made more fit). The potential range of a bird adapted to fatten up enough to cross extensive barriers like the open ocean or GOM is approximated by data on shorebirds, which may be an accurate proxy for the maximum possible flight range of forest songbirds that may traverse the GOM. The computed maximum non-stop range of a bar-tailed godwit leaving Alaska (based on a model of fuel load) was to the South Pole (Pennycuick and Battley, 2003). Small populations of birds may be affected, which may affect species richness (community structure). That may, in turn, affect bird watching and bird hunting as economically valuable activities. Injury or mortality at the small population level for a long term (10+ years) with almost full recovery means that impacts to trans-Gulf migrants would be minor. **Minor** impacts would result partly because estimated annual mortality from collisions due to structure presence has been estimated at 200,000-321,000 birds of the up to 316 million birds that migrate (Russell, 2005). Impacts on trans-Gulf migrants from platform presence and lighting need further study of both positive and negative effects to be precisely assessed. The OCS oil- and gas-related construction of onshore facilities would require obtaining permits for any projects that could harm wetlands or any other habitats protected by conservation laws and regulations. For example, construction in a wetland area would require a COE permit under Section 404 of the Clean Water Act; this would include mitigations and monitoring of the activities. Further reinforcement of wetland protection is expected because of the long-standing goal of no net wetland loss. As a result, **negligible** impacts from OCS oil- and gas-related construction of onshore facilities and the resulting habitat loss to birds are expected.

Impacts from a pipeline landfall could disturb shoreline or wetland habitat that is utilized by birds. The resulting habitat loss to birds from installation method of directional drilling is expected to result in a **negligible** impact.

Accidental Events

Impacts for accidental events to birds are caused by oil spills, spill cleanup, and emergency air emissions. Impacts of hydrocarbons from oil spills depend on the hydrocarbons' ultimate destination, i.e., in the air (from evaporation), in the water, or in the sediment. Birds may be affected by hydrocarbons through means of inhalation. They may also be affected by hydrocarbons through means of ingestion when eating oiled benthic, planktonic, or pelagic prey; preening oiled plumage; or drinking hydrocarbons in water. Prey may be killed by oiling. Oiled plumage causes loss of insulation and buoyancy. While some birds can be rehabilitated after contamination by oil or dispersants, others may sustain injuries or die. Oil and dispersants can affect birds at the small population level. Birds that feed aquatically are vulnerable to oil, and migrants or residents that occur in the GOM when oil from a spill is present are also vulnerable. These circumstances are discussed in detail in **Chapter 4.8.1**. Impacts on long-lived seabirds can last longer because generation time is longer and can have delayed impacts (e.g., a delay on first-breeders would have a delayed reduction in recruitment), which would go unnoticed until years after exposure; therefore, detection would not occur without long-term studies. In addition, oiling may sometimes be more severe in shallow water, wetlands, and shorelines where avian diversity and abundance, as well as hydrocarbon accumulation and persistence, may be high. Refer to **Chapter 4.3** (Coastal Habitats) for a discussion of the fate of oil in wetlands. Sometimes, because of lack of adequate personnel training or the sheer scale of activity, shoreline cleanup (**Chapter 3.2.7**) may disturb nesting birds and have a **minor** impact. Disturbance to GOM nonnesting shorebirds from the *Deepwater Horizon* oil-spill cleanup may have affected bird conditions later on the northern breeding grounds (Henkel et al., 2014). An oil-spill sublethally affecting birds that migrate may have carry-over impacts to one or migratory destinations, including the ecosystems at those destinations.

Long-term impacts are possible to seabirds (with long generation time) that delay first breeding (and hence impacts on first breeders would have a delayed reduction in recruitment) (Dunnet et al., 1982). Long-term impacts also occur when local population extirpation occurs, resulting in loss of species richness (community structure) until a colony or other small population can recover from extirpation. Refer to **Chapter 4.12** (Recreational Resources) for a discussion of the socioeconomics of wildlife tourism. Finally, long-term impacts occur when oil persists (sometimes for years) in sediment and may contact seafloor organisms or be resuspended and contact organisms in the water column. Resuspended oil may then be transported to other areas and settle out where it could be encountered by birds. The impact level from oil spills would depend on the combined result of the effects on habitat (sediment oiling in shallow water) and abundance (effect on small populations) of affected birds, as well as long-term persistence of oil in some habitats. A minor offshore spill (<1,000 bbl) could disappear even before a crew could arrive and clean it up; therefore, impacts would be **negligible**. A minor inshore spill (e.g., <1,000 bbl spilled during vessel refueling) could be completely cleaned up right away; therefore, impacts would be **negligible**. Impacts of a large spill (≥1,000 bbl) associated with a proposed action under Alternative A, B, C, or D would be expected to be **moderate** because a large population of birds would be chronically disturbed or affected, because of the size and persistence of the oil spill.

Combined probabilities of occurrence and contact of an oil spill with shoreline bird species and nearshore bird species can be found in **Figures E-2 through E-7 and Figure E-20**, respectively. Seabirds may take longer to recover from the impacts of an oil spill than other bird groups because of their unique population ecology (demography), regardless of the intensity of the initial impacts on a population.

Emergency air emissions may cause various toxic effects to a bird or flock of birds exposed to the discharge. An example would be a hydrogen sulfide leak from a pipe. A single incident of toxic effects could affect nothing more than a flock; therefore, impacts from emergency air emissions would be **minor**.

Cumulative Impacts

OCS Oil- and Gas-Related Impacts

Routine OCS oil- and gas-related impacts that could add to the cumulative impacts to coastal and marine birds are effects to air and water quality, noise, platform severance with explosives (barotrauma), geophysical surveys with airguns (barotrauma), platform presence and lighting, and construction. They are discussed in detail in the “Routine Activities” section above. Accidental events are oil spills, cleanup, and emergency air emissions, which are discussed in the “Accidental Events” section above. Cumulative OCS oil- and gas-related impacts are presented briefly here.

Impacts from routine air and water discharges are discussed in **Chapters 4.1** (Air Quality) **and 4.2** (Water Quality). As a result of these discharges, impacts on birds would be expected to be **negligible**. Drilling discharges, produced waters, and the discarding of marine trash and debris would have **negligible** impacts on birds. Impacts of aircraft and vessel noise would be expected to be **negligible**. Impacts of severance with explosives during platform decommissioning and of geophysical surveys with airguns would have **minor** impacts. Structure presence would possibly result in collision of birds with a structure, nocturnal circulation, or an opportunity to rest and/or feed. It may have a net beneficial or a net negative impact on birds (Ramirez et al., 2014; Marquenie et al., 2013). Structure presence is discussed in the “Incomplete or Unavailable Information” section below. Impacts of coastal OCS oil- and gas-related facility construction would be expected to be **negligible**. A large oil spill (≥1,000 bbl) could **moderately** impact coastal and marine birds, and oil-spill response and emergency air emissions could have **minor** impacts on them; refer to the “Accidental Events” section above for more details. Modeling shows that, without a thorough understanding of a species’ habitat use and preferences, a species’ ability to locate and colonize alternative habitat, and the population structure, it is difficult to make inferences regarding the ability of individual birds or groups to successfully emigrate and colonize novel, undisturbed habitat (assuming it is available) (Fahrig, 1997, 1998, and 2001). BOEM used scientific reasoning about habitat in lieu of empirical studies to help understand the impacts of oil spills on colonial nesting birds. Habitat may be occupied at or below carrying capacity, or it may not be occupied at all, so it may have various amounts of room for immigrant birds (and various sources of mortality or depression of realized reproductive rate) when immigrants are escaping disturbance or an oil spill. For habitat that is occupied, any single patch or group of patches of habitat may change periodically in the resource or resources (which could include the amount of the habitat itself) that are limiting to its occupants. The impact of an area of major degradation of habitat quality (with no change in total habitat area) can be more or less important than the impact of complete loss of a large area of habitat. For purposes of this discussion, habitat availability is defined as presence of unoccupied habitat. The following statement applies only if birds are able to move into habitat that is occupied below carrying capacity. Habitat does not become limiting until it is filled up (completely occupied), so habitat availability is not itself limiting. Filled habitat (habitat limitation) can be ideal for birds if that is the pervasive condition of a bird population. Filled habitat only becomes a problem when no extra space is available for immigrants trying to escape a major event such as an oil spill or when the amount of filled habitat is so small that a bird is listed as threatened, endangered, or of conservation concern. Unoccupied habitat for colonial nesting birds is likely pervasive because periodic surveys of bird colonies in the northern Gulf of Mexico show regular formation of completely new bird colonies. Therefore, impacts of an oil spill on colonial nesting birds are expected to be **negligible**. Impacts from pipeline landfalls are expected to be **negligible**.

Non-OCS Oil- and Gas-Related Impacts

All OCS oil- and gas-related impact-producing factors and their impact levels also hold for State oil- and gas-related activities. The **moderate** impacts from State oil and gas activities include a large oil spill (≥1,000 bbl). Impact levels for collision of trans-Gulf migrants with platforms, and possibly nocturnal circulation of trans-Gulf migrants, need further study. Impacts are expected to be **minor**. A large tanker spill (≥1,000 bbl) would have the same impact (**moderate**) as a similar sized OCS oil- and gas-related spill or State oil- and gas-related spill discussed above. Impacts to birds would be expected to be **moderate**.

A source of cumulative impacts is obstruction lighting on platforms in State waters or on the OCS; obstruction lighting is under the jurisdiction of the USCG and is not likely to be changed by mitigations to protect birds. The impact level of obstruction lighting would need further study.

In addition to the OCS oil- and gas-related discharges discussed above, other regulated discharges include the discharge of bilge or ballast water from ships, runoff to waters, and industrial discharges into the coastal atmosphere, all of which are regulated by the USEPA. Also, agricultural nutrient (fertilizer) and pesticide runoff occurs. For more information and impact levels for runoff, other discharges into waters, and discharges into the atmosphere, refer to **Chapter 4.1** (Air Quality) and **Chapter 4.2** (Water Quality). Pollutants are expected to be diluted to a level below that which is harmful to birds or otherwise safely disposed of, and effects are not expected at a population level.

Discard of trash and debris from non-OCS oil- and gas-related sources (e.g., from State oil- and gas-related activities, recreational fishing boats, and land-based sources; refer to **Chapter 3.3.2.3.7**) is prohibited; however, despite regulation, unknown quantities of plastics and other materials are discarded and lost in the marine environment and remain a threat to individual birds. Many species readily consume plastic debris, either intentionally or incidental to consuming prey, and can become trapped or entangled in discarded fishing line or nets. Although the short-term prognosis suggests that plastic impacts are increasing significantly, analyses also suggest that reductions in exposure would result in reduced ingestion (Wilcox et al., 2015). Seabirds are sometimes caught in commercial fishermen's gear. Seabird bycatch numbers in the GOM (Hale et al., 2009) indicated that the pelagic and bottom longline fisheries had **negligible** impacts on seabirds. Discarded bycatch of fishes and invertebrates would benefit seabirds. Impacts to birds from trash and debris as a whole are expected to be **moderate** in the short term but **negligible** with forecasted reductions in exposure (Wilcox et al., 2015).

The Mississippi River watershed contributes nutrients causing a seasonal population explosion of phytoplankton, which decomposes to create a hypoxic or anoxic "dead zone" over the continental shelf (**Chapter 3.3.2.12**). Aquatic food for coastal waterbirds could be decimated in places in the hypoxic zone. However, the zone has been occurring since prehistoric times, and only its magnitude has recently changed (by application of agricultural fertilizer). No massive phytoplankton blooms have been reported to produce massive mortality to seabirds and other waterbirds in the zone. It is possible that birds are able to move from impacted areas with no food to patches of sufficient food; doing so would make the effects short term. All birds likely need to search for food sometimes. Impacts on a whole population are expected to be **minor**.

Historical wetland loss due to Mississippi River hydromodification (**Chapter 3.3.2.10**) would be at least somewhat ameliorated by wetland creation form Atchafalaya River sediments and coastal restoration and hurricane protection programs. Also Louisiana's Master Plan, which was partly designed for maximizing coastal wetlands, would likely increase habitat for four selected waterbird species and for neotropical birds over the next 50 years (refer to **Chapter 4.3**, Coastal Habitats). These predictions are based on Habitat Suitability Index models and were controlled for other, non-habitat environmental variables (Nyman et al., 2013). Therefore, wetland loss would probably not be an issue that would exacerbate other impacts of a proposed action and other cumulative impacts for coastal and marine birds. For these reasons, impacts on whole populations are expected to be **negligible**.

Military activities, including training overflights and sonic booms, would occur in special areas offshore in seabird habitat. Military operations in the Gulf of Mexico are undertaken primarily by the U.S. Air Force and the U.S. Navy within federally designated areas for the purposes of training personnel, as well as research, design, testing, and evaluation activities. There are 18 U.S. military bases along the northern Gulf of Mexico. The greatest impacts would come from sonic booms, which would likely cause an acute behavioral change such as flushing of a flock resting on the water or cessation of feeding by a flock. No individual or group of individuals would be injured or killed. Impacts would be expected to be **negligible**.

Nonconsumptive recreation includes bird-watching activities, all-terrain vehicle use, walking and jogging with pets, other beach use, and recreational boating. For economic impacts, refer to **Chapter 4.12** (Recreational Resources). In most cases, recreational boats are subject to strict speed and wake restrictions. Disturbances of an area could be regular but impacts would be benign and direct (limited to the time period of disturbance); therefore, they would be **minor**.

Consumptive recreation (hunting game birds) is carefully controlled by hunting regulations. Usually, total mortality of hunted species does not increase because of hunting—it remains the same because the overall carrying capacity of a species does not change with hunting. However, some species of game birds have experienced hunting-related mortality impacts at the population level, a **major** impact that would be mitigated to a net **negligible** impact by adjustments in hunting regulations.

Use of navigable waters by boats may cause erosion of banks by vessel wake, possibly causing wetland habitat loss. However, boat wakes are regulated by controlling vessel speed, so impacts on wetlands would be minimal. Because wetland habitat loss would be **negligible**, the potential impacts on birds would be **negligible** also.

There are a myriad of anthropogenic avian mortality sources, including collisions and predation by domestic cats. No GOM regional estimates are available for annual mortality rates for these sources. However, recent quantitative national estimates allow for a qualitative extrapolation to the GOM. An estimated range of national annual mortality from collision with vehicles is 62-275 million birds per year (Loss et al., 2014a). An estimate of national annual mortality from collision with buildings is 599 million birds per year (Loss et al., 2014b). Finally, an estimate of annual mortality from predation by free-ranging domestic cats is 1.4-3.7 billion birds per year (Loss et al., 2013). The mortality estimates are nationwide and not just for the northern GOM, where impacts would be much less. Impacts of collisions with vehicles and buildings and predation by domestic cats are expected to be **moderate** (chronic but not causing steady declines in whole large populations).

Emerging infectious diseases include West Nile virus. LaDeau et al. (2007) stated that "Emerging infectious diseases present a formidable challenge to the conservation of native species in the twenty-first century." The population responses of bird species to the virus was complex (LaDeau et al., 2007). Of 20 selected avian species across North America that were potential hosts to the West Nile virus, 7 species (35%) exhibited negative changes at the population level that were attributed to the virus, and only 2 of the 7 recovered to pre-West Nile virus levels by 2005 based on 26 years of data (LaDeau et al., 2007). These continental estimates were meant to be qualitatively extrapolated to other species and can also be qualitatively extrapolated to the smaller area of the northern Gulf of Mexico (like the collision mortality estimates above). Impacts of the West Nile virus are at the population level and are expected to be **major**.

Impacts of climate change (from global warming; refer to the Five-Year Program EIS, USDOI, BOEM, 2016b) and ocean acidification could eventually be expected to decline because the gas emissions are controlled by law. If not curtailed, climate change could result in a decline in biodiversity that is vital to the ecosystems that support all bird life (McDaniel and Borton, 2002). Sea-level rise, along with natural wetland subsidence, can cause a landward retreat of the shoreline and coastal wetlands as discussed in **Chapter 4.3** (Coastal Habitats). A recent comprehensive meta-analysis was completed on the impacts of ocean acidification on sea taxa (Kroeker et al., 2013). Some of the taxa are related to important prey for birds or are related to organisms that support ecosystems important to those birds. Of taxa related to organisms important to birds, some features of some of them are expected to be impacted negatively by ocean acidification, some positively impacted, and some not affected at all (Kroeker et al., 2013). Forecasted impact levels of climate change and ocean acidification from burning the hydrocarbons produced by a proposed action or other sources of greenhouse gases cannot be determined at this time. Overall impacts of anthropogenic climate change, combined with ocean acidification on the bird resource in the northern GOM and contiguous land area due to a reduction in biodiversity of supporting ecosystems, are expected to be as great as **major**; however, there is still need for research in this area of science.

Cumulative incremental impacts to birds, when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, and the minimization of OCS oil- and gas-related impacts through lease stipulations and regulations, would be expected to be **negligible** as a result of a proposed action. This is because birds are wide-ranging, and population-level impacts are not anticipated. However, cumulative impacts could have a **major** impact on a particular bird species with a low population level, dependent upon the level of impact and the number of individuals affected by it (e.g., if an impact to a federally listed red knot or piping plover were to result in substantial mortality, it would diminish the continued viability of the population, including the annual rates of recruitment or survival).

Incomplete or Unavailable Information

BOEM has identified incomplete or unavailable information related to impacts on birds resulting from OCS oil- and gas-related activities and non-OCS oil- and gas-related activities in the GOM. BOEM's subject-matter experts have used the available scientifically credible evidence presented below and applied accepted scientific methodologies to integrate existing information and extrapolate potential outcomes in completing this analysis and formulating the conclusions presented here.

Analyses of routine activities, accidental events, and cumulative impacts drew upon the most current and best available research to assess the potential impacts on birds, including available information from the NRDA process as a result of the *Deepwater Horizon* explosion, oil spill, and response. This incomplete information may be relevant to the evaluation of adverse effects because it could identify changes in the baseline environmental conditions for bird populations from the *Deepwater Horizon* oil spill and response, exacerbating any impacts from a proposed action. Much of these data are being developed through the NRDA process, which may take years to complete. At present, the best available information does not provide a complete understanding of the effects of the spilled oil or the recovery potential for the most impacted species. However, any additional (NRDA) information obtained from the *Deepwater Horizon* oil spill and response is unlikely to be so significant as to change the relative importance of OCS oil- and gas-related and non-OCS oil- and gas-related impacts to bird populations. Also, even after it is released, the impacts of the oil spill may be difficult or impossible to discern from other factors. It is not possible for BOEM to obtain all of this information and incorporate it into this analysis within the timeline contemplated by the NEPA analysis of this Multisale EIS regardless of the costs or resources needed. Although additional information may be relevant to the evaluation of impacts to birds, BOEM has determined that the incomplete information is not essential to a reasoned choice among alternatives because existing information could be used instead, and because that information is already conservative, new information is unlikely to show an increase in impacts.

Impacts to habitat could also be due to urbanization, or they could be rural. Habitat (e.g., wetland) loss, alteration, and fragmentation associated with building, factory, and road construction is kept from harming sensitive bird habitat by standard mitigating measures required by the COE and State wetland permitting regulations. A major policy goal (not yet fully reached) is “no net loss” of wetlands. Therefore, impacts to birds would be expected to be **negligible**.

Because information on the impact of artificial light along the coast on birds has not been studied, BOEM used available information to fill the data gap. Existing information (Longcore and Rich, 2004) shows that outdoor lights at night can have both lethal impacts from collisions and sublethal impacts from a variety of mechanisms on birds. The impact level of obstruction lighting located on platforms would also need further study. The best available information was obtained from a study done by observers on platforms, from a model of energy reserves of migratory birds, and from several studies of the effect of light on birds. This scientific information presented in the “Routine Activities” section and under State oil and gas activities in the “Cumulative Impacts” section was used to conclude that platform lighting, in general, has **minor** impacts.

4.8.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

This chapter summarizes the potential impacts of routine activities, accidental events, and cumulative impacts associated with Alternative A on birds. Under Alternative A, BOEM would hold a regionwide lease sale comprised of the WPA, CPA, and a portion of the EPA.

Birds overlap with the proposed action area throughout their various life history stages. Different species have different feeding behaviors for different habitats. Many migrate seasonally and seabirds sometimes come to shore only to breed.

For impacts from routine activities, the effects from discharges and wastes, air and water quality, and noise would be **negligible** to coastal and migratory birds. Impacts of barotrauma from seismic airguns and platform severance with explosives would be **minor**. Impacts on trans-Gulf migrants from platform presence and lighting are tentatively **minor** but need further study of both positive and negative effects to be precisely assessed.

An accidental event that may be associated with a proposed action and that has the largest impact on coastal and migratory birds is a large oil spill (≥1,000 bbl). Seabirds (compared with other bird groups) may not always experience the greatest impacts from a spill but may take longer to recover because of their unique population ecology (demography).

State oil- and gas-related activities would have the same impact-producing factors and expected impact levels as OCS oil- and gas-related activities. Discarding trash and debris would be a negligible impact. The hypoxic "dead zone" of the Mississippi River would have a minor impact. Net impacts of historic wetland loss and coastal wetland creation would be negligible. A large tanker spill (≥1,000 bbl) would have **moderate** impacts. Military activities would have minor impacts. Nonconsumptive recreation would have minor impacts. Consumptive recreation with any hunting regulation mitigation would have **negligible** impacts. Boat traffic would have a negligible impact on wetland bird habitat. Impacts of collisions with vehicles and buildings as well as predation by domestic cats would be **moderate**. Impacts of the West Nile virus and future emerging infectious diseases are at the population level. Partly because of this, the impacts, including the incremental contribution of a proposed lease sale, are expected to be **major**. Impacts of commercial fishing are expected to be positive for discarded fish and invertebrate bycatch and **negligible** for seabird bycatch. Impacts of climate change and ocean acidification cannot be determined at this time. Finally, impacts of wetland subsidence are expected to be **moderate**. The overall impacts from a proposed action on coastal and migratory birds are moderate. The incremental cumulative impacts of a proposed action to OCS oil- and gas-related anthropogenic events are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). However, the combined probabilities of a large oil spill for occurrence and contact with shoreline birds and nearshore waterbirds are small. The incremental cumulative impacts of a proposed action to non-OCS oil- and gas-related anthropogenic events and natural processes are considered **major**, but only because of the impact of non-native infectious diseases.

While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), offshore pelagic seabird habitat is distributed throughout the planning areas. Therefore, activities isolated to specific planning areas pose similar potential impacts to offshore pelagic seabird populations as do activities occurring in all planning areas. Therefore, because of the diversity and distribution of offshore pelagic seabird species in the Area of Interest, the level of impacts would be the same for Alternatives A, B, C, and D. From a bird perspective, since Alternative A is regionwide, which includes the WPA, CPA, and EPA portions of the proposed lease sale area, it would have more of all of the types of OCS oil- and gas-related activities; therefore, it would have more potential for impacts. Impacts from the other alternatives would follow in a graded fashion. For platforms, the number of spills between 1,000 and 10,000 bbl has been estimated to be <1 for Alternatives A, B, and C (i.e., spill); also for platforms, the number of spills ≥10,000 bbl has also been estimated to be <1 for Alternatives A, B, and C. For pipelines, the number of spills between 1,000 and 9,999 bbl has been estimated to be <1 to 1 for Alternative A; also for pipelines, the number of spills ≥10,000 bbl has been estimated to be <1 for Alternative A.

4.8.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Under Alternative B, BOEM would hold a lease sale excluding the WPA available lease sale blocks and offer all available blocks in the CPA and a portion of the EPA. The impacts to birds from Alternative B are similar to those from Alternative A since a majority of the activity is projected to occur in the CPA, as described in **Chapter 3.1**, and since overall routine and accidental impacts are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). The combined probabilities for occurrence and contact with shoreline birds and nearshore waterbirds are small. The incremental cumulative impacts of Alternative B to OCS oil- and gas-related impacts are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). Trans-Gulf migrant birds stopping over on platforms and drilling vessels mostly follow a fall southward migratory route that, under East Continental High synoptic wind conditions, crosses mostly outside the western Gulf (refer to **Figure 4-20**). Migrant birds stop over on GOM offshore structures in fall, collide with the structures, and exhibit nocturnal circulation just like in the spring (Russell, 2005), even though they are just beginning their nonstop flight in the fall. During Bermuda High wind conditions, birds mostly do not migrate in the fall (Russell, 2005). Drilling vessels and new platforms under Alternative B would be entirely outside the western Gulf; therefore, both positive and negative impacts from offshore structures on trans-Gulf migrants migrating during an East Continental High would be less than under Alternative C. Juvenile trans-Gulf southward fall migration often differs from adult migration in that it often hugs the Texas coast. It is possible that juveniles lack the reserves for nonstop overwater flight. In any case, they would possibly stop over on platforms on the OCS near the Texas coast, and the leasing area under Alternative C (i.e., the WPA) is off the Texas coast. The leasing area for Alternative B is the CPA/EPA. Therefore, both positive and negative impacts on juveniles would occur under Alternative C but not under Alternative B. The incremental cumulative impacts of Alternative B to non-OCS oil-and gas-related anthropogenic events and natural processes are considered **major**, but only because of the anthropogenic impact of non-native infectious diseases. The significance of impact-producing factors on birds would be the same for Alternative B as for Alternative A. The degree of impacts as a result of Alternative B would be somewhat less than Alternative A since a majority of the routine activities and impact-producing factors from a proposed lease sale would occur in the CPA/EPA, as projected in the scenario in **Chapter 3.1.1**. For platforms, the number of spills between 1,000 and 9,999 bbl has been estimated to be <1 for Alternative B; also for platforms, the number of spills ≥10,000 bbl has also been estimated to be <1 for Alternative B. For pipelines, the number of spills between 1,000 and 9,999 bbl has been estimated to be <1 for Alternative B.

4.8.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Under Alternative C, BOEM would hold a lease sale excluding the CPA/EPA available lease blocks and offer all available blocks in the WPA. The impacts to birds from OCS oil-and gas-related activities are similar in the WPA or wherever they may occur in the GOM, and overall routine and accidental impacts from Alternative C are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). Trans-Gulf migrant birds stopping over on platforms and drilling vessels mostly follow a spring northward migratory route that, under East Continental High synoptic wind conditions, crosses mostly the western Gulf (refer to **Figure 4-20**). Drilling vessels and new platforms under Alternative C would be entirely in the WPA; therefore, both positive and negative impacts from offshore structures on trans-Gulf migrants migrating during an Eastern Continental High would be greater than under Alternative C than under Alternative B. However, under Bermuda High synoptic wind conditions, migration would no longer be mostly just across the western Gulf (refer to **Figure 4-21**); therefore, the favorable reduced impacts to trans-Gulf migrants extant under Alternative C under East Continental High conditions in spring would not occur. Juvenile trans-Gulf southward fall migration often differs from adult migration in that it often hugs the Texas coast. It is possible that juveniles lack the reserves for nonstop overwater flight. In any case, they would possibly stop over on platforms on the OCS near the Texas coast, and the leasing area under Alternative C (i.e., the WPA) is off the Texas coast. The leasing area for Alternative B is the CPA/EPA; therefore, both positive and negative impacts on juveniles would occur under Alternative C but not under Alternative B. For platforms, the number of spills between 1,000 and 9,999 bbl has been estimated to be <1 for Alternatives C; also for platforms, the number of spills ≥10,000 bbl has also been estimated to be <1 for Alternative C.

Alternative C would have the same potential for impact as Alternative A or B since the level of projected OCS oil- and gas-related activities and impact-producing factors are less in the WPA but are still substantial. For example, a range of 11-67 production wells are projected to be drilled and developed under Alternative C, whereas 58-464 production wells are projected to occur under Alternative B. The incremental cumulative impacts of Alternative C to OCS oil- and gas-related anthropogenic events are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). However, the incremental cumulative impacts of Alternative C to OCS oil- and gas-related anthropogenic events are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). The significance of impact-producing factors on birds would be somewhat the same for Alternative C as for Alternative A. Alternative C would have a somewhat less impact than Alternatives A and B since the geographical planning area is smaller and less activity is projected to occur in the WPA under the scenario in **Chapter 3.1.1**.

4.8.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Under Alternative D, the impacts to birds are similar wherever they may occur in the GOM, and overall routine and accidental impacts are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). The incremental cumulative impacts of Alternative D to OCS oil- and gas-related anthropogenic events are considered **moderate**, but only because of the impacts of a large oil spill (≥1,000 bbl). Also, the incremental impacts of Alternative D on other non-OCS oil-and gas-related anthropogenic events and natural processes are considered **major**, but only because of the anthropogenic impact of non-native infectious diseases. The significance of impact-producing factors on birds could be somewhat less for Alternative D than for Alternative A, B, or C since a few blocks and associated activities would be removed from the proposed lease sale area. However, since there are so few unleased blocks subject to the Topographic Features, Live Bottom, and Blocks South of Baldwin County, Alabama, Stipulations, this would be a small incremental change compared with the other action alternatives. The impacts under Alternative D would not be much different and likely not even measurable when compared with the other action alternatives.

4.8.2.5 Alternative E—No Action

Alternative E would result in no impacts from a proposed lease sale; there would only be impacts associated with the continuing impacts from past lease sales, at least in the short term. Alternative E would offer no new lease blocks for exploration and development; therefore, no impacts from a proposed lease sale would occur. Existing oil and gas activities from previously permitted activities, previous lease sales, and associated impacts would continue.

4.9 PROTECTED SPECIES

The Endangered Species Act of 1973 (ESA), as amended, establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. In fulfilling these requirements, each agency must use the best scientific and commercial data available. The FWS and NMFS share responsibility for implementing the ESA.

The Marine Mammal Protection Act of 1972 (MMPA) prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas and the importation of marine mammals and marine mammal products into the U.S. The NMFS and FWS are also responsible for the MMPA.

For the GOM, the NMFS is charged with protecting all cetaceans while manatees are under the jurisdiction of the FWS. Details on BOEM's consultations and coordination are presented in **Chapter 5.7** (Endangered Species Act).

Protected species for the purposes of this Multisale EIS include ESA- and MMPA-listed species and associated designated critical habitat under the ESA. The species considered in this chapter, pursuant to our consultations and coordination, and within **Table 4-12** are those that could be affected within the GOM Area of Interest and that are subject to the proposed activities under the alternatives. For those species not considered further because they are unlikely to be affected by the proposed activities, refer to **Appendix F**. Critical habitats noted within the GOM Area of Interest are shown in **Figure 4-23** and are mentioned in this chapter, but comprehensive details on many of these habitats can be found in **Chapters 4.3** (Coastal Habitats), **4.5** (*Sargassum* and Associated Communities), and **4.6** (Live Bottom Habitats).

Table 4-12. Species within the Gulf of Mexico That Are Protected Under the Endangered Species Act and/or the Marine Mammal Protection Act.

Common Name	Scientific Name	Common Name	Scientific Name
Marine Mammals		Sea Turtles	
Atlantic spotted dolphin*	*Stenella frontalis**	Green sea turtle[2]	*Chelonia mydas*[2]
Blainville's beaked whale*	*Mesoplodon densirostris**	Hawksbill sea turtle[3]	*Eretmochelys imbricata*[3]
Bottlenose dolphin*	*Tursiops truncatus**	Kemp's ridley sea turtle[3]	*Lepidochelys kempii*[3]
Bryde's whale*	*Balaenoptera edeni**	Northwest Atlantic Ocean loggerhead sea turtle[4]	*Caretta caretta*[4]
Clymene dolphin*	*Stenella clymene**	Leatherback sea turtle (Atlantic Northwest)[3]	*Dermochelys coriacea*[3]
Cuvier's beaked whale*	*Ziphius cavirostris**	Beach Mice	
Dwarf sperm whale*	*Kogia sima**	Alabama beach mouse[3]	*Peromyscus polionotus ammobates*[3]
False killer whale*	*Pseudorca crassidens**	Choctawhatchee beach mouse[3]	*Peromyscus polionotus allophrys*[3]
Fraser's dolphin*	*Lagenodelphis hosei**	Perdido Key beach mouse[3]	*Peromyscus polionotus trissyllepsis*[3]
Gervais' beaked whale*	*Mesoplodon europaeus**	St. Andrew beach mouse[3]	*Peromyscus polionotus peninsularis*[3]
Killer whale*	*Orcinus orca**	Birds	
Melon-headed whale*	*Peponocephala electra**	Cape Sable seaside sparrow[3]	*Ammodramus maritimus mirabilis*[3]
Pantropical spotted dolphin*	*Stenella attenuate**	Mississippi sandhill crane[3]	*Grus canadensis pulla*[3]
Pygmy killer whale*	*Feresa attenuata**	Piping plover[4]	*Charadrius melodus*[4]
Pygmy sperm whale*	*Kogia breviceps**	Red knot[4]	*Calidris canutus rufa*[4]
Risso's dolphin*	*Grampus griseus**	Roseate tern[4]	*Sterna dougallii dougallii*[4]
Rough-toothed dolphin*	*Steno bredanensis**	Whooping crane[3]	*Grus americana*[3]
Short-finned pilot whale*	*Globicephala macrorhynchus**	Wood stork[4]	*Mycteria americana*[4]
Sperm whale[1]	*Physeter macrocephalus*[1]	Corals	
Spinner dolphin*	*Stenella longirostris**	Elkhorn coral[4]	*Acropora palmata*[4]
Striped dolphin*	*Stenella coeruleoalba**	Staghorn coral[4]	*Acropora cervicornis*[4]
West Indian manatee[1]	*Trichechus manatus*[1]	Boulder star coral[4]	*Orbicella franksi*[4]
		Lobed star coral[4]	*Orbicella annularis*[4]
		Mountainous star coral[4]	*Orbicella faveolata*[4]

* This species is protected under the Marine Mammal Protection Act (MMPA).
[1] This species is listed under the Endangered Species Act (ESA) as “endangered” and is also protected under the MMPA.
[2] This species is listed under the ESA as “threatened,” except for breeding populations of Florida which are “endangered.”
[3] This species is listed under the ESA as “endangered.”
[4] This species is listed under the ESA as “threatened.”

Impact-Level Definitions

As the routine activities, accidental events, and cumulative impacts are considered for specific listed species, each is given criteria per level of impact represented below.

Negligible – An individual or group of animals would be subject to nominal to nominal to slight measurable impacts. No mortality or injury to any individual would occur, and no disruption of behavioral patterns would be expected. The disturbance would last only as long as the human-caused stimulus was perceptible to the individual or group.

Minor – An individual or group of animals would be subject to a human-caused stimulus and be disturbed, resulting in an acute behavioral change. No mortality or injury to an individual or group would occur.

Moderate – An individual or group of animals would be subject to a human-caused stimulus and be disturbed, resulting in a chronic behavioral change. Individuals may be impacted but at levels that do not affect the fitness of the population. Some impacts to individual animals may be irreversible.

Major – An individual or group of animals would be subject to a human-caused stimulus, resulting in physical injury or mortality, and would include sufficient numbers that the continued viability of the population is diminished, including annual rates of recruitment or survival. Impacts would also include permanent disruption of behavioral patterns that would affect a species or stock.

The analyses of the potential impacts of routine activities and accidental events associated with a GOM proposed action and a proposed action’s incremental contribution to the cumulative impacts are presented in detail within the chapters below. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define impact-level measures for each impact-producing factor for protected species, as summarized in **Table 4-13**. These impacts are across all action alternatives (A, B, C, and D) except for beach mice and protected corals. Beach mice are not found in the WPA; therefore, they are not relevant for Alternative B, and the ranges given for potential impacts to protected corals are based on whether or not stipulations are placed on leases.

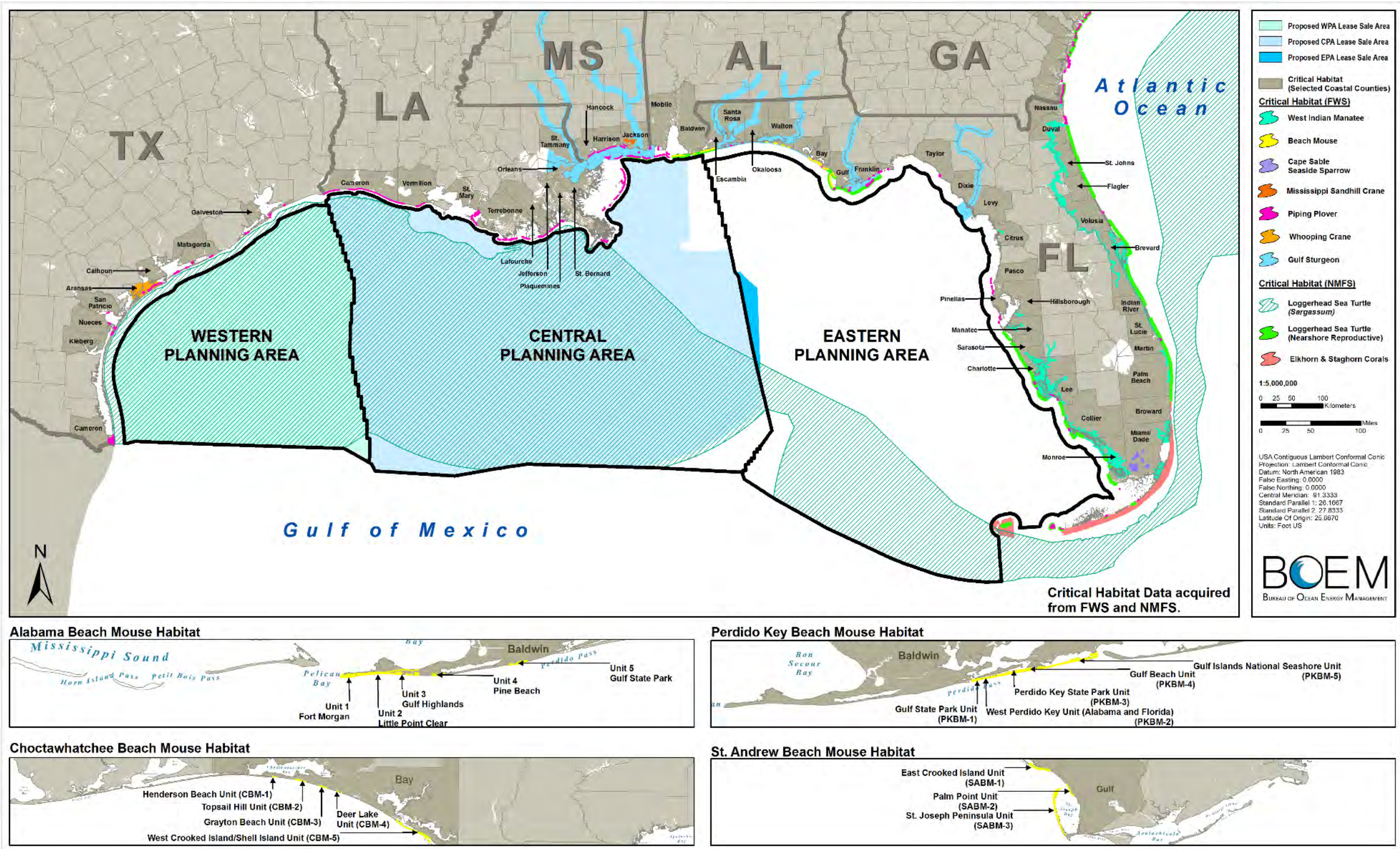

Figure 4-23. Gulf of Mexico Protected Species' Critical Habitats.

Table 4-13. Protected Species Impact-Producing Factors.

Protected Species	Magnitude of Potential Impact				
Impact-Producing Factors	Marine Mammals	Sea Turtles	Beach Mice[1]	Protected Birds	Protected Corals[2]
Routine Impacts					
Geological and Geophysical Activities	Negligible to Moderate	Negligible to Moderate	N/A	N/A	N/A
Transportation (vessel strikes)	Negligible to Major	Negligible to Moderate	N/A	N/A	N/A
Discharges (air and water quality degradation)	Negligible	Negligible	N/A	Negligible	Moderate
Marine Trash and Debris	Negligible to Major	Moderate	Negligible	Negligible to Moderate	N/A
Decommissioning (explosive severance)	Negligible to Moderate	Negligible to Moderate	N/A	Minor	N/A
Noise	Negligible to Minor	Negligible	N/A	Negligible	N/A
Drilling and Exploration (bottom-disturbing activities)	N/A	N/A	N/A	N/A	Negligible to Minor
Offshore Lighting/Platform Presence	N/A	N/A	N/A	Negligible to Moderate	N/A
Vessel Operation (bottom-disturbing activities)	N/A	N/A	N/A	N/A	Negligible to Minor
Accidental Impacts					
Oil Spills	Negligible to Major	Negligible to Moderate	Negligible	Negligible to Moderate	Negligible to Moderate
Oil-Spill Response Activities	Negligible to Moderate	Negligible to Moderate	Negligible	Negligible to Moderate	Negligible to Moderate
Cumulative Impacts					
All OCS Activities	Negligible to Major	Negligible to Moderate	Negligible	Negligible to Moderate	Negligible to Minor
All Non-OCS Activities	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Moderate

[1] Beach mice are not found in the WPA; therefore, they are not likely to be impacted by Alternative B.

[2] Ranges for the potential impacts to protected corals are based on whether or not protected stipulations are placed on leases.

N/A represents those impact-producing factors that are not applicable to that protected species group.

For protected coral impact-producing factors, refer to **Table 4-8** in **Chapter 4.6.1** (Topographic Features) since coral impact-producing factors are covered in detail there and would apply to protected corals as well. For protected birds impact-producing factors, refer to **Table 4-12** in **Chapter 4.8** (Birds) since the impact-producing factors that impact coastal, marine, and migratory birds (the listed birds are either found in coastal areas or are migratory and utilize coastal areas as part of their life history) are covered in detail there. For beach mice, the most relevant impact-producing factors are those causing harm to the populations by affecting their habitat (beaches). **Table 4-5** in **Chapter 4.3.2** (Coastal Barrier Beaches and Associated Dunes) covers the impact-producing factors that affect beaches and dunes, and details about those impacts to beach mouse habitat can be found there. The specific impact-producing factors that are covered in **Table 4-13** above and that would affect the biology of beach mice are marine debris (negligible), oil spills (negligible), and cumulative (negligible). For more details on the biological effects to beach mice, refer to **Chapter 4.9.3** (Beach Mice).

4.9.1 Marine Mammals

The Gulf of Mexico marine mammal community is diverse and distributed throughout the GOM, including northern U.S. waters. The GOM's Cetacea include the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales), and the order Sirenia, which includes the West Indian manatee. Most marine mammal distributions vary widely across the northern GOM with very little known about their respective breeding and calving grounds, as well as any potential migratory routes. While all marine mammals are protected under the MMPA, two species (i.e., the sperm whale and West Indian manatee) are listed as endangered under the ESA due to various factors, which are described in this chapter. The analyses of the potential impacts of routine activities and accidental events associated with a proposed lease sale and a proposed lease sale's incremental contribution to the cumulative impacts to marine mammals are presented in this chapter. Potential impact-level criteria are defined in **Chapter 4.9** (Protected Species) and apply to marine mammal species described in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define impact-level measures for each impact-producing factor in relation to the best available population estimates (refer to **Table 4-13** in **Chapter 4.9**). Some impact-producing factors may have different potential impact levels to different marine mammal species due to their various population sizes, as well as their wide-ranging behavior; thus, some potential impact-producing factors are described in a range.

4.9.1.1 Description of the Affected Environment

Twenty-one species of cetaceans and one species of sirenian (West Indian manatee) regularly occur in the GOM and are identified in the NMFS's Gulf of Mexico Stock Assessment Reports (Jefferson et al., 1992; Davis et al., 2000; Waring et al., 2014). Along with stock estimates, the NMFS also calculates the Potential Biological Removal (PBR), which is defined under the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (USDOC, NMFS, 2007b). The PBR level is the product of the minimum population estimate of the stock, one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size, and a recovery factor of between 0.1 and 1.0 (USDOC, NMFS, 2007b). The PBR plays an important role in marine mammal management due to the fact that the same potential impact-producing factor may have a more serious impact on a marine mammal stock that has a lower PBR and a less serious impact to a marine mammal stock with a higher PBR.

There are species that have been reported from GOM waters either by sighting or stranding that, due to their rarity, are not considered in this Multisale EIS (Wursig et al., 2000; Mullin and Fulling, 2004). These species include the following: the blue whale (*Balaenoptera musculus*), North Atlantic right whale (*Eubalaena glacialis*), and Sowerby's beaked whale (*Mesoplodon bidens*), all of which are considered extralimital in the Gulf of Mexico; and the humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and minke whale (*Balaenoptera acutorostrata*), all of which are considered rare occasional migrants in the Gulf of Mexico (Wursig et al., 2000; Mullin and Fulling, 2004). Because these species are uncommon in the GOM and because they are not included in the most recent NMFS Gulf of Mexico Stock Assessment Reports, BOEM did not consider them for this analysis as they are unlikely to be impacted by OCS oil- and gas-related activities. Population estimates for marine mammals in the GOM are represented in **Table 4-14**. The most recent abundance estimates available for all cetacean species mentioned in this Multisale EIS can be found on NMFS's website (USDOC, NMFS, 2015b), and estimates for manatees can be found on the Florida Fish and Wildlife Conservation Commission's website (State of Florida, Fish and Wildlife Conservation Commission, 2015).

Table 4-14. Best Available Population Estimates for Marine Mammal Species in the Northern Gulf of Mexico.

Species	Population Estimate	PBR*
Bryde's Whale (*Balaenoptera brydes*)	33	0.1
Sperm Whale (*Physeter macrocephalus*)	763	1.1
Pygmy Sperm Whale (*Kogia breviceps*)	186[a]	0.9
Dwarf Sperm Whale (*Kogia sima*)	186[a]	0.9
Gervais' Beaked Whale (*Mesoplodon europaeus*)	149[b]	0.8
Blainville's Beaked Whale (*Mesoplodon densirostris*)	149[b]	0.8
Cuvier's Beaked Whale (*Ziphius cavirostris*)	74	0.4
Bottlenose Dolphin (*Tursiops truncatus*)		
Oceanic waters	5,806	42
Northern Coastal Stock	7,185	60
Eastern Coastal Stock	12,388	111
Western Coastal Stock	20,161	175
Continental Shelf Stock	51,192	469
Bay, Sound, and Estuary (27 stocks)	Unknown for all but 4 stocks	Undetermined for all but 4 stocks
Barataria Bay Estuarine System	Unknown	Undetermined
Mississippi Sound, Lake Borgne, and Bay Boudreau	901	5.6

Species	Population Estimate	PBR*
Clymene Dolphin (*Stenella clymene*)	129	0.6
Pantropical Spotted Dolphin (*Stenella attenuata*)	50,880	407
Atlantic Spotted Dolphin (*Stenella frontalis*)	Unknown	Undetermined
Risso's Dolphin (*Grampus griseus*)	2,442	16
Rough-toothed Dolphin (*Steno bredanensis*)	624	3
Spinner Dolphin (*Stenella longirostris*)	11,441	62
Striped Dolphin (*Stenella coeruleoalba*)	1,849	10
False Killer Whale (*Pseudorca crassidens*)	Unknown	Undetermined
Fraser's Dolphin (*Lagenodelphis hosei*)	Unknown	Undetermined
Killer Whale (*Orcinus orca*)	28	0.1
Melon-headed Whale (*Peponocephala electra*)	2,235	13
Pygmy Killer Whale (*Feresa attenuata*)	152	0.8
Short-finned Pilot Whale (*Globicephala macrorhynchus*)[c]	2,415	15
West Indian Manatee	6,063	Undetermined

[a] This estimate includes both the dwarf and pygmy sperm whales.
[b] This estimate includes Gervais' beaked whales and Blainville's beaked whales in the GOM.
[c] This estimate includes all *Globicephala* sp., though it is presumed that only short-finned pilot whales are present in the Gulf of Mexico.
* Potential Biological Removal (PBR) estimates from Waring et al., 2014.
Sources: State of Florida, Fish and Wildlife Conservation Commission, 2015.
Waring et al., 2014.

Threatened or Endangered Species

The sperm whale (*Physeter macrocephalus*) and the West Indian manatee (*Trichechus manatus*) are the only ESA-listed marine mammals that regularly occur in the GOM. The sperm whale is common in oceanic waters of the northern GOM and appears to be a resident species (Mullin et al., 1991; Davis and Fargion, 1996; Jefferson and Schiro, 1997). The West Indian manatee is commonly found along the coast of Florida in the winter and may migrate as far as Texas in the warmer seasons, typically inhabiting only shallow coastal marine, brackish, and freshwater areas. The FWS provided notice of the petition on January 8, 2016, to reclassify the West Indian manatee from endangered to threatened (*Federal Register*, 2016b). If this petition becomes a final rule and the West Indian manatee meets the requirements to be reclassified as threatened, it would still have protection under the ESA because it would still be an ESA-listed species.

Cetaceans—Odontocetes

The sperm whale was listed as endangered in 1970 (*Federal Register*, 1970). It is found worldwide in deep waters between approximately 60°N. and 60°S. latitude (Whitehead, 2002), although generally only large males venture to the extreme northern and southern portions of their range (Jefferson et al., 1993). Females and juveniles form pods that are found mainly at tropical and temperate latitudes (between 50°N. and 50°S. latitude), while the solitary adult males can be found at higher latitudes (between 75°N. and 75°S. latitude) (Reeves and Whitehead, 1997). In the western North Atlantic, they range from Greenland to the Gulf of Mexico and the Caribbean Sea. As deep divers, sperm whales generally inhabit oceanic waters at depths greater than 591 ft (180 m), 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 NMFS considers sperm whales in the GOM as a distinct stock in the Marine Mammal Stock Assessment Report (Waring et al., 2014), and research supports this distinction from the Atlantic and Caribbean stocks (Engelhaupt et al., 2009; Gero et al., 2007; Jaquet, 2006; Jochens et al., 2008). Consistent sightings, satellite tracking, strandings, whale catching, and recent research indicate that sperm whales occupy the northern GOM throughout all seasons and that aggregations are commonly found in waters over the shelf edge in the vicinity of the Mississippi River Delta, which are 1,641-6,562 ft (500-2,000 m) in depth, and represent a resident population (Mullin et al., 1994a; Davis and Fargion, 1996; Sparks et al., 1996; Jefferson and Schiro, 1997; Davis et al., 2000; Jochens et al., 2008). Seasonal aerial surveys confirmed that sperm whales sightings are more common during summer (Mullin et al., 1991 and 1994a; Mullin and Hoggard, 2000; Mullin and Fulling, 2004), but this may be an artifact of movement patterns of sperm whales associated with reproductive behavior, hydrographic features, or other environmental or seasonal factors. Because of the lack of adult males observed in the GOM, it is not known whether females leave the area to mate or whether males sporadically enter the area to mate with females, which would make this a very important area for sperm whale reproduction. Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA to determine if the information was relevant to reasonably foreseeable significant adverse impacts; if so, whether it was essential to a reasoned choice among alternatives; and, if it was essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether credible scientific information applied using generally accepted scientific methodologies can be used in its place (40 CFR § 1502.22). BOEM has made conscientious efforts to comply with the spirit and intent of NEPA and to be comprehensive in its analyses of potential environmental impacts.

While they may be encountered almost anywhere on the high seas, their distribution shows a preference for continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves, 1983). The low-salinity, nutrient-rich water from the Mississippi River contributes to enhanced primary and secondary productivity in the north-central GOM and may explain the presence of sperm whales in the area (Würsig et al., 2000; Davis et al., 2000 and 2002; Jochens et al., 2008). The continental margin in the north-central GOM is only 12 mi (20 km) wide at its narrowest point, and the ocean floor descends quickly along the continental slope, reaching a depth of 3,281 ft (1,000 m) within 25 mi (40 km) of the coast. This unique area of the GOM brings deepwater organisms within the influence of coastal fisheries, contaminants, and other human impacts on the entire northern GOM. Sperm whales are noted for their ability to make prolonged deep dives and are likely the deepest and longest diving mammal. Typical foraging dives last approximately 40 minutes and descend to about 1,312 ft (400 m), followed by approximately 8 minutes of resting at the surface (Papastavrou et al., 1989). However, dives of over 2 hours and deeper than 2.1 mi (3.3 km) have been recorded (Clarke, 1976; Watkins et al., 1985; Watkins et al., 1993), and individuals may spend extended periods of time at the surface to recover.

Evidence suggests that the disproportionately large head of the sperm whale is an adaptation to produce vocalizations (Norris and Harvey, 1972; Cranford, 1992). This suggests that vocalizations are extremely important to sperm whales. The function of vocalizations is relatively well-studied (Weilgart and Whitehead, 1997; Goold and Jones, 1995). Long series of monotonous, regularly spaced clicks are associated with feeding and are thought to be produced for echolocation. Sperm whales also use unique stereotyped click sequence "codas" (Mullins et al., 1988; Watkins and Scheville, 1977; Watkins et al., 1985), according to Weilgart and Whitehead (1988), to possibly convey information about the age, sex, and reproductive status of the sender. Groups of closely related females and their offspring have group-specific dialects (Weilgart and Whitehead, 1997). Sperm whale vocalization and audition are important for echolocation and feeding, social behavior and intragroup interactions, and maintaining social cohesion within the group. Further detailed information on sperm whale hearing may be found in BOEM's *Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement*, which can be found on BOEM's website at http://www.boem.gov/Atlantic-G-G-PEIS/#Final PEIS (USDOI, BOEM, 2014a).

The age distribution of the GOM sperm whale population is unknown, but they are believed to live at least 60 years. Potential sources of natural mortality in sperm whales include killer whales and a papilloma virus (Lambertsen et al., 1987). Little is known of recruitment and mortality rates; however, recent abundance estimates based on surveys indicate that the population appears to be stable, but the NMFS believes that there is insufficient data to determine population trends in the GOM for this species at this time (Waring et al., 2014).

Cephalopods (i.e., squid, octopi, cuttlefishes, and nautilus) are the main dietary component of sperm whales. Other sperm whale populations are known to also take significant quantities of large demersal and mesopelagic fishes, especially the mature males in higher latitudes (Clarke, 1962 and 1979). Postulated feeding and hunting methods include lying suspended and relatively motionless near the ocean floor and ambushing prey, attracting squid and other prey to the white lining of their mouths by disturbing bioluminescent organisms around them to make their mouths more visible, or stunning prey with ultrasonic sounds (Norris and Mohl, 1983; Würsig et al., 2000). Evidence of ingested stones, sand, sponges, and other non-food items suggests they forage on or near the bottom (Rice, 1989) and may occasionally drown after becoming entangled in deep-sea cables that wrap around their lower jaw (Würsig et al., 2000).

The primary factor for the population decline was commercial whaling in the 18th, 19th, and 20th centuries. A commercial fishery for sperm whales operated in the GOM during the late 1700's to the early 1900's, but the exact number of whales taken is not known (Townsend, 1935). The overharvest of sperm whales resulted in their alarming decline in the last century. The total take of sperm whales worldwide between 1800 and 1909 has been estimated as close to 700,000 and between 1910 and 1973 as close to 605,000 (Best et al., 1984). Sperm whales have been protected from commercial harvest by the International Whaling Commission since 1981, although the Japanese continued to harvest sperm whales in the North Pacific until 1988 (Reeves and Whitehead, 1997). Since the ban on nearly all hunting of sperm whales, there has been little evidence that direct effects of anthropogenic causes of mortality or injury (e.g., vessel strikes, commercial fishing, entanglements, etc.) are significantly affecting the recovery of sperm whale stocks (Perry et al., 1999), yet the effects of these activities on the behavior of sperm whales has just recently begun to be studied. Sperm whales are also protected by the Convention on International Trade in Endangered Species of Wild Flora and Fauna and the Marine Mammal Protection Act of 1972. As of 2002, the global population of sperm whales is estimated to be at 32 percent of its pre-whaling number (Whitehead, 2002).

Since sperm whales were listed under the ESA, a concern for the impacts of anthropogenic activities on the physiology and behavior of marine mammals has received much attention. The NMFS published a final recovery plan for the sperm whale (USDOC, NMFS, 2010b), and current threats to sperm whale populations worldwide are discussed. Threats are defined as “any factor that could represent an impediment to recovery” and include fisheries interactions, anthropogenic noise, vessel interactions, contaminants and pollutants, disease, injury from marine debris, research, predation and natural mortality, direct harvest, competition for resources, loss of prey base due to climate change and ecosystem change, and cable laying. In the GOM, the impacts from all of these threats are identified as either low or unknown (USDOC, NMFS, 2010b).

The commercial fishery, which potentially could interact with the GOM sperm whale stock, is the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico large pelagic longline fishery (Waring et al., 2013). There have been no reports of mortality or serious injury to sperm whales by this fishery (Waring et al., 2013), although one sperm whale was released alive with no serious injury after an entanglement interaction with the pelagic longline fishery in 2008 (Garrison et al., 2009).

In regards to the impacts of anthropogenic noise, the Five-Year Review of the NMFS’s recovery plan recognizes that there is a concern, but additional research is needed to fully understand possible injury and behavior changes (USDOC, NMFS, 2015c). Anthropogenic sources from vessel noise, noise associated with oil production, seismic surveys, and other sources have the potential to impact sperm whales. Little is known about sperm whale reactions to seismic exploration, and available studies provide inconsistent results. Further discussion of seismic exploration and marine mammals can be found in the “Routine Activities” section below (**Chapter 4.9.1.2**).

BOEM has completed the “Sperm Whale Seismic Study in the GOM,” and a synthesis report was published in 2008 (Jochens et al., 2008). The principle conclusions from this multiyear research effort were as follows:

- the data support the conservation of sperm whales in the northern GOM as a discrete stock;
- sperm whales are present year-round in the GOM, with females generally having significant site fidelity and with males and females exhibiting significant differences in habitat usage;
- the sperm whale population off the Mississippi River Delta likely has a core size of about 140 individuals;
- GOM sperm whales seem to be smaller in individual size than sperm whales in some other oceans;
- some groups of sperm whales in the GOM were mixed-sex groups of females/immatures and others were groups of bachelor males and typical group size for mixed groups was 10 individuals, which is smaller than group sizes in some other oceans;
- the typical diving and underwater behaviors of the GOM's sperm whales are similar to those of animals in other oceans;
- the typical feeding and foraging behaviors of the GOM's sperm whales are similar to those of animals in other oceans, although differences in defecation rates suggest possible differences in feeding success;
- in the otherwise oligotrophic Gulf of Mexico, the eddy field contributes to the development of regions of locally high surface productivity that, in turn, may create conditions favorable for the trophic cascade of surface production to the depths where GOM sperm whales dive to forage;
- there appeared to be no horizontal avoidance to controlled exposure of seismic airgun sounds by sperm whales in the main "Sperm Whale Seismic Study" area;
- data analysis suggests it is more likely than not that some decrease in foraging effort may occur during exposure to full-array airgun firing as compared with the post-exposure condition, at least for some individuals; and
- knowledge of the acoustic propagation and airgun sound characteristics is critical to developing the capability for accurate predictions of exposures and the modeling of potential resulting effects.

Recommendations from the "Sperm Whale Seismic Study" included continued conservation of GOM sperm whales as a separate stock, implementation of a long-term monitoring program, continued controlled exposure experiments, investigation into sperm whale prey fields, continued development of tagging sensor and instrument capabilities, and continued development of passive acoustic monitoring techniques.

In 2009, BOEM entered into an Interagency Agreement with the NMFS's Southeast Fisheries Science Center for the "Sperm Whale Acoustic Prey Study." Study objectives include quantitative sampling of the mid-water pelagic community within the foraging depths of sperm whales, examination of the relationships between acoustic backscatter and prey taxonomic composition, and comparison of sperm whale distribution and prey composition across habitats of the northern GOM. Field work is complete and sample analyses and data synthesis are ongoing.

Sirenians

The West Indian manatee typically inhabits only coastal marine, brackish, and freshwater areas of the southeastern U.S., the GOM, and the Caribbean Sea (Jefferson et al., 1993; O'Shea et al., 1995). There are two subspecies of the West Indian manatee: the Florida manatee (*T. m. latirostris*), which ranges from the northern GOM to Virginia; and the Antillean manatee (*T. m. manatus*), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea. The Florida manatee was listed as endangered in 1967 (*Federal Register*, 1967).

Manatees are generalist feeders and are known to consume more than 60 species of aquatic vegetation in marine, estuarine, and freshwater habitats (USDOI, FWS, 2001). Manatees primarily use open coastal areas and estuaries, and they are also found far up in freshwater tributaries. Shallow grassbeds with access to deep channels are their preferred feeding areas in coastal and riverine habitats (near the mouths of coastal rivers), and sloughs are used for feeding, resting, mating, and calving (USDOI, FWS, 2001).

Florida manatees have been divided into four distinct regional management units:

- the Atlantic Coast Unit that occupies the east coast of Florida, including the Florida Keys and the lower St. Johns River north of Palatka, Florida;
- the Southwest Unit that occurs from Pasco County, Florida, south to Whitewater Bay in Monroe County, Florida;
- the Upper St. Johns River Unit that occurs in the river south of Palatka, Florida; and
- the Northwest Unit that occupies the Florida Panhandle south to Hernando County, Florida (Waring et al., 2011). Manatees from the Northwest Unit are more likely to be seen in the northern GOM, and they can be found as far west as Texas; however, most sightings are in the eastern GOM (Fertl et al., 2005).

During warmer months (June to September), manatees are common along the Gulf Coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida. Although manatees are less common farther westward, manatee sightings increase during the warmer summer months. Winter habitat use is primarily influenced by water temperature as animals congregate at natural (springs) and/or artificial (power plant outflows) warm water sources (Alves-Stanley et al., 2010). In 2013, a red-tide event in southwest Florida claimed 277 manatees. This is the highest number of red-tide-related deaths in a single calendar year on record. State and Federal scientists are monitoring and responding to manatees affected by the ongoing red-tide bloom along the southwest Florida coast (State of Florida, Fish and Wildlife Conservation Commission, 2015b). Research into the causes of death is currently ongoing and undetermined for the No. 58 Florida unusual mortality event (UME). A previous UME in 2011 (No. 52) was determined to have been caused by ecological factors.

As of November 2015, the best available count of Florida manatees was 6,063 animals, based on a February 2015 aerial survey of warm water refuges (State of Florida, Fish and Wildlife Conservation Commission 2015c). As of November 20, 2015, of the 372 manatee carcasses collected in Florida, 94 of these animals died of human causes (State of Florida, Fish and Wildlife Conservation Commission, 2015c). The human causes identified included entrainment in water-control structures, entanglement in and ingestion of marine debris, entrapment in pipes/culverts, and collisions with watercraft. Eighty-six percent of those manatees that died of human causes were killed by watercraft. The remaining 278 manatee carcasses either died of natural causes (e.g., cold stress) or were too decomposed to accurately determine a cause of death.

Per the guidance of NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protection Species Reporting", an operator is to report an observation of an injured or dead protected species, though many operators also report live animals. Recently, three live manatees have been spotted offshore. The first sighting was on March 20, 2013, in Green Canyon Block 653 in 4,356 ft (1,328 m) of water; another was on March 27, 2013, next to a drillship in approximately 6,000 ft (1,829 m) of water; and the third was on December 18, 2013, about 16 ft (5 m) off a seismic vessel's port stern in 466 ft (142 m) of water. Again, these sightings at these depths are uncommon, and these are the only reports of a manatee sighted by seismic observers in the GOM.

Other Protected Marine Mammal Species

One baleen cetacean (Bryde's whale) and 19 toothed cetaceans (including beaked whales and dolphins, but excluding the sperm whale since they are already discussed above) occur in the Gulf of Mexico. None of these species are protected under the ESA; however, all marine mammals are protected under the Marine Mammal Protection Act (1972).

Cetaceans—Mysticetes

The only commonly occurring baleen whale in the northern GOM is the Bryde's whale (*Balaenoptera edeni*). The Bryde's whale is found in tropical and subtropical waters throughout the world. They feed on small pelagic fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson et al., 1993). Bryde's whales in the northern GOM, 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 De Soto Canyon region and off western Florida, although there have been some in the west-central portion of the northeastern GOM.

A recent study from NMFS' Southeast Fisheries Science Center (Rosel and Wilcox, 2014) evaluated genetic diversity and phylogenetic distinctiveness of this population to determine how unique it is in comparison to other Bryde's whales worldwide. The study found that the Gulf of Mexico Bryde's whale population has little genetic diversity, suggesting a small population size and a history of isolation; and that the population is evolutionarily distinct from all other Bryde's whales examined to date. The scientists conclude that the level of divergence suggests a unique evolutionary lineage for this population that is equivalent to currently recognized subspecies and species within the Bryde's complex, and among species and subspecies of certain other baleen whales. The small population in the Gulf of Mexico, which is also morphologically and behaviorally distinct from others in the complex, constitutes the only known members of this unique lineage.

The GOM population is considered a separate stock (northern GOM) for management purposes (Waring et al., 2012). The status of Bryde's whales in the northern GOM is unknown, as there are insufficient data to determine the population trends for this stock. On April 6, 2015, the NMFS announced a 90-day finding on a petition to list the GOM Bryde's whale as endangered under the Endangered Species Act (*Federal Register*, 2015f).

Cetaceans—Odontocetes

Family Kogiidae: The pygmy sperm whale (*Kogia breviceps*) and dwarf sperm whale (*Kogia sima*) have a worldwide distribution in temperate to tropical waters (Caldwell and Caldwell, 1989). They feed mainly on squid but they would also eat crabs, shrimp, and smaller fishes (Würsig et al., 2000). In the GOM, they occur primarily along the continental shelf edge and in deeper waters off the continental shelf (Mullin et al., 1991). At sea, it is difficult to differentiate dwarf sperm whales from pygmy sperm whales, and sightings are often grouped together as "*Kogia* spp." Very little is known about the species except from studies on stranded individuals. Because information is incomplete or unavailable, BOEM has made conscientious efforts to comply with the spirit and intent of NEPA and to be comprehensive in its analyses of potential environmental impacts to poorly studied marine mammals.

Family Ziphiidae (Beaked Whales): Beaked whales in the GOM are identified either as Cuvier's beaked whales or are grouped into an undifferentiated complex (*Mesoplodon* spp.) because of their similarity in appearance and potential identification errors. In the northern GOM, they are broadly distributed in waters >3,281 ft (1,000 m) over lower slope and abyssal landscapes (Davis et al., 1998 and 2000). Beaked whales were seen in the GOM in all seasons during GulfCet aerial surveys (Mullin and Hoggard, 2000). Beaked whale species that may occur within the GOM are usually observed singly or in small groups of individuals (Jefferson et al., 2008). As a group they are poorly known but are thought to be deep-diving animals. They feed at depth on deepwater cephalopods and fishes (Mead, 2002).

Three species of *Mesoplodon* are known to occur in the GOM based on sighting and stranding data and are considered provisional stocks (Wursig et al., 2000; Waring et al., 2014). The Gervais' beaked whale (*Mesoplodon europaeus*) appears to be widely but sparsely distributed worldwide in temperate to tropical waters (Leatherwood and Reeves, 1983). Stranding records suggest that this is probably the most common mesoplodont in the northern GOM (Jefferson and Schiro, 1997). The Blainville's beaked whale (*Mesoplodon densirostris*) is distributed throughout temperate and tropical waters worldwide, but it is not considered common (Würsig et al., 2000). Cuvier's beaked whale (*Ziphius cavirorostris*) is widely (but sparsely) distributed throughout temperate and tropical waters worldwide (Würsig et al., 2000). They are sighted in the GOM in all seasons in water depths typically >1,640 ft (500 m) (Maze-Foley and Mullin, 2006). Sightings data indicate that Cuvier's beaked whale is probably the most common beaked whale in the GOM (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

Family Delphinidae (Dolphins): Fourteen members of the dolphin family are known to occur in the GOM. Dolphins are often gregarious and commonly form aggregations that can range from a few to several thousand individuals depending on the species (Jefferson et al., 2008; Würsig et al., 2000).

Of the 14 members, the bottlenose dolphin (*Tursiops truncatus*) is the most common inhabitant of the continental shelf and upper slope waters of the northern GOM. 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). There appears to be two ecotypes of bottlenose dolphins, a coastal form (52-210 ft;16-67 m) and an offshore form (about 820 ft; 250 m) (Hersh and Duffield, 1990; Mead and Potter, 1990; Baumgartner, 1995). The coastal or inshore stocks are genetically isolated from the offshore stock (Curry and Smith, 1997). Inshore stocks are further provisionally delineated into 32 bay, sound, and estuarine stocks (Waring et al., 2014).

Species endemic to tropical and subtropical waters of the Atlantic Ocean include the Clymene dolphin (*Stenella clymene*) (Perrin and Mead, 1994) and pantropical spotted dolphin (*Stenella attenuata*) (Perrin and Hohn, 1994). The Clymene dolphin is thought to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994b). Sightings in the GOM are relatively common and suggest a primary range offshore of the 100-m (328-ft) isobath (Davis et al., 2000; Würsig et al., 2000). The pantropical spotted dolphin feeds on epipelagic fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). It is the most common cetacean in the oceanic northern GOM (Mullin et al., 1994a) and is found in the deeper waters off the continental shelf between the 100-m and 2,000-m (328- and 6,565-ft) depth contours (Mullin et al., 1994a; Davis et al., 1998 and 2000; Würsig et al., 2000).

The Atlantic spotted dolphin (*Stenella frontalis*), Risso's dolphin (*Grampus griseus*), rough-toothed dolphin (*Steno bredanensis*), spinner dolphin (*Stenella longirostris*), striped dolphin (*Stenella coeruleoalba*), and the false killer whale (*Pseudorca crassidens*) are found in tropical to temperate waters (Jefferson and Schiro, 1997; Leatherwood and Reeves, 1983; Miyazaki and Perrin, 1994; Perrin and Gilpatrick, 1994; Perrin et al., 1994a; Perrin et al., 1994c). Another species, the Fraser's dolphin (*Lagenodelphis hosei*), has a worldwide distribution in tropical waters (Perrin et al., 1994b). These dolphin species are known to feed on a wide variety of fishes, cephalopods, crustaceans, and benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Jefferson and Schiro, 1997; Perrin et al., 1994a). In the GOM, they occur primarily along the continental shelf and continental slope (Mullin and Fulling, 2004). The rough-toothed dolphin, striped dolphin, spinner dolphin, and false killer whale can occur in deeper waters off the continental shelf (Davis and Fargion, 1996, Mullin and Fulling, 2004).

The killer whale (*Orcinus orca*) has a worldwide distribution from tropical to polar waters (Dahlheim and Heyning, 1999). They feed on marine mammals, marine birds, sea turtles, cartilaginous and bony fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the GOM, they occur primarily in the deeper waters off the continental shelf (Davis and Fargion, 1996).

The melon-headed whale (*Peponocephala electra*) and pygmy killer whale (*Feresa attenuata*) have worldwide distributions in subtropical to tropical waters (Jefferson et al., 1992; Ross and Leatherwood, 1994), feeding on cephalopods and fishes (Mullin et al., 1994a; Jefferson and Schiro, 1997). In the GOM, they occur in the deeper waters off the continental shelf (Mullin et al., 1994a).

The short-finned pilot whale (*Globicephala macrorhynchus*) is distributed worldwide in tropical to temperate waters (Leatherwood and Reeves, 1983). They feed predominantly on squid, with fishes being consumed occasionally (Würsig et al., 2000). Aggregations of short-finned pilot whales are commonly associated with other cetacean species (Jefferson et al., 2008). In the GOM, they are most frequently sighted along the continental shelf and continental slope.

Factors Influencing Cetacean Distribution and Abundance

The distribution and abundance of cetaceans within the northern GOM is strongly influenced by various mesoscale oceanographic circulation patterns. These patterns are primarily driven by river discharge (primarily the Mississippi River), wind stress, and the Loop Current and its derived circulation phenomena. Approximately once or twice a year, the Loop Current sheds anticyclonic eddies (also called warm-core rings), which, in turn, spawn cyclonic eddies (also called cold-core rings) during interaction with one another and upon contact with topographic features of the continental slope and shelf edge. These cyclonic eddies contain and maintain high concentrations of nutrients and stimulate localized production of phytoplankton (Davis et al., 2000), which, in turn, provides various food resources for various predators. River outflow also may be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. Marine mammals may focus their foraging efforts on these abundant prey locations to improve overall efficiency and reduce energy costs (Bailey and Thompson, 2010). Other than factors influencing feeding behaviors, very little is known about other factors that may influence marine mammal distribution in the GOM because there are few studies that examine them.

Critical Habitat

Critical habitat is designated if specific areas of habitat occupied by a species listed as endangered or threatened under the ESA may contain physical or biological features essential to the species' conservation, and may require special management considerations or protection. The only marine mammal that has critical habitat currently listed within the GOM is the West Indian manatee; this is illustrated in **Figure 4-23** (50 CFR § 17.95).

4.9.1.2 Environmental Consequences

This chapter provides detailed information regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts from activities described in **Chapter 3** and their potential impacts that would potentially result from a single lease sale or the alternatives. This analysis applies to all considered alternatives analyzed in **Chapter 4**. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), marine mammal species are widely distributed throughout the planning areas. As such, activities isolated to specific planning areas pose similar potential impacts to populations as do activities occurring in all planning areas. Therefore, because of the diversity and wide distribution of species in the Area of Interest, the level of impacts would be the same for Alternatives A, B, C, and D. Under Alternative E, there would be no new activities associated with a proposed lease sale; however, activities associated with past lease sales and non-OCS oil- and gas-related activities would continue. Following this discussion of environmental consequences, there is a more detailed summary of the potential impacts as they relate to the action alternatives.

As mentioned earlier in **Chapter 4.9.1.1,** the population estimate of a marine mammal species plays an important role in marine mammal management due to the fact that the same impact-producing factor may have a more serious impact on a marine mammal stock that has a lower population estimate and a less serious impact to a marine mammal stock with a higher population estimate. The following evaluation considers how the impact-producing factors from routine activities, reasonably foreseeable accidental events, and cumulative impacts from activities described in **Chapter 3** may potentially impact a marine mammal species based on its respective population estimate (refer to **Table 4-14** for list of marine mammal species and their respective population estimates).

Routine Activities

Potential impacts on marine mammal species may occur from routine activities associated with a proposed lease sale. As a result of OCS oil- and gas-related routine activities in the GOM, the major impact-producing factors affecting marine mammals include geological and geophysical activities, transportation, operational discharges, marine debris, decommissioning, and noise.

Geological and Geophysical Activities

Geophysical (seismic) exploration is an integral part of oil and gas discovery, development, and production in the GOM (refer to **Chapter 3.1.2.1**). With technical advances that now allow extraction of petroleum from the ultra-deep areas of the Gulf, seismic surveys are routinely conducted in virtually all water depths of the GOM, including the deep habitat of the endangered sperm whale. The impacts of noise from airguns could include one or more of the following: masking of natural sounds; behavioral disturbance (e.g., changes in feeding or mating behaviors); tolerance; and temporary or permanent hearing impairment, or nonauditory physical or physiological impacts (Richardson et al., 1995; Nowacek et al., 2007; Southall et al., 2007). Permanent hearing impairment would constitute injury; however, temporary threshold shift is not considered an injury (Southall et al., 2007). The only other impact-producing factor to marine mammals that is associated with G&G activities is the potential for gear interaction. Marine mammals can become entangled in some types of lines associated with G&G activities. The G&G permit applications are reviewed by BOEM and the NMFS to set conditions of approval with each activity that would minimize impacts caused by gear interactions which are expected to be rare.

The NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," provides guidance to protect marine mammals and sea turtles during seismic operations. This NTL clarifies how operators should implement seismic survey mitigating measures, including ramp-up procedures, the use of a minimum sound source, airgun testing, and protected species observation and reporting. The Protected Species Stipulation, if applied, would make compliance with the guidance identified in the NTL mandatory for lessee activities. For more information about G&G activities, refer to the *Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf: Final Programmatic Environmental Assessment*, (USDOI, MMS, 2004b). In addition, the NMFS, BOEM, and BSEE collaborated to publish National Standards for a Protected Species Observer Program to reduce impacts to protected species from G&G activities by standardizing the variation in and improving the management of the program (Baker et al., 2013).

Without implementation of BOEM's mitigations, marine mammals would be vulnerable to impacts from the noise produced from airguns, vessel strikes, and entanglement from gear interaction. The impacts from these factors with mitigations mentioned above would be expected to be **negligible** to **moderate**. Although mitigations may drastically reduce potential impacts to marine mammals from G&G activities, they do not eliminate them completely and could have a **moderate** impact on marine mammal species. For example, if an individual bottlenose dolphin would become entangled from gear interaction, some impacts may result in physical injury or mortality. However, with the use of ramp-up procedures, minimum sound sources, airgun testing, and protected species observation and reporting, it is reasonably foreseeable that marine mammals would be detected and that proper procedures, including shutdowns, would be used to avoid any impacts, making them **negligible**.

Transportation

The oil and gas industry uses a variety of vessels running from shore bases to offshore OCS oil and gas structures (refer to **Chapter 3.1.4**). Increased traffic from service and support vessels would increase the probability of collisions between vessels and marine mammals. These collisions can cause major injuries and/or fatalities (e.g., the sperm whale [Waring et al., 2013] and bottlenose dolphin [Fertl, 1994]). Slow-moving cetaceans or those that spend extended periods of time at the surface might be expected to be the most vulnerable (Vanderlaan and Taggert, 2007). Smaller delphinids often approach vessels that are in transit to bow-ride; however, vessel strikes are less common for these faster moving mammals or are underreported (Wells and Scott, 1997). Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared with control periods (no boats present within 100 m [328 ft]) 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.

Collisions of vessels with marine mammals are not uncommon (Laist et al., 2001). Vanderlaan and Taggert (2007) examined the literature for large whale species and reported that the probability for vessel strikes is largely a function of vessel speed. Data compiled by Laist et al. (2001) indicate that relatively large (>80 m; 262 ft) and fast-moving vessels (>14 kn; 16 mph) are most commonly involved in collisions with marine mammals. They also conclude that the majority of collisions appear to occur over or near the continental shelf and that the whales usually are not seen beforehand or are seen too late to be avoided. The rapid increase in exploration and development of petroleum resources in deep oceanic waters of the northern Gulf has increased the risk of OCS vessel collisions with sperm whales and other deep-diving cetaceans (e.g., Kogia and beaked whales). Deep-diving whales may be more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. Although the sperm whale is the most likely large whale to be struck by a vessel in the GOM, there has only been one possible mortality due to vessel strike documented as of 2012 (Waring et al., 2013). Sperm whales have been shown to be unable to outmaneuver a fast vessel approaching under stratified water conditions (Gannier and Marty, 2015).

Florida manatees are commonly found in shallow coastal waters of Florida, but they have been found along the entire northern GOM from Florida to Texas (Fertl et al., 2005), though some recent deepwater sightings have occurred. Vessel strikes are the most common cause of human-induced mortality for manatees (State of Florida, Fish and Wildlife Conservation Commission, 2015c), and most manatees bear prop scars from contact with vessels. The vast majority of strikes result from recreational and fishing vessels, not those related to oil and gas activities. Service and support vessels traveling through coastal areas to and from oil and gas structures have the rare potential to impact manatees by vessel collisions. In 1995, for example, an oil crew workboat struck and killed a manatee in a canal near coastal Louisiana (Fertl et al., 2005). Inadequate hearing sensitivity at low frequencies (Gerstein et al., 1999), slow movement, and use of shallow and surface waters are contributing factors to their vulnerability to vessel strike impacts. While manatees are less common in the western Gulf, they are being seen more frequently, and increased sightings indicate that there is a potential for risks to this species from OCS vessel traffic. There is the possibility of short-term disruption of movement patterns and/or behavior caused by vessel noise and disturbance; however, these are not expected to impact survival and growth of manatees in the GOM.

Expected industry service trip numbers as a result of Alternative A, B, C, or D are described in **Chapter 3.1.4.5** (**Table 3-2**). BOEM and BSEE issued NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," which explains how operators must implement measures to minimize the risk of vessel strikes to protected species and to report observations of injured or dead protected species. The Protected Species Stipulation, if applied, would make compliance with the guidance identified in the NTL mandatory for lessee activities. Adherence to the NTL protocols is expected to reduce but not eliminate the risk of potential vessel strikes with marine mammals.

Without implementation of mitigations, marine mammals would be vulnerable to direct impacts from vessel strikes. The impacts from these factors with mitigations are expected to be **negligible** to **major**. Although mitigations may drastically reduce potential impacts to marine mammals from vessel strikes, they do not completely eliminate the risk. Therefore, depending on the population estimate of any given species, vessel strikes could have a **major** impact. For example, if an individual Bryde's whale (population estimate of 33 individuals) were to be struck by a vessel, some impacts may result in physical injury or mortality. Because the population estimate is so low for this species, a mortality on an individual would diminish the continued viability of the population, including the annual rates of recruitment or survival. However, with the use of vessel strike avoidance guidelines, it is reasonably foreseeable that marine mammals would be detected and that proper procedures, including reduced speed, change in course, or shutdown, would be used to avoid impacts to marine mammals, which would be **negligible**.

Discharges and Wastes

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 (refer to **Chapter 3.1.5**). During production activities, additional waste streams include well treatment, workover, and completion 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. Discharges are regulated by the USEPA through the issuance of NPDES permits. Pollutants discharged into navigable waters of the U.S. are regulated by the USEPA under the Clean Water Act of 1972 and subsequent provisions (33 U.S.C. § 1251 *et seq*.). Specifically, an NPDES permit must be obtained from the USEPA under Sections 301(h) and 403 (*Federal Register*, 1980) of the Clean Water Act (refer to **Chapter 4.2**, Water Quality).

Heavy metal accumulations in marine mammal tissues are of concern worldwide (Bossart, 2006). Trace metals, including mercury, in drilling discharges have been a particular concern. However, Neff et al. (1989) concluded that metals associated with drilling fluid were virtually nonbioavailable to marine organisms. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from live GOM and Atlantic bottlenose dolphins showed high levels of polyfluoroalkyl compounds (Houde et al., 2005). Recent work by Kucklick et al. (2011) in the GOM identified a number of persistent organic pollutants in bottlenose dolphins, and Fair et al. (2010) documented unusually high levels of organic chemicals in bottlenose dolphins in Atlantic populations. Adequate baseline data are not available to determine the significant sources of contaminants that accumulate in GOM cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the GOM from a variety of national watersheds. Many cetaceans are wide-ranging animals, which also compounds the issue. Coastal 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).

Most operational discharges are diluted and dispersed when released in offshore areas, and they are not expected to directly affect any marine mammal species (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 (Neff et al., 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. Releases of toxic discharges are regulated by the USEPA through the issuance of NPDES permits to keep contaminants below harmful levels. These regulations and permit provisions are designed to prevent unreasonable degradation of the marine environment, and adherence to these requirements by industry would be expected to result in limited impacts to water quality, and therefore, indirect impacts to marine mammals would likewise be small. Without implementation of requirements, marine mammals would be vulnerable to direct and indirect impacts from operational discharges. The impacts from these factors are, therefore, expected to be **negligible** given assumed compliance with existing regulations and permit requirements.

Marine Trash and Debris

Marine mammal ingestion of, and entanglement in, accidentally released industry debris is a concern (refer to **Chapter 3.1.5.3.4**). A marine mammal could suffer reduced feeding and reproductive success, and potential injury, infection, and death from entanglement in marine debris. 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 from a variety 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); however, ingestion of net materials can also be fatal (Jacobsen et al., 2010). Sheavely (2007) reports that as much as 49 percent of marine debris is considered land based. There are many types of materials used in offshore energy production and some of this material is accidentally lost overboard from service vessels or OCS structures where marine mammals could ingest it or become entangled in it. 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). Many of the plastics used by industry could withstand years of saltwater exposure without disintegrating or dissolving. To address the potential impacts of marine debris, the BSEE issued NTL 2012-BSEE-G01, "Marine Trash and Debris Awareness and Elimination," which provides information on the marine trash and debris awareness training video and slide show, and both postal and email addresses for submitting annual training reports. The information provided is intended to greatly minimize the amount of debris that is accidentally lost overboard by offshore personnel; however, these directives do not eliminate the accidental release of debris, which could impact an individual or group of individuals if they become entangled in or ingest accidentally released debris. The Protected Species Stipulation, if applied, would make compliance with the guidance identified in the NTL mandatory for lessee activities.

Without implementation of mitigations, marine mammals would be vulnerable to direct impacts from entanglement in or ingestion of marine debris. The impacts from these factors with mitigations are expected to be **negligible** to **major**. Although mitigations may drastically reduce potential impacts to marine mammals from marine debris, they do not completely eliminate the risk. Therefore, depending on the population estimate of any given species, marine debris could have a **major** impact. For example, if an individual Bryde's whale (population estimate of 33 individuals) were to ingest or become entangled in marine debris, some impacts may result in physical injury or mortality. Because the population estimate is so low for this species, this would diminish the continued viability of the population, including the annual rates of recruitment or survival. However, with the use of marine trash and debris guidelines, it is reasonably foreseeable that marine mammals would not encounter OCS oil- and gas-related marine trash or debris, which would result in a **negligible** impact.

Decommissioning

The use of explosives is one of industry's preferred methods for the severance of structures from their foundations in the GOM (refer to **Chapter 3.1.6**). It has been demonstrated that nearby underwater blasts can injure or kill marine mammals (Richardson et al., 1995). Injuries from high-velocity underwater explosions result from two factors: (1) the very rapid rise time of the shock wave; and (2) the negative pressure wave generated by the collapsing bubble, which is followed by a series of decreasing positive and negative pressure pulses (USDOI, MMS, 2004b). The extent of injury largely depends on the intensity of the shock wave and the size and depth of the animal at the time of the detonation (Yelverton et al., 1973).

BOEM (then BOEMRE) issued "Decommissioning Guidance for Wells and Platforms" (NTL 2010- BSEE-G05) to offshore operators; it provides clarification and interpretation of regulations regarding decommissioning, as well as guidance to operators proposing to use explosives to perform well/casing severance. These guidelines specify and reference mitigation, monitoring, and reporting requirements. As noted in **Chapter 3.1.6**, decommissioning for wells and platforms are site specific and are reviewed by the BSEE and BOEM.

Expected numbers of production structures to be removed using explosives as a result of Alternative A, B, C, or D are reported in **Chapter 3.1.4.5**. Explosive severance could moderately impact marine mammals; however, with implementation of the Bureau of Safety and Environmental Enforcement's NTL guidelines and regulations, and NMFS's Observer Program for explosive removal, impacts to marine mammals from explosive severance are expected to be negligible to moderate. Although the NTL's guidelines and regulations, along with the NMFS's Observer program for explosive removal, would greatly reduce impacts of decommissioning activities to marine mammals, they may not be completely eliminated. To date, there are no documented "takes" of marine mammals resulting from explosive removals of offshore structures. Decommissioning activities and their potential impacts to different marine mammal species are described further in the *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf: Programmatic Environmental Assessment* (USDOI, MMS, 2005), as well as in **Chapter 3**. In addition, a site-specific NEPA analysis, in the form of an EA or EIS, is completed for all structure removals that propose explosive severance methods and/or site-clearance trawling. Without implementation of mitigations, marine mammals would be vulnerable to direct impacts from explosive charges used for the removal of production structures. The impacts from these factors with mitigations are expected to be **negligible** to **moderate**. Although mitigations may drastically reduce potential impacts to marine mammals from explosive severance methods, they do not completely eliminate the risk. Therefore, depending on the population estimate of any given species, explosive severance methods could have a **major** impact. For example, if a group of pantropical spotted dolphins (population estimate of 50,880 individuals) were not detected prior to a detonation and experienced physical injuries or mortalities, it would have a localized and irreversible impact on that group of individuals, but it would not diminish the continued viability of the population. However, with the use of decommissioning guidelines, as well as the fact that there have been no documented "takes" of marine mammals, it is reasonably foreseeable that decommissioning activities would have a **negligible** impact.

Noise

Aircraft overflights (either helicopter or fixed-wing) in close proximity to marine mammals may elicit a startle response due to either the increasing noise as the aircraft approaches or due to the physical presence of the aircraft in the air. Refer to **Chapter 3.1.9** for more information on OCS oil- and gas-related noise. With more than 1 million helicopter take offs/landings expected per year from activity related to past, proposed, and future lease sales, the OCS industry's activity contributes greatly to this noise source. Although air traffic offshore is limited, the military maintains 11 military warning areas and 6 water test areas in the GOM (**Figure 2-7**). Some commercial fisheries include aerial surveillance. Scientific research aerial surveys are occasionally scheduled over the GOM. Commercial and private aircraft also traverse the area.

Marine mammals often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as species, the activity the animals are engaged in, and water depth (Richardson et al., 1995). Marine mammals engaged in feeding or social behavior are often insensitive to overflights, while those in confined waters or those with calves may be more responsive. The impacts appear to be transient, and there is no indication that long-term displacement of marine mammals occurs. However, the absence of conspicuous response does not show that the animals are unaffected; it is not known whether these subtle impacts are biologically significant (Richardson and Würsig, 1997). Because information is incomplete or unavailable, BOEM has made conscientious efforts to comply with the spirit and intent of NEPA and to be comprehensive in its analyses of potential environmental impacts of aircraft noise to marine mammals.

Aircraft noise is generally short in duration and transient in nature, although it may ensonify large areas. Much of the noise from a passing aircraft is reflected and does not penetrate the water (Urick, 1972). Helicopter noises contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). The Federal Aviation Administration's Advisory Circular 91-36D (2004) encourages pilots to maintain an altitude of higher than 2,000 ft (610 m) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft (213 m) while in transit offshore and 500 ft (152 m) while working between platforms. It is unlikely that marine mammals would be affected by routine OCS helicopter traffic operating at these altitudes. Routine overflights may elicit a startle response from and interrupt marine mammals nearby (depending on the activity of the animals), possibly causing temporary displacement from feeding, mating, or traveling activities. This temporary disturbance to marine mammals may occur as helicopters approach or depart OCS oil- and gas-related facilities if animals are near the facility. Without implementation of guidelines and regulations by the NMFS under the authority of the MMPA, marine mammals would be vulnerable to direct impacts from routine overflights. The impacts from these factors with these guidelines and mitigations are expected to be **negligible**.

The dominant source of human noise in the sea is ship noise (Tyack, 2008). 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). The intensity of noise from service vessels is roughly related to ship size 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 unladed vessels. For a given vessel, relative noise also tends to increase with increased speed. The ambient noise environment in the GOM is filled with ship "noise" associated with oil- and gas-related activities, shipping, and recreational vessels, raising concerns that elevated levels of noise may interfere with the behavior and physiology of marine mammals (Tyack, 2008). Many of the industry-related noises are believed to be out of, or on the limits of, marine mammal hearing, and the sounds are also generally temporary. Impacts from vessel noise could disturb animals in the immediate vicinity of the vessel; however, the noise would be transitory in nature. Further detailed information on marine mammal hearing may be found in BOEM's *Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement*, which can be found on BOEM's website (USDOI, BOEM, 2014a).

Andrew et al. (2002) reported that, over a 33-year period, increases in shipping noise levels in the ocean may account for a 10-decibel (dB) increase in ambient noise between 20 and 80 Hz and between 200 and 300 Hz, and a 3-dB increase in noise at 100 Hz on the continental slope of Point Sur, California. Although comparable baseline data are not available for the GOM, it is likely that similar ambient noise increases have occurred. Much of the change is expected to be attributable to commercial shipping (greater numbers of ships in the GOM and larger ship size are both factors). However, the expansion of oil and gas industry activities, including more structures, more exploration (seismic surveys) and drilling, a larger service boat fleet, and much greater distances to travel to deepwater installations, has also contributed to more noise in GOM waters.

Evidence suggests that some whale species 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 vessel traffic indicates a considerable degree of tolerance to vessel noise and disturbance. Vessel noise could interfere with marine mammal communication either by masking important sounds from conspecifics, masking sounds from predators, or by forcing animals to alter their vocalizations (Tyack, 2008). There is the possibility of short-term disruption of movement patterns and/or behavior caused by vessel noise and disturbance; however, these are not expected to impact survival and growth of any marine mammal populations in the GOM. BOEM and BSEE issued NTL 2012-JOINT-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," explains how operators must implement measures to minimize the risk of vessel strikes to protected species and report observations of injured or dead protected species. This guidance should also minimize the chance of marine mammals being subject to the increased noise level of a service vessel in very close proximity. The Protected Species Stipulation, if applied, would make compliance with the guidance identified in the NTL mandatory for lessee activities.

Without implementation of the guidance mentioned above to avoid marine mammals, marine mammals would be vulnerable to direct noise impacts from routine vessel traffic, resulting in short-term disruptions of movement patterns or behaviors. However, with the use of the guidelines mentioned above to minimize the chance of marine mammals being subjected to increased noise levels from service vessels, the impacts are expected to be **negligible**.

Drilling and production activities, which include operating platforms and drillships, produce underwater noise that may be detected by marine mammals. The OCS industry's drilling and production impacts are discussed in **Chapter 3.1.2.2 and 3.1.3**. Noises produced by these types of activities are generally low frequency and have the potential to mask cetaceans' reception of sounds produced for echolocation and communication. Most species of marine mammals in the GOM (except the Bryde's whale) use sounds at frequencies that are generally higher than the dominant noise generated by offshore drilling and production activities. Baleen whales use low-frequency sounds that overlap broadly with the dominant frequencies of many industrial sounds, and there are indications that baleen whales are sensitive to low- and moderate- frequency sounds (Richardson et al., 1995). However, all baleen whale species, except for the Bryde's whale, are considered extralimital or rare in the GOM. There is a small population of Bryde's whales in the GOM that may represent a resident stock, but there is no information on stock differentiation (Waring et al., 2013). It is expected that noise from drilling activities would be relatively constant during the temporary duration of drilling. 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). 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).

Noise from drilling and production operations may impact marine mammals similarly to other anthropogenic sounds in the ocean. Noise can mask important sounds from conspecifics (a member of the same species), mask sounds from predators, or force animals to alter their vocalizations. Noises 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). Noises can cause reactions that might include the 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. Some demographic groups may be more vulnerable to noise impacts, including females in late pregnancy or lactating. 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 marine mammals may be affected by noise in difficult-to-observe ways. 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 it is little studied in marine mammals. Tyack (2008) suggests that a more significant risk to marine mammals from sound are these less visible impacts of chronic exposure. Drilling and production noise would contribute to increases in the ambient noise environment of the GOM, but they are not expected in amplitudes sufficient to cause either hearing or behavioral impacts. Expected numbers of exploration and delineation wells, as well as development wells, projected to be drilled as a result of Alternative A, B, C, or D can be found in **Chapter 3.1.4.5**.

The temporary and transient noise associated with drilling and production is not expected to produce more than **negligible** to **minor** impacts on marine mammals since they are not expected in amplitudes sufficient to cause hearing behavioral effects and due to the wide-ranging behavior of marine mammal species.

Although there would always be some level of incomplete information on the impacts from routine activities under a proposed action on marine mammals, there is credible scientific information, applied using acceptable scientific methodologies, to support the conclusion that any realized impacts would be sublethal in nature and not in themselves rise to the level of reasonably foreseeable significant adverse (population-level) effects. There are no data to suggest that routine activities from the preexisting OCS Program are significantly impacting marine mammal populations.

Accidental Events

Accidental, unexpected events reasonably foreseeable as a result of a proposed lease sale could negatively impact marine mammals. Such impacts would primarily be the result of oil spills and spill-response activities.

Oil Spills

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore could occur during any phase of development, i.e., exploratory drilling, development drilling, production, completion, or workover operations. In the event of an accidental spill, 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 probability that a marine mammal would be in the vicinity of a loss of well control at the exact moment it occurs is relatively small due to the wide-ranging behavior of marine mammal species, along with the low probability of a loss of well control (refer to **Chapter 3.1.2** for more information on oil spills).

The impacts of an oil spill on marine mammals depend on many variables, such as location and size of the spill, oil characteristics, weather and water conditions, time of year, and types of habitats, as well as the behavior and physiology of the marine mammals themselves (Johnson and Ziccardi, 2006). The oil from a spill can adversely affect marine mammals by causing soft-tissue irritation, fouling of baleen plates, respiratory stress from the inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats. The long-term impacts to marine mammal populations are poorly understood but could include decreased survival and lowered reproductive success (Matkin et al., 2008). An oil spill may physiologically stress an animal (Geraci and St. Aubin, 1980), making it more vulnerable to disease, parasitism, environmental contaminants, and/or predation. In any case, the impact could negatively impact a marine mammal population or stock.

The resident marine mammal species in the GOM include a baleen whale, toothed whales, delphinids, and a sirenian. Baleen whales are particularly vulnerable to direct impacts from fouling of baleen plates, which could impact feeding behavior. Marine mammals may have direct contact with oil by swimming through oil on the surface and/or subsurface. Surfacing behavior exposes skin, eyes, nares, and other mucus membranes to volatile hydrocarbons. This contact with oil could cause soft-tissue damage to eye tissues, potentially leading to ulcers, conjunctivitis, or blindness. Most of the information on the potential impacts of oil on marine mammals comes as a result of the *Exxon Valdez* oil spill in Alaska and some limited exposure experiments (Geraci and St. Aubin, 1990).

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 components (Geraci and St. Aubin, 1982).

Studies by Geraci and St. Aubin (1982 and 1985) have shown that the cetacean epidermis functions as an effective barrier to many of the toxic substances found in petroleum. This barrier is a result of 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). Marine mammals are more likely to have dermal contact with weathered oil, which is more persistent but contains fewer of the toxic compounds found in fresh oil (Geraci and St. Aubin, 1990). Dolphins maintained at a captive site that were exposed to petroleum products initially exhibited a sharp decrease of food intake, along with excited behavior, eye inflammation, and changes in hemoglobin as well as erythrocyte content (Lukina et al., 1996). Prolonged exposure to oil led to a decrease of those blood parameters, changes in breathing patterns and gas metabolism, depressed nervous functions, and the appearance of skin injuries and burns (Lukina et al., 1996).

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 dolphins to spilled oil appear varied, ranging from avoidance to apparent indifference (reviewed by Geraci, 1990; Smultea and Würsig, 1991). In contrast to captive dolphins, bottlenose dolphins were observed off Galveston, Texas, during the *Mega Borg* oil spill in the summer of 1990 and did not consistently avoid entering the 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 GOM (Smultea and Würsig, 1995). 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 impacts 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).

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). Types of impacts to manatees from contact with oil include (1) asphyxiation due to inhalation of hydrocarbons, (2) acute poisoning due to contact with fresh oil, (3) lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum components into body tissues, (4) nutritional stress through damage to food sources, and (5) inflammation or infection and difficulty eating due to oil sticking to the sensory hairs around their mouths (Preen, 1989, in Sadiq and McCain, 1993). Direct contact with discharged oil likely does not impact adult manatees' thermoregulatory abilities because they use blubber for insulation. Also, they exhibit no grooming behavior that would contribute to ingestion (USDOI, FWS, 2006). Manatees are nonselective, generalized feeders that might consume tarballs along with their normal food, although 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). Spilled oil may also affect the quality or availability of aquatic vegetation, including seagrasses, upon which manatees feed.

There have been no experimental studies and only a few observations suggesting that oil has harmed any manatees (St. Aubin and Lounsbury, 1990), although for a population under pressure from other mortality factors (e.g., vessel strikes), even a localized incident could be significant (St. Aubin and Lounsbury, 1990). Oil spills that may occur from OCS energy-related activities that reach the coast or the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could further endanger local populations. The physiological costs of animals moving to colder waters to escape oiled areas may result in thermal stress that would exacerbate the impacts of even brief exposure to oil (St. Aubin and Lounsbury, 1990).

Indirect consequences of oil pollution on marine mammals include those impacts that may be associated with changes in the availability or suitability of food resources (Hansen, 1992). Spilled oil can lead to the localized reduction, disappearance, or contamination of some 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, although apparently do not accumulate high concentrations of hydrocarbons in tissues, and may transfer them to predators (Neff, 1990). In general, the potential for ingesting oil-contaminated prey organisms with petroleum-hydrocarbon, body-burden content is highest for benthic-feeding whales, which are not common in the GOM. The potential is reduced for plankton-feeding whales and is lowest for fish-eating whales (Würsig, 1990). An analysis of stomach contents from captured and stranded toothed whales suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989). 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.

Several factors increase the probability of marine mammal/oil-spill contact, including:(1) marine mammals often travel long distances in the GOM, increasing the geographic areas of potential impact; (2) marine mammals are relatively long-lived and have many years during which they may be exposed; (3) the life of a proposed action also means many years for an impact to occur; and (4) some spills would be larger, increasing the area of potential impact. It is impossible to know precisely which cetacean species, population, or individuals would be most impacted, to what magnitude, or in what numbers since each species has unique distribution patterns in the GOM and because of difficulties attributed to predicting when and where oil spills would occur over the 50-year lifetime of a proposed action. The potential impacts associated with an accidental spill may be more severe depending on the size of the reasonably foreseeable accidental spill. The impact from a reasonably foreseeable, higher volume accidental spill could potentially contribute to more significant and longer-lasting impacts that could include mortality and longer-lasting chronic or sublethal impacts.

Given the distribution of available leases and pipelines associated with a proposed lease sale and the distribution of marine mammals in the northern GOM, the fate of an oil spill must be considered relative to the region and period of exposure. Spills of any size can degrade water quality at least locally (**Chapter 4.2**, 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, would disperse into smaller units as it evaporates (if at the sea surface) and weathers. 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, marine mammals may be exposed via the waters that they inhabit, as well as via the prey they consume. For example, tarballs may be consumed by marine mammals and by other marine organisms that are eaten by marine mammals.

OSRA Modeling

The OSRA modeling results, which show the probabilities of a large spill (≥1,000 bbl) occurring in Federal offshore waters making contact with State offshore waters, are provided in **Figure E-20**. In general terms, coastal waters of the area may be contacted by many, frequent, small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 and <1,000 bbl); and a single large spill (≥1,000 bbl) as a result of a proposed lease sale. Pipelines pose the greatest risk of a large spill occurring in coastal waters compared with platforms and tankers. Spill estimates over a 50-year time period are indicated in **Table 3-18**. According to **Table 3-18**, the majority of estimated spills would be small (<10 bbl). The actual number of spills that may occur in the future could vary from the estimated number. A spill size group for ≥10,000 bbl was not included in **Table 3-18** because the catastrophic *Deepwater Horizon* oil spill (4.9 MMbbl released from the well) was the only spill in this size range during 1996-2010 and such a spill is not reasonably foreseeable in the future; thus, limited conclusions can be made from a single data point. For more information on OSRA, refer to **Chapter 3.2.1.4** ("Analysis of Offshore Spills ≥1,000 bbl").

Depending on the timing of a spill's occurrence in coastal waters, its impact and resulting cleanup activities may interrupt marine mammal migration, feeding, mating, and/or calving activities for extended periods (i.e., days, weeks, or months). Spills originating in or migrating through coastal waters of Florida may impact any marine mammal species inhabiting the area, including the West Indian manatee, which commonly inhabits Florida's coastal waters. However, it is highly unlikely that any spill occurring in Federal offshore waters would make contact with coastal waters in Florida (<0.5%) where manatees are commonly found. Aside from the acute impacts noted earlier, if marine mammals encounter an oil slick, the displacement of marine mammals to less suitable habitats from habitual feeding areas impacted by oil spills may increase vulnerability to predators, disease, or mortality from anthropogenic causes.

The likelihood that individuals of a marine mammal population may encounter an oil slick resulting from a single spill during a 50-year period is greater than that of a single individual encountering a slick during its lifetime. It is impossible to estimate precisely what marine mammal species, populations, or individuals would be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the GOM and because of difficulties attributed to estimating when and where oil spills would occur over a 50-year period.

Given the distribution of available leases and pipelines associated with a proposed lease sale and the distribution of marine mammals in the northern GOM, the fate of an oil spill must be considered relative to the region and period of exposure. Projected oil production is 0.211-1.118 BBO and 0.547-4.424 Tcf of gas over 50 years. **Chapter 3.2.1** details the persistence, spreading, and weathering process for offshore spills.

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 at some point in their lifetime. 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 GOM would likely be exposed to residuals of spilled oil throughout their lifetime. Depending on where the actual spill occurs, the species of marine mammal, the distance of marine mammals in relation to the spill, and if the marine mammal accidentally ingests oil while feeding, impacts may be **negligible** to **major**. An example of a **negligible** impact would be if a group of oceanic bottlenose dolphins were traveling in an area where a reasonably foreseeable small accidental spill occurred at a well, but the group of bottlenose dolphins never encountered the oil and continued traveling. An example of a **major** impact would be if an individual Bryde's whale (population estimate of 33 individuals) were to ingest oil while feeding and the impacts resulted in physical injury or mortality. Because the population estimate is so low for this species, this would diminish the continued viability of the population, including the annual rates of recruitment or survival.

Spill-Response Activities

Spill-response activities that may impact marine mammals include increased vessel traffic, the use of dispersants, and remediation activities (e.g., controlled burns, skimmers, boom, etc.). The increased human presence after an oil spill (e.g., vessels) would likely add to changes in behavior and/or distribution, thereby potentially stressing marine mammals further and perhaps making them more vulnerable to various physiologic and toxic effects of spilled oil. In addition, the large number of response vessels could place marine mammals at a greater risk of vessel collisions, which could cause fatal injuries. Manatees are particularly vulnerable to vessel collisions that may result from increased vessel traffic. Vessel noise would also increase as a result of increased vessel activity and could result in behavioral changes in some individuals.

Spill-response activities could also include the application of dispersants to the affected area. Dispersants are designed to break oil on the water's surface into minute droplets, which then break down in seawater. Essentially little is known about the impacts 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). A laboratory experiment by Wise et al. (2014) found that chemical dispersants used during the *Deepwater Horizon* oil-spill response were cytotoxic to sperm whale cells and could lead to fibrosis and impaired organ function. However, it is difficult to determine how these exposures relate to the actual exposures in the GOM since there is no known accurate method to measure the amount of whale exposure to dispersants (Wise et al., 2014). 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 a study by Wells (1989) showed that the rate of biodegradation of dispersed oil is equal to or greater than that of undispersed oil. Varieties of aquatic organisms readily accumulate and metabolize surfactants from oil dispersants; however, 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). Impacts from dispersants are unknown but may be irritants to tissues and sensitive membranes (NRC, 2005). One assumption concerning the use of dispersants is that the chemical dispersion of oil would considerably reduce the impacts to marine mammals, primarily by reducing their exposure to petroleum hydrocarbons (French-McCay, 2004; NRC, 2005). However, the impacts to marine mammals from chemical dispersants could include nonlethal injury (e.g., tissue irritation and inhalation), long-term exposure through bioaccumulation, and potential shifts in distribution from some habitats.

Some remediation activities that could impact marine mammals include the use of skimmers, booms, and controlled burns. Impacts from skimmers could be through capture and/or entrainment. Booming operations could potentially impact marine mammals, particularly manatees, as they are close to shore and known to explore and interact with objects in their environment (Hartman, 1979). Lines used to anchor booms are more likely than the boom itself to impact manatees, by entanglement. Controlled burns could impact marine mammals if they were in the burning oil; however, it is expected that animals would avoid the area once it is ignited. In both skimming and controlled burning activities, the use of trained observers is common and reduces the likelihood of impacts to marine mammals. Because of the low probability of marine mammals being in the vicinity of an OCS-related oil-spill response activity due to their wide-ranging behavior, impacts are expected to be **negligible** to **moderate**. An example of a **negligible** impact would be if a small group (5-8 individuals) of Atlantic spotted dolphins was traveling in an area where remediation activities are being conducted to control an oil spill, but the group of Atlantic spotted dolphins never encountered the remediation activities and continued traveling. An example of a **moderate** impact would be if a small group (5-8 individuals) of spinner dolphins (population estimate of 11,441 individuals) encountered dispersants while traveling and experienced a nonlethal injury via inhalation at the water-surface interface. Although it may have a localized impact on that particular group of spinner dolphins, it would not diminish the continued viability of the population, including the annual rates of recruitment or survival.

Cumulative Impacts

The cumulative analysis considers past, present, and foreseeable future human and natural activities that may occur and adversely affect marine mammals in the same general area that may be affected by a proposed action.

The major impact-producing factors relative to a proposed action are described in **Chapter 4.9** (Protected Species) above in **Table 4-13**. Chapters providing supportive material for the marine mammals analysis include **Chapters 4.9.1** (description of marine mammals), **3.1.2** (Exploration and Delineation), **3.1.3** (Offshore Development and Production), **3.1.4** (Transport), **3.1.5** (Discharges and Wastes), **3.1.9** (Noise), **3.1.7** (Coastal Infrastructure), **3.1.6** (Decommissioning and Removal Operations), and **3.2.1** (Oil Spills).

OCS Oil- and Gas-Related Impacts

The major potential impact-producing factors affecting marine mammals in the GOM as a result of cumulative past, present, and reasonably foreseeable OCS energy-related activities are described under the "Routine Activities" and "Accidental Events" sections above and include the following: decommissioning; operational discharges; G&G activities; noise; transportation; marine debris; and accidental oil spill and spill-response activities. The cumulative impact of these ongoing OCS energy-related activities on marine mammals is expected to result in a number of chronic and sporadic sublethal effects (i.e., behavioral effects and nonfatal exposure to or intake of OCS oil- and gas -related contaminants or discarded debris) due to the fact that these activities may stress and/or weaken individuals of a local group or population and may predispose them to infection from natural (e.g., bacteria) or anthropogenic (e.g., marine debris) sources.

As previously discussed in **Chapter 4.9.1.2** ("Routine Activities"), the use of explosives is the preferred method for the severance of structures from their foundations in the GOM. Explosive structure removals put loud but temporary noise into the ocean, and these can occur in Federal or State waters. The shock wave and blast noise from explosions are of most concern to marine mammals. Depending on the intensity of the shock wave and size and depth of the animal, an animal can be injured or killed. Farther from the blast, an animal may suffer nonlethal physical impacts. Outside of these zones of death and physical injuries, marine mammals may experience hearing-related impacts with or without behavioral responses. A limited amount of information is available on the impacts of explosions on marine mammals (O'Keeffe and Young, 1984; Ketten, 1998). However, BOEM (then BOEMRE) issued "Decommissioning Guidance for Wells and Platforms" (NTL 2010-G05), which specifies and references mitigation requirements in the current ESA and MMPA guidance and which should minimize the chance of a marine mammal being impacted from explosive severance activities. "Decommissioning Guidance for Wells and Platforms" (NTL 2010-G05) is discussed in **Chapter 4.9.1.2** ("Routine Activities").

Industry noise sources include seismic operations, fixed platforms and drilling rigs, drilling ships, low-flying aircraft, vessel traffic, and explosive operations, particularly for structure removal. **Chapter 3.1** describes the offshore infrastructure and activities (impact-producing factors) associated with a proposed lease sale. A discussion of all activities that are projected from past, present, and future lease sales during a 70-year activity period (2017-2086) can be found in **Chapter 3.3**.

Accidental events related to a proposed action, as discussed above, have the potential to have adverse, impacts to marine mammal populations in the GOM.

Oil spills may cause chronic (long-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) impacts on marine mammals. Long-term impacts include (1) decreases in prey availability and abundance because of increased mortality rates, (2) change in age-class population 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). The impacts of cleanup activities are unknown, but increased human presence (e.g., vessels) could add to changes in marine mammal behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic impacts. However, there is no supporting evidence that marine mammal populations of the GOM are impacted by the cumulative OCS oil-and-gas related activities. Therefore, the incremental cumulative contribution of OCS- oil and gas-related activities is expected to have **negligible** to **major** impacts.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS energy-related activities that may affect marine mammal populations include pollution, marine debris, explosive severance of structures in non-OCS State waters as part of State oil- and gas-related activities, vessel traffic and related noise (e.g., from military operations, commercial shipping, and research vessels); commercial and recreational fishing (**Chapters 4.10 and 4.11**), scientific research, diseases, UMEs, and natural phenomena. Specific types of impact-producing factors considered in this cumulative analysis include noise from numerous sources, pollution, ingestion and entanglement in non-OCS marine debris, and vessel strikes.

Pollution in the ocean comes from many point (e.g., non-OCS discharges, factories, wastewater treatment facilities) and nonpoint (e.g., drainage, precipitation, land runoff) sources, and the GOM is certainly no exception. The drainage of the Mississippi River results in massive amounts of chemicals and other pollutants being constantly discharged into the GOM. 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) and does not support adequate food resources due to its low oxygen levels (refer to **Chapter 3.3.2.12**). Primarily, bottlenose dolphins and manatees are most at risk for nearshore pollution. Bottlenose dolphins have been reported having very high levels of contaminants, including heavy metals, in tissue samples (Borrell, 1993). Since other marine mammals are not commonly found in coastal waters, they are less likely to be impacted by nearshore pollution. Prey species also affect the influence of pollution on marine mammals. Biomagnification in fish results in the generally higher contaminant levels in fish-eating marine mammals (Gray, 2002). Manatees are herbivores, but pollution and habitat degradation may impact the manatee. Manatees are exposed to herbicides by ingesting aquatic vegetation containing concentrations of these compounds (O'Shea et al., 1984). The propensity of manatees to aggregate at industrial and municipal outfalls also may expose them to high concentrations of contaminants (Stavros et al., 2008). Antifouling bottom paint on the hulls of boats has been linked to the release of contaminants (Schiff et al., 2004). For coastal dolphins and especially manatees that are very well known to frequent marinas and that scratch on the hulls of vessels, areas with high concentrations of vessels may have extremely polluted waters. However, there are non-OCS regulations that limit the discharge of pollutants in State waters (e.g., NPDES). Therefore, impacts to marine mammals from non-OCS pollutants would be **negligible** to **minor**.

Ingestion of, or entanglement in, non-OCS marine debris is a global concern for marine organisms. Estimates indicate that approximately 6.4 million tons of marine litter is dumped in oceans every year, resulting in an estimated 13,000 pieces of litter per square kilometer of ocean (United Nations Environment Programme, 2005). There is general consensus that land-based sources are the dominant origin of marine debris, contributing up to 49 percent, with marine or undetermined sources contributing the remainder (Sheavly and Register, 2007). 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); however, ingestion of net materials can also be fatal (Jacobsen et al., 2010). Plastics are very persistent, yet they are not immune to degradation. Microplastics, or microscopic plastic particles, may be ingested by a wide range of organisms, and there are indications that microplastics are propagated over trophic levels of the marine food web (Farrell and Nelson, 2013; Setälä et al., 2014). Therefore, marine mammals may be ingesting plastic particles through consumption of various prey sources.

Entanglement in marine debris can cause decreased swimming ability, disruption in feeding, life-threatening injuries, and death. 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 from a variety of vessels. Impacts from non-OCS marine debris are expected to be **negligible** to **major**. An example of a negligible impact would be if small pieces of marine debris were ingested by a marine mammal species and then later passed through their digestive tract with no complications. An example of a major impact would be if a discarded monofilament fishing net were to cause physical injury or mortality to a marine mammal species with a low population estimate (e.g., Bryde's whale).

Structure removals that take place in GOM State waters are under the jurisdiction of the COE. Impacts to marine mammals from these activities are similar to the impacts discussed in **Chapter 4.9.1.2** ("OCS Oil- and Gas-Related Impacts") and may potentially include injury or death from shockwave depending on the intensity of the shock wave and size and depth of the animal; nonlethal physical effects; and hearing-related effects with or without behavioral responses.

Numerous sources of aircraft fly over the coastal and offshore areas. The air space over the GOM is used extensively by DOD for conducting various air-to-air and air-to-surface operations. Eleven military warning areas and six water test areas are located within the GOM, as stated in NTL 2009-G06, "Military Warning and Water Test Areas" (**Figure 2-7**). Additional activities, including vessel operations and ordnance detonation, also may impact marine mammals. Subject to Federal Aviation Administration guidelines, private and commercial air traffic further traverse these areas and have the potential to cause impacts to marine mammals.

The GOM has very little fishery interaction with marine mammals compared with other areas. However, marine mammals can be injured or killed by commercial fishing gear. Mammals can either get caught on longline hooks or can be entrained into a net by a shrimp boat or groundfish vessel. There is also the chance of entanglement by lines from crab traps to buoys. Gillnets, which have now been banned in many places around the GOM, have been reported to take marine mammals. However, recent reports of these impacts are uncommon. Depending on the type of fishing gear and the number of marine mammals affected by the interaction with the fishing gear, impacts would be **negligible** to **major**. An example of a negligible impact would be if a marine mammal species observed fishing activities, made no behavior change, and ultimately had no interaction with the fishing gear or activities. An example of a major impact would be if a commercial fishing net were to cause physical injury or mortality to a marine mammal species with a low population estimate (e.g., killer whale).

All manner of commercial shipping vessels, commercial fishing vessels, military ships, research ships, recreational craft, and others are always present in the GOM and increases the possibility of vessel collisions between vessels and marine mammals. Slow-moving marine mammals or those that spend extended periods of time at the surface might be expected to be the most vulnerable (Vanderlaan and Taggert, 2007). In 2014, approximately 85 percent of human-caused manatee mortalities in Florida were attributed to collisions with watercraft (State of Florida, Fish and Wildlife Conservation Commission, 2015c). Noise from various non-OCS vessels could interfere with marine mammal communication either by masking important sounds from conspecifics, masking sounds from predators, or by forcing animals to alter their vocalizations (Tyack, 2008).

Some factions of the boating public, mainly recreational fishermen and boaters, create adverse impacts by paying too much attention to marine mammals. Reports of harassment, inappropriate feeding, and even attempting to swim with marine mammals are common. Dolphins have been injured and killed after becoming accustomed to being fed by humans. Animals become sick from eating the "food" that people throw. Very close approaches by boats are likely major causes of stress in marine mammals, as is chasing and following.

Scientific research can impact marine mammal species. Numerous marine mammal research cruises have been conducted, and permitted activities have included tagging and biopsy sampling. The U.S. protocols are always in place to keep the mammals safe, but some of the research techniques do involve harassment and possible stress to the animal. Scientific seismic studies often use the same tools and techniques as industry seismic work, which could have the same impacts to marine mammals. Scientific groundfish or shrimp cruises can entrap a dolphin in a net just as commercial fisheries can. In 2011, a scientific cruise that was associated with NRDA killed six dolphins while sampling fish with nets. Scientific aerial surveys are also periodically conducted in the GOM, and aircraft can startle marine mammals. Circling pods for identification may stress multiple individuals in a pod. Such marking techniques as freeze branding were used in the past to do mark-recapture studies. This required the live capture and branding of dolphins. Both the Navy and the public-display industry took bottlenose dolphins from the GOM in years past. A moratorium on live captures has been in effect for several years, as captive breeding programs have become successful enough to provide dolphins for aquariums and zoos.

Occasionally, numbers of marine mammals strand, either alive or already dead. Die-offs happen infrequently but can seriously deplete small, discrete stocks. The causes of die offs are not always well known and vary by event. Some appear to be triggered by natural events (i.e., unusually cold weather) but others are suspected to at least be indirectly caused by pollution of various contaminants. Exposure to certain compounds may weaken the natural immunity of marine mammals and make them susceptible to viruses and diseases that would normally not affect them. Certain viruses, such as morbilliviruses, which affect the lungs and brain in cetaceans, are being observed more frequently than in the past (USDOC, NMFS, 2013). A red-tide event that began in southwest Florida in late September 2012 claimed the highest number of red-tide-related manatee deaths in a single calendar year on record (State of Florida, Fish and Wildlife Conservation Commission, 2015c). The NMFS may declare a large die-off to be an UME, which is defined under the MMPA as "a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response" (USDOC, NMFS, 2015e). The causes for more than 20 UMEs that have been declared by NMFS in the GOM region since 1991 have either been due to infectious diseases or biotoxins, or were declared undetermined. However, some UMEs in the GOM are still ongoing and may be subject to change as new information from these strandings becomes available. The most recent information for UMEs in the GOM can be found on the NMFS website (USDOC, NMFS, 2015f).

Impacts from climate change to marine mammals have become a concern, and responses both at the individual and population level of marine mammal species to climate change are poorly understood (Evans and Bjørge, 2013). Making predictions about future impacts becomes even more speculative. In the last 15 years, a number of marine mammal scientists have attempted to do this (Tynan and DeMaster, 1997; International Whaling Commission, 1997; Würsig et al., 2002; Learmonth et al., 2006; Simmonds and Isaac, 2007; Huntington and Moore, 2008; Kovacs and Lyderson, 2008; Laidre et al., 2008; International Whaling Commission, 2009; MacLeod, 2009; Evans et al., 2010; Kaschner et al., 2011). Some of major hypothesized impacts to marine mammals from climate change are changes in water temperatures, which may result in distribution changes, changes to physical habitat, changes to the food web, thermal Intolerance (e.g. heat stress), and susceptibility to increased diseases and contaminants (Evans and Bjørge, 2013). Lastly, tropical storms and hurricanes are normal occurrences in the GOM and along the Gulf Coast. Generally, the impacts have been localized and infrequent. However, the GOM has been hit extremely hard by very powerful hurricanes. Few areas of the coast have not suffered some damage in 2004 and 2005, and activities in the GOM have also been severely impacted. In 2004, Hurricane Ivan took a large toll on oil and gas structures and operations in the GOM and caused widespread damage to the Alabama-Florida Panhandle coast. In 2005, Hurricanes Katrina, Rita, and Wilma reached Category 5 strength in the GOM, and these hurricanes were followed in 2008 by Hurricane Gustav and by Hurricane Isaac in 2012. These storms caused damage to all five of the Gulf Coast States and damage to structures and operations both offshore and onshore. The actual impacts of these storms on marine mammals in the GOM have not yet been determined and, for the most part, may remain very difficult to quantify.

The impacts of such natural disasters on marine mammal populations are poorly understood and difficult to assess due to the limited predictability of storm occurrence, course, strength, and location of impact. Some immediate and direct impacts of hurricanes on marine mammals have been documented, such as the temporary displacement or stranding of individuals (e.g., dugongs [*Dugong dugon*; Marsh, 1989]; pygmy killer whales [*Feresa attenuata*; Mignucci-Giannoni et al., 1999]; and bottlenose dolphins [*Tursiops truncatus*; Rosel and Watts, 2008]). Under some circumstances, hurricanes can cause massive mortalities of fish and destruction of their habitats in coastal and estuarine ecosystems (Tabb and Jones, 1962) causing dolphins to be temporarily displaced when seeking new foraging areas.

Evaluation of long-term impacts of severe storms to marine mammals requires multi-year studies to be in place prior to a disaster to adequately measure the impacts (Smith et al., 2013), in which there are few. Langtimm et al. (2006) found that the destruction of habitat in important foraging areas following severe tropical systems may have indirectly increased mortality in Florida manatees (*Trichechus manatus latirostris*) (Langtimm et al., 2006). However, some evaluations of long-term impacts to coastal marine mammals have documented their resilience and adaptability. Miller et al. (2010) investigated the impacts of Hurricane Katrina on bottlenose dolphin reproduction in the Mississippi Sound area. The study reported an increase in reproduction, which was attributed, in part, to a potential increase in prey abundance in the area following a widespread decrease in annual fisheries landings in the area during the year following the storm (Miller et al., 2010). A similar study in the same area by Smith et al. (2013) also found that bottlenose dolphin foraging activity increased significantly following the passage of Hurricane Katrina, suggesting that there may have been an increase in feeding opportunity, prey abundance, and/or a need for increased food consumption likely attributed to the same decrease in annual fisheries landings. Cumulative incremental impacts to marine mammals, when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, and the minimization of OCS oil- and gas-related impacts through lease stipulations and regulations, would be expected to be **negligible** as a result of a proposed lease sale. This is because marine mammals are wide-ranging and population-level impacts are not anticipated. However, cumulative impacts could have a **major** impact on particular marine mammal species with a low population level, dependent upon the level of impact and number of individuals affected by it (e.g., if an impact to a Bryde's whale [population estimate of 33 individuals] were to result in a mortality, it would diminish the continued viability of the population including the annual rates of recruitment or survival).

Incomplete or Unavailable Information

BOEM has identified incomplete information regarding impacts of the *Deepwater Horizon* explosion, oil spill, and response on marine mammals in the GOM. This incomplete information may be relevant to the evaluation of adverse impacts because it could provide changes in the baseline environmental conditions for marine mammals in the affected environment from the *Deepwater Horizon* oil spill and response, exacerbating any impacts from a proposed action. Much of these data are being developed through the NRDA process, which may take years to complete. Even after it is available, the impacts of the oil spill may be difficult or impossible to discern from other factors.

The NMFS declared an UME for cetaceans (whales and dolphins) in the northern Gulf of Mexico in February 2010, before the *Deepwater Horizon* explosion, oil spill, and response. In addition to investigating all other potential causes, scientists are investigating what role *Brucella* may have played in the UME, which is still in effect as of publication of this Multisale EIS. *Brucella* spp. refers to a genus of bacteria that infect many terrestrial and aquatic vertebrates around the world. The disease, called brucellosis, is best known for its role in causing abortion in domestic livestock and undulant fever in people. Updated information on *Brucella* and its role in this UME can be found on NMFS's website (USDOC, NMFS, 2015e).

It is unclear at this time whether the increase in strandings is related partially, wholly, or not at all to the *Deepwater Horizon* explosion, oil spill, and response. According to the NMFS website referenced above, which is the only publicly available source of information at this time on the UME, evidence of the UME was first documented by the NMFS as early as February 2010, nearly 2 months prior to the *Deepwater Horizon* explosion and oil spill. The NMFS has also documented an additional 12 UMEs that have been previously declared in the GOM for cetaceans (an additional 7 specific to manatees only) since 1991. However, studies published from the NRDA process evaluating the possible impacts of the *Deepwater Horizon* explosion, oil spill, and response on bottlenose dolphins exposed to oiling have shown overall poor health and prevalence of poor body condition, disease, and abnormalities as compared with bottlenose dolphins in the Gulf of Mexico that were not exposed to oiling (Schwacke et al., 2013; Venn-Watson et al., 2015). Bacterial pneumonia was also identified from dolphins before and during the UME but it was detected more in the UME dolphins (Venn-Watson et al., 2015). Continued research would provide a better understanding about the UME, which is still under investigation as of the publication of this Multisale EIS. While this information may ultimately be useful in expanding the available knowledge on baseline environmental conditions following the *Deepwater Horizon* explosion, oil spill, and response, it remains difficult to draw specific conclusions regarding the current overall bottlenose dolphin population in the GOM. It is also important to note that evaluations have not yet confirmed the cause of death, and it is possible that many, some, or no carcasses collected were related to the *Deepwater Horizon* explosion, oil spill, and response.

Even with recent publications, such as the Venn-Watson et al. (2015) marine mammal study, the best available information on impacts to GOM marine resources does not yet provide a complete understanding of the impacts of the oil spill and active response/cleanup activities from the

Deepwater Horizon explosion and oil spill on marine resources as a whole in the GOM and whether these impacts reach population-level impacts. Relevant data on the status of marine mammal populations after the UME and *Deepwater Horizon* explosion, oil spill, and response may take years to acquire and analyze, and impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. For example, even 20 years after the *Exxon Valdez* spill, the long-term impacts to marine mammal populations are still being investigated (Matkin et al., 2008). Therefore, it is not possible for BOEM to obtain this information within the timeline contemplated for analysis in this Multisale EIS, regardless of the cost or resources needed. Unavailable information, such as the anthropogenic impacts following an oil-spill response and the population variation due to naturally occurring events such as hurricanes and heightened stranding numbers, provides challenges in understanding the baseline conditions and changes within marine mammal populations. However, BOEM used existing information and reasonably accepted scientific methodologies to extrapolate from available information in completing the relevant analysis of potential oil exposure impacts to marine mammals using studies investigating evidence of oil and impacts stemming from exposure to oil (Schwacke et al., 2013; Venn-Watson et al., 2015). Although additional information may be relevant to the evaluation of impacts to marine mammals, BOEM has determined that the incomplete information is not essential to a reasoned choice among alternatives because none of the sources reveal reasonably foreseeable significant adverse impacts to marine mammals not otherwise considered in this Multisale EIS (e.g., the assumption that released oil and dispersants could reduce fitness of individuals). In addition, non-OCS energy-related factors would continue to occur in the GOM irrespective of a proposed action.

Nevertheless, there are existing leases in the GOM with either ongoing or the potential for exploration, drilling, and production activities. In addition, non-OCS oil- and gas-related activities would continue to occur in the GOM irrespective of a proposed action (e.g., fishing, military activities, and scientific research).

4.9.1.2.1 Alternatives A, B, C, and D

With respect to marine mammal species, the effects associated with selection of any of the alternatives would be equivalent because of the diversity and distribution of marine mammal species throughout the potential areas of interest. The preceding analyses assumed a wide distribution of species and considered impacts to marine mammal species occurring in a wide range of habitats across all planning areas. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), marine mammal species are widely distributed throughout the planning areas. As such, activities isolated to specific planning areas pose similar potential impacts to individuals as do activities occurring in all planning areas. Therefore, a similar mix of species would be exposed to the analyzed impact-producing factors, regardless of the specific action alternative selected. The activities proposed under Alternatives A, B, C, and D could directly impact marine mammal species within the GOM and contribute incrementally to the cumulative effects on these species. Although there would always be some level of incomplete information on the impacts from routine activities under a proposed action on marine mammals, there is credible scientific information, applied using acceptable scientific methodologies, to support the conclusion that any realized impacts would be sublethal in nature and not in themselves rise to the level of reasonably foreseeable significant adverse (population-level) impacts. Also, routine activities would be ongoing in the proposed action area as a result of active leases and related activities. There are no data to suggest that routine activities from the previous OCS Program are significantly impacting marine mammal populations. The net result of any disturbance would depend upon the size and percentage of the population likely to be affected, the ecological importance of the disturbed area, the 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). Accidental events that involve large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (i.e., days, weeks, or months), pose an increased likelihood of impacting marine mammal populations inhabiting these waters.

The effects of a proposed action, when viewed in light of the impacts associated with other past, present, and reasonably foreseeable future activities, may result in greater impacts to marine mammals than before the *Deepwater Horizon* explosion, oil spill, and response; however, the magnitude of those impacts cannot yet be determined. Nonetheless, operators are required to follow all applicable lease stipulations and regulations, as clarified by NTLs, to minimize these potential interactions and impacts. The operator's reaffirmed compliance with NTL 2012-JOINT-G01 ("Vessel Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2012-BSEE-G01 ("Marine Trash and Debris Awareness and Elimination"), as well as the limited scope, timing, and geographic location of a proposed lease sale, would result in negligible impacts from the proposed drilling activities on marine mammals. In addition, NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimizes the potential for injury from seismic operations to marine mammals. These mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source. The Protected Species Stipulation, if applied, requires compliance with any terms and conditions from past and future biological opinions from the NMFS and FWS.

Cumulative impacts on marine mammals are expected to result in a number of chronic and sporadic sublethal impacts (i.e., behavioral effects and nonfatal exposure to or intake of OCS oil- and gas-related or non-OCS oil- and gas-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 (Harvey and Dahlheim, 1994). Disturbance (i.e., noise from vessel traffic and drilling operations) 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 (Harvey and Dahlheim, 1994). There is potential for impacts from routine activities or accidental events to be greater on individuals or populations already impacted by other OCS oil- and gas-related or non-OCS oil- and gas-related impact-producing factors. However, within the GOM, there is a long-standing and well-developed OCS Program (more than 50 years) and there are no data to suggest that activities from the previous OCS Program are significantly impacting marine mammal populations.

The incremental contribution of a proposed lease sale (Alternatives A, B, C, or D) to cumulative impacts to marine mammal populations, depending upon the affected species and their respective population estimate, even when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response; non-OCS oil- or gas-related factors; and the minimization of OCS oil- or gas-related impacts through lease stipulations and regulations, would be expected to be **negligible** to **moderate** as a result of a proposed action (Alternatives A, B, C, or D) and the period analyzed.

4.9.1.2.2 Alternative E—No Action

If selected, Alternative E would not contribute to impacts on marine mammal species within the GOM. However, cumulatively, the impacts resulting from the routine activities and accidental events and the cumulative impacts from previously permitted activities and prior lease sales would continue and be unchanged from the conclusion reached for the action alternatives because of existing oil and gas activities. Therefore, the significance of impact-producing factors on marine mammals would be the same for Alternative E as the impacts discussed in **Chapter 4.9.1.2** for previously permitted activities and prior lease sales.

4.9.2 Sea Turtles

Five sea turtles are known to inhabit the waters of the GOM (Pritchard, 1997): the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempii*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*). These five species are all highly migratory with individual animals migrating into nearshore waters as well as other areas of the Gulf of Mexico, North Atlantic Ocean, and the Caribbean Sea. All of the sea turtles species found in the GOM are protected under the Endangered Species Act of 1973. The FWS and NMFS share Federal jurisdiction for sea turtles. The FWS has responsibility for sea turtles (i.e., eggs, hatchlings, and nesting turtles) on the nesting beaches, and the NMFS has jurisdiction for sea turtles in the marine environment. Refer to **Chapter 4.9** above for additional information. The approach of this analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as reasonably foreseeable accidental events and cumulative impacts, and to define impact-level measures for each impact-producing factor under a proposed action (refer to **Table 4-13** in **Chapter 4.9**).

4.9.2.1 Description of the Affected Environment

All five species of sea turtles found in the GOM have been federally listed as endangered or threatened since the 1970's. Information on individual species is discussed in the subsections below this general introduction. Information relevant to all five species, such as status reviews and nesting, are discussed here.

After reviewing all of the best scientific and publicly/commercially available information, the NMFS recommended that the current listing classification for each of the five sea turtle species remain unchanged in the GOM. In 2009, the NMFS completed a status review of loggerhead sea turtles, and on September 22, 2011, the NMFS issued the final rule to list nine Distinct Population Segments (DPSs) of loggerhead sea turtles under the ESA and designated the GOM under the Northwest Atlantic Ocean DPS (*Federal Register*, 2011b). The Kemp's ridley 5-year review was completed in July 2015 and the status has not changed (USDOC, NMFS and USDOI, FWS, 2015). In 2015, the NMFS completed a status review of green sea turtles, and although a proposed rule (*Federal Register*, 2015g) to designate green sea turtles as the North Atlantic DPS in the GOM was extended on August 26, 2015, the threatened status still remains. In 2013, the 5-year reviews for leatherback and hawksbill sea turtles were updated and the status has not changed (USDOC, NMFS and USDOI, FWS, 2013a and 2013b).

Nesting on the U.S. Gulf Coast has been documented for the five species of sea turtles; loggerheads and Kemp's ridleys are the most common, followed by green sea turtles, and finally leatherback and hawksbill sea turtles, which rarely nest in the GOM (USDOC, NMFS and USDOI, FWS, 2007a-c, 2013a, and 2013b). While nesting female sea turtles can provide a useful index of specific species' population size by looking at trends in the number of crawls, estimating clutch size, hatchlings, etc.; there are still data gaps to accurately assess overall population trends (NRC, 2010b). An example of why population estimates are difficult is that the reported status and trends are variable for subpopulations and nesting aggregations. Data can be found for sea turtle nesting through different websites, including the National Park Service who has data for Texas (USDOI, NPS, 2016), Alabama's Sea Turtle Conservation Program (Share the Beach, 2015), and the State of Florida, Fish and Wildlife Conservation Commission's websites (State of Florida, Fish and Wildlife Conservation Commission, 2016a).

Although the use of turtle excluding devices has lessened interactions, fisheries impacts remain as the biggest threat to sea turtles (Lewison et al., 2013). Additionally, gas embolisms or decompression sickness has been recently observed in sea turtles caught as bycatch similar to that observed in postmortem humans that were autopsied, for example, following scuba diving accidents (Garcia-Parraga et al., 2014). Natural phenomenon, such as tropical storms and hurricanes, occur in the GOM and may impact nesting beaches (Dewald and Pike, 2013), depending on timing, size, and location of the storm. Storm impacts to nesting activity can be difficult to assess, but beach erosion has been shown to be one of the major factors affecting turtle hatchling success (Brost et al., 2015). Within the planning areas, offshore species and the offshore habitat are not expected to be severely affected in the long term by natural events.

The Sea Turtle Stranding and Salvage Network monitors and investigates sea turtle strandings. The NMFS provides stranding data for the Gulf of Mexico (i.e., Texas, Louisiana, Mississippi, and Alabama) through its Office of Protected Resources site. These data are updated when the NMFS has the complete dataset from the Sea Turtle Stranding and Salvage Network. Because this can change at any time, BOEM refers the reader to the NMFS's website (USDOC, NMFS, 2015g). Florida is not included in the NMFS's Gulf of Mexico stranding data; however, Florida-specific stranding data can be found on the State of Florida, Fish and Wildlife Conservation Commission's Florida Sea Turtle Stranding and Salvage Network website (State of Florida, Fish and Wildlife Conservation Commission, 2016b). There are many reasons, both natural and human caused, for the strandings in the northern GOM (USDOC, NMFS, 2015g). Looking at the NMFS's 2011-2013 data, stranding events, primarily in Mississippi, have included all five listed species. The majority of these turtles have been endangered Kemp's ridleys, loggerhead, and green turtles. However, stranding data are not indicative of population status because there are too many uncertainties associated with those data (Epperly et al., 1996; Nero et al., 2013).

Niedeoroda et al. (2014) modeled relative environmental sensitivity to BOEM-regulated OCS oil- and gas-related activities for nine OCS regions. Sea turtles selected as representative species for the model in the GOM included green, hawksbill, and Kemp's ridley sea turtles; loggerheads were used in the southeast OCS for marine species' impact sensitivity (i.e., vulnerability and resilience). Niedeoroda et al. (2014) also modeled offshore and shoreline habitat sensitivity. Overall, the eastern GOM and southeast U.S. continental shelf had the highest relative environmental sensitivity of the nine OCS regions, although loggerhead sensitivity ranked lower than the others out of the top species, with the 10 highest averages. Hawksbills in the GOM ranked slightly lower than the loggerhead in the southeast OCS. Live hard bottoms ranked second among the 25 environmentally sensitive habitats, and open water and *Sargassum* also ranked relatively high on the list. This model was based on species and habitat parameters that were used, and scoring was difficult due to behavior considerations and overall lack of environmental data (Niedeoroda et al., 2014).

Loggerhead Sea Turtle

The loggerhead sea turtle was listed as threatened on July 28, 1978 (*Federal Register*, 1978). It is still considered threatened under the reclassification as the Northwest Atlantic Ocean DPS in the GOM (*Federal Register*, 2011b). Loggerhead turtles have been primarily sighted in waters over the continental shelf, although many surface sightings of this species have also been made over the outer slope beyond the 1,000-m (3,281-ft) isobath. Additionally, Van Houtan and Halley (2011) modeled oceanographic processes in relation to loggerhead regional population dynamics and found that they are strongly correlated; therefore, they should be considered in baseline conditions. Sightings of loggerheads in waters over the continental slope suggest that they may be in transit through these waters to distant foraging sites or while seeking warmer waters during the winter. Although loggerheads are widely distributed during both summer and winter, their abundance in surface waters over the slope was greater during winter than in summer (Mullin and Hoggard, 2000). Adult loggerheads are known to make extensive migrations between foraging areas and nesting beaches. During nonnesting years, adult females from U.S. beaches are distributed in waters off the eastern U.S. and throughout the Gulf of Mexico, Bahamas, Greater Antilles, and Yucatán (Conant et al., 2009).

Major nesting areas include the coastal islands of Georgia, South Carolina, and North Carolina, Florida's Atlantic coasts. In the GOM, major nesting areas include some coastal beaches in Mississippi, Alabama, and Florida. In the western Atlantic, most loggerhead sea turtles nest in the geographic area ranging from North Carolina to the Florida Panhandle. Reproductive adult females return to their original hatching site to nest, preventing recolonization with turtles from other nesting beaches. The southeastern U.S. nesting aggregation, which is mainly in the Atlantic, is of great importance on a global scale and is second in size only to the nesting aggregation on islands in the Arabian Sea off Oman (Ross, 1979; Ehrhart, 1989; USDOC, NMFS and USDOI, FWS, 2007b). Nesting data trends are declining in this species (*Federal Register*, 2011b; Witherington et al., 2009; Lamont et al., 2012). Five recovery units have been identified; three that are relevant are Peninsular Florida, Dry Tortugas, and the northern GOM. According to Ehrhart et al. (2003), the peninsular Florida Recovery Unit represents approximately 87 percent of all nesting effort in the Northwest Atlantic Ocean DPS. Atlantic loggerhead sea turtles concentrate their nesting in the north and south temperate zones and subtropics, and they generally do not nest in tropical areas (Magnuson et al., 1990; USDOC, NMFS and USDOI, FWS, 2007b).

Developmental habitat for small juveniles is in the open ocean. Offshore, they reside for months in the oceanic zone in *Sargassum* floats, generally along the Loop Current and the west coast of Florida. Refer to **Chapter 4.5** (*Sargassum* and Associated Communities) for additional information on pelagic waters. Somewhere between 7 and 12 years old, oceanic juveniles migrate to nearshore coastal areas to mature into adults. These nearshore waters become important foraging and migratory habitat for juveniles and adults. Juveniles may also spend time in bays, sounds, and estuaries (Epperly et al., 2007). Benthic immature loggerheads have been found from Cape Cod, Massachusetts, to southern Texas (USDOC, NMFS and USDOI, FWS, 2007d). Large benthic immature loggerheads (28-36 in; 70-91 cm) represent a larger proportion of the strandings and in-water captures along the south and western coasts of Florida as compared with the rest of the coast. Benthic immature loggerheads foraging in northeastern U.S. waters are known to migrate southward in the fall as water temperatures cool (Epperly et al., 1995; Morreale and Standora, 1999) and migrate northward in spring. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd, 1988). Subadult and adult loggerheads are primarily coastal and typically prey on benthic invertebrates such as mollusks and decapod crustaceans in hard bottom habitats. McClellan and Read (2007) found that the shift from oceanic to neritic (i.e. coastal) waters is complex and reversible; some move into coastal waters and then return to open ocean.

Loggerheads mate in late March through early June in the southeastern U.S. Females emerge from the surf, excavate a nest cavity in the sand, and deposit a mean clutch (number of eggs per nest) size of 100-126 eggs (USDOC, NMFS, 2013). Individual females nest multiple times during a nesting season, with a mean of 4.1 nests/nesting individual (Murphy and Hopkins, 1984). Nesting migrations for an individual female loggerhead are usually on an interval of 2-3 years but can vary from 1 to 7 years (Dodd, 1988). Loggerhead sea turtles originating from the western Atlantic nesting aggregations are believed to lead a pelagic existence in the North Atlantic gyre for as long as 7-12 years, but there is some variation in habitat use by individuals at all life stages. Stranding records indicate that, when pelagic immature loggerheads reach a 16- to 24-in (40- to 60-cm) straight-line carapace length, they begin to recruit to coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic and GOM. Bjorndal et al. (2013) combined datasets over a large spatial scale (range of 9-33°N. latitude) to examine northwest Atlantic loggerhead growth rates and found that there was a decline with increasing body size. Their study indicated that latitude may be a major factor for smaller turtles (<2.6 ft; 80 cm) and that loggerheads may grow more rapidly in waters south of the U.S., noting that more data are needed for those waters to determine growth rates (Bjorndal et al., 2013).

Several recent reports are available concerning GOM loggerheads' nesting habitats and movements (Hart et al., 2013a), post-nesting behavior (Foley et al., 2013), foraging sites (Foley et al., 2014; Tucker et al., 2014), and body size effects on growth rates (Bjorndal et al., 2013). These reports confirm the importance of Gulf of Mexico beaches, specifically for loggerheads. Lamont et al. (2015) also published a report on the importance of the GOM for different life stages of the Northwest Atlantic Ocean DPS. Lamont et al. (2015) suggested that the loss of individual habitats could have long-term consequences to population recovery by affecting several life stages. Additional relevant information can be found in **Chapter 4.3.2** (Coastal Barrier Beaches and Associated Dunes).

Ongoing threats to the western Atlantic loggerhead populations include incidental takes from dredging, commercial trawling (Epperly et al., 2002), longline fisheries (Lewison et al., 2004), and gillnet fisheries; loss or degradation of nesting habitat from storms (Brost et al., 2015) or coastal development and beach armoring; disorientation of hatchlings by beachfront lighting; nest predation by native and nonnative predators (Brost et al., 2015); degradation of foraging habitat; marine pollution and debris; watercraft strikes; and disease (USDOC, NMFS and USDOI, FWS, 2007b).

Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970 (*Federal Register*, 1970b). On September 22, 2011, the Final Bi-National (Mexico and U.S.) recovery plan for Kemp's ridleys was released. The 5-year review for Kemp's ridleys was released on August 21, 2015, and the classification did not change. This species was given higher recovery priority from the NMFS due to the potential for future extinction; while priority under the FWS remained the same (USDOC, NMFS and USDOI, FWS, 2015). Internationally, the Kemp's ridley sea turtle is considered the most endangered sea turtle throughout its range.

Kemp's ridleys have a restricted distribution through all its life stages relative to other sea turtle species. Data suggest that Kemp's ridley turtles are found mainly in coastal areas of the GOM and the northwestern Atlantic Ocean. Sea-water temperature plays an important role in the distribution of this species (Ogren, 1989; Renaud, 1995; Renaud and Williams, 2005). The nearshore waters of the GOM are believed to provide important developmental habitat for juvenile Kemp's ridley and loggerhead sea turtles. Ogren (1989) suggests that the Gulf Coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult Kemp's ridleys in the northern GOM. Juvenile/subadult Kemp's ridleys have been found along the Eastern Seaboard of the U.S. (Epperly et al., 2007) and in the GOM. Atlantic juveniles/subadults travel northward with spring warming to feed in the productive, coastal waters of Georgia through New England, returning southward with the onset of winter to escape the cold (Ogren, 1989; USDOC, NMFS and USDOI, FWS, 2015).

Kemp’s ridleys nest in daytime aggregations (April into July), known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico, Tamaulipas State (USDOC, NMFS and USDOI, FWS, 2015). Remigration of females to the nesting beach varies from annually to every 4 years, with a mean of 2 years (Turtle Expert Working Group, 1998). The mean clutch size for Kemp's ridleys is 100 eggs per nest, with an average of 2.5 nests per female per season. According to the 2011 bi-national recovery plan, nests in and surrounding Rancho Nuevo exceeded 20,000, thereby representing 8,000 females for 2009 (Secretariat of Environment & Natural Resources et al., 2011). Kemp’s ridley sea turtle nests have increased in recent years along the South Padre Island National Seashore in Texas (USDOI, NPS, 2016).

In the GOM, juvenile/subadult Kemp’s ridleys occupy shallow, coastal regions. Little is known of the movements of the post-hatching, planktonic stage within the GOM, although model predictions suggest that it is mainly in waters offshore of Tamaulipas, Mexico (Putman et al, 2013). Studies have shown the post-hatchling pelagic stage varies from 1 to 4 years, and the benthic immature stage lasts 7-9 years (Schmid and Witzell, 1997). Benthic immature turtles with an 8- to 24-in (20- to 60-cm) straight-line carapace length are found in nearshore coastal waters including estuaries of the GOM and the Atlantic, although adult-sized individuals sometimes are found on the Eastern Seaboard of the U.S. The post-pelagic stages are commonly found dwelling over crab-rich sandy or muddy bottoms. Juveniles frequent bays, coastal lagoons, and river mouths. Adults of this species are usually confined to the GOM, although adult-sized individuals sometimes are found on the Eastern Seaboard of the U.S. The Turtle Expert Working Group (1998) estimates age at maturity to range from 7 to 15 years.

Stomach contents of Kemp’s ridleys along the lower Texas coast consisted of a predominance of nearshore crabs and mollusks, as well as fish, shrimp, and other foods considered to be shrimp fishery discards (Shaver, 1991). Pelagic stage, neonatal Kemp’s ridleys presumably feed on the available *Sargassum* and associated infauna or other epipelagic species found in the GOM (USDOI, FWS, 2015a). Shaver et al. (2013) described Kemp’s ridley nearshore foraging habitat “hotspots” in the northern GOM and, in another study, rehabilitated juveniles that were released showed similar foraging areas in coastal areas of Louisiana and Florida (Lyn et al., 2012).

Of the five species in the GOM, the Kemp’s ridley has suffered the greatest population decline, and historically, that decline was caused by commercial and local exploitation. Many natural and anthropogenic threats to the future of the species remain, including interactions with fishery gear (and managing agencies’ continued concern for the adequacy of existing regulatory mechanisms), dredging, marine pollution, foraging habitat destruction, entrainment in power plant cooling system intake structures, potential for illegal poaching of nests, cold stunning (turtles are lethargic and stressed from cold temperatures, which could lead to disorientation and mortality), and the potential threats to nesting beaches from such sources as global climate change and development (USDOC, NMFS and USDOI, FWS 2015).

Green Sea Turtle

Federal listing of the green sea turtle occurred on July 28, 1978 (*Federal Register*, 1978). All green sea turtle populations are listed as threatened except for the breeding populations of Florida and the Pacific Coast of Mexico, which are endangered. The NMFS and FWS have proposed a rule (*Federal Register*, 2015g) to remove the current range-wide listing for green sea turtles, to replace it with eight DPSs as threatened and three as endangered, and to include application of existing protective regulations to the DPSs. Green sea turtles found in the GOM are proposed to be part of the threatened North Atlantic DPS (*Federal Register*, 2015g).

Green sea turtle mating occurs in the waters off the nesting beaches. Each female deposits 1-7 clutches (usually 2-3) during the breeding season at 12- to 14-day intervals. Mean clutch size is highly variable among populations but averages about 110 eggs. Females usually have 2-4 years between breeding seasons, while males may mate every year (Balazs, 1983). The complete nesting range of the green sea turtle includes sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands between Texas and North Carolina and at the U.S. Virgin Islands and Puerto Rico (USDOC, NMFS and USDOI, FWS, 1991). Principal U.S. nesting areas for green sea turtles are in eastern Florida (Ehrhart and Witherington, 1992), but the most important nesting concentration in the western Atlantic is in Costa Rica because it has increased markedly since the 1970s (USDOI, NMFS and USDOI, FWS, 2007c).

After hatching, green sea turtles go through a post-hatchling pelagic stage where they move offshore and are associated with drift lines of algae, *Sargassum*, and other debris. The post-hatchlings are believed to live within these drift lines for several years, feeding close to the surface on a variety of pelagic plants and animals. The post-hatchling, pelagic-stage individuals are assumed to be omnivorous, but little data are available. Once the juveniles reach a certain age/size range, they leave the pelagic habitat and travel to nearshore foraging grounds. Once they move to these nearshore benthic habitats, adult green turtles are almost exclusively herbivores, feeding on seagrasses and algae. Age at sexual maturity is estimated to be between 20 and 40 years (USDOC, NMFS and USDOI, FWS, 2007c). Adult females migrate from foraging areas to mainland or island nesting beaches and may travel hundreds or thousands of kilometers each way (USDOC, NMFS and USDOI, FWS, 2007c).

Green sea turtles depend on shallow foraging grounds with sufficient benthic vegetation. Direct destruction of foraging areas from dredging, boat anchorage, deposition of spoil, and siltation (Coston-Clements and Hoss, 1983; Williams, 1988) may have considerable impacts on the distribution of foraging green turtles. Eutrophication, heavy metals, radioactive elements, and hydrocarbons all may reduce the extent, quality, and productivity of foraging grounds (Frazier, 1980; USDOC, NMFS and USDOI, FWS, 2007c).

The principal cause of past declines and extirpations of green sea turtle assemblages has been the over exploitation for eggs and meat. Significant threats on green turtle nesting in the region include beach armoring and erosion control, artificial lighting, and general disturbance from human activity, such as trampling. Armoring of beaches (e.g., seawalls, revetments, rip-rap, sandbags, and sand fences) in Florida, which is meant to protect developed property, is increasing and has been shown to discourage nesting, even when armoring structures do not completely block access to nesting habitat (Mosier, 1998). Marine debris is a threat to the pelagic habitat of juvenile green turtles. Older juvenile green turtles have also been found dead after ingesting seaborne plastics (Balazs, 1985). A major threat from manmade debris is the entanglement of turtles in discarded monofilament fishing line and abandoned netting (Balazs, 1985). This can have physical impacts in addition to more susceptibility to disease.

Ongoing threats to green sea turtles include the occurrence of green turtle fibropapillomatosis disease, which was originally reported in the 1930's (Smith and Coates, 1938). This disease is globally widespread and has been found to affect large numbers of animals in some areas, including Hawaii and Florida (Herbst, 1994; Jacobson, 1990; Jacobson et al., 1991). The tumors related to this disease are commonly found in the eyes, occluding sight. It was thought for many years that the cause of this disease was contributed by environmental pollutants; however, Keller et al. (2014) found the causing factor of fibropapillomatosis is not only related to environmental pollutants. Gillnets, trawl nets, pound nets (Crouse, 1982; Hillestad et al., 1982; NRC, 1990), and abandoned nets of many types (Balazs, 1985; Ehrhart et al., 1990) are known to kill sea turtles as bycatch. To address interactions between marine turtles and trawl fishing gear, the NOAA worked cooperatively with the commercial shrimp trawl industry to develop sea turtle excluder devices (*Federal Register*, 2015g). Green sea turtles are also threatened and taken by hook-and-line fishing. Collisions with power boats and encounters with suction dredges have killed green sea turtles along the U.S. coast and may be common elsewhere where boating and dredging activities are frequent.

Leatherback Sea Turtle

The leatherback sea turtle was listed as endangered on December 2, 1970 (*Federal Register*, 1970b). Leatherback distribution and nesting grounds are found around the world in waters of the Atlantic, Pacific, and Indian Oceans; the Caribbean Sea; and the Gulf of Mexico (Ernst et al., 1994; USDOC, NMFS and USDOI, FWS 2013a). Adult leatherbacks forage in temperate and subpolar regions from 71°N. to 47°S. latitude in all oceans and undergo extensive migrations between 90°N. and 20°S. latitude to and from the tropical nesting beaches (USDOC, NMFS and USDOI, FWS 2013a). Female leatherbacks nest from the southeastern U.S. (east coast of Florida) to southern Brazil in the western Atlantic Ocean and from Mauritania to Angola in the eastern Atlantic Ocean (USDOC, NMFS and USDOI, FWS, 2013a; USDOI, FWS, 2015b).

The leatherback is the most abundant sea turtle in waters over the northern GOM continental slope (Mullin and Hoggard, 2000). Leatherbacks appear to spatially use continental shelf and slope habitats in the GOM (Collard and Ogren, 1990; Davis and Fargion, 1996). Surveys indicate the region from Mississippi Canyon to De Soto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Mullin and Hoggard, 2000). Leatherbacks have been frequently sighted in the GOM during summer and winter (Mullin and Hoggard, 2000). They nest frequently (up to 7 nests per year) during a nesting season and nest about every 2-3 years, although nesting is rare on GOM beaches (State of Florida, Fish and Wildlife Conservation Commission, 2015). There was a recorded nest site in Texas during the 2008 season (USDOI, NPS, 2008). Most nesting occurs outside the GOM.

The leatherback is the largest and most pelagic of sea turtles. The average curved carapace length for adults is 61 in (155 cm) and weights from worldwide populations range from 441 to 1,543 lb (200 to 700 kg). The leatherback forages widely throughout the water column from the surface to great depths throughout tropical and temperate oceans of the world. The distribution of leatherbacks appears to be dependent upon the distribution of their prey (Leary, 1957), consisting mostly of jellyfish and other pelagic gelatinous organisms, such as tunicates. Adults have been tracked foraging in the GOM (Evans, 2006). Adult leatherbacks are deep divers, with estimated dives to depths in excess of 3,281 ft (1,000 m) (Eckert et al., 1989), but they may come into shallow waters if there is an abundance of jellyfish nearshore. Little is known about the pelagic habits of the hatchlings and juveniles, and they have not been documented to be associated with the *Sargassum* areas as are the other four species. Details about *Sargassum* can be found in **Chapter 4.5** (*Sargassum* and Associated Communities).

The current estimate of the northern Atlantic population, which includes the GOM, is 34,000-94,000 adults (USDOC, NMFS and USDOI, FWS, 2013a). Leatherbacks are a long-lived species (>30 years), with an estimated age at sexual maturity reported at about 3-19 years (Zug and Parham, 1996). During each nesting, females may produce 100 eggs or more in each clutch (Schultz, 1975), although the leatherback clutches recorded at Buck Island in 2014 ranged from 48 to 72 (Pollock et al., 2015). The eggs require approximately 60 days of incubation until the turtle breaks through the shell.

Ongoing threats to leatherbacks include ingestion of marine debris (Shoop and Kenney, 1992; Bugoni et al., 2001; Mrosovsky et al., 2009), poaching of eggs and animals (Boulon, 2000), entanglement in longline fishing gear (USDOC, NMFS, 2001), coastal trawl, and net and longline fisheries (Marcano and Alio-M, 2000; USDOC, NMFS, 2007b). Leatherback sea turtles seem to be the most susceptible to entanglement. This susceptibility may be the result of attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, and perhaps to the lightsticks used to attract target species in the longline fishery. According to observer records, an estimated 6,363 leatherback sea turtles were caught by the U.S. Atlantic tuna and swordfish longline fisheries between 1992 and 1999, of which 88 were discarded dead (USDOC, NMFS, 2001). Since then, U.S. pelagic longline fisheries in the Atlantic have incorporated mandatory bycatch reduction measures (USDOC, NMFS and USDOI, FWS, 2013a). However, Atlantic (including the Mediterranean, which has much higher fishing effort) longline sea turtle bycatch rates are higher than Pacific bycatch (Lewison et al., 2004). Reports of incidental takes of leatherback turtles are incomplete for many nations, including and in particular the GOM (USDOC, NMFS, 2001).

Hawksbill Sea Turtle

The hawksbill turtle was listed as endangered on December 2, 1970 (*Federal Register*, 1970b). Hawksbill sea turtles were once abundant in tropical and subtropical regions. Hawksbill sea turtles are highly migratory and use a wide range of habitats during their lifetime. In the continental U.S., hawksbills are found primarily in Florida and Texas, although they have been recorded in all the Gulf Coast States and along the east coast as far north as Massachusetts.

While most nesting occurs throughout the world's oceans with the most nests found in beaches of the Caribbean Sea, hawksbill nesting on northern GOM beaches, including Florida, is rare (Mays and Shaver, 1998; USDOI, FWS, 2015c). The Atlantic Coast of Florida is the only area in the U.S. where hawksbills nest on a regular basis, but the maximum number of nests documented in any year during 1979-2000 was only four.

The life history of hawksbills consists of a pelagic stage that lasts from the time they leave the nesting beach as hatchlings until they are approximately 7-12 in (20-30 cm) in straight carapace length (Meylan, 1988; Bell and Pike, 2012), followed by residency in developmental habitats (foraging areas where immature individuals reside and grow) in coastal waters. As with most sea turtle species, hatchlings and early juveniles are often found in association with oceanic *Sargassum* floats. As later juveniles, they move nearshore for feeding habitat and may associate with the same feeding locality for more than a decade (Musick and Limpus, 1997). Adult foraging habitat, which may or may not overlap with developmental habitat, is typically coral reefs, although other hard bottom communities and occasionally mangrove-fringed bays may be occupied. Hawksbills show fidelity to their foraging areas over periods of time as great as several years (van Dam and Diez, 1998). The diet is highly specialized and consists primarily of sponges and macroalgae, although other food items have been documented to be important in some areas of the Caribbean (USDOC, NMFS and USDOI, FWS, 2013b). The lack of sponge-covered reefs and the cold winters in the northern GOM may prevent hawksbills from establishing a strong population in this area.

The majority of hawksbill sightings are reported from the sea turtle stranding network. Hawksbills may undertake developmental migrations (movements as immature turtles) and reproductive migrations that involve travel over hundreds or thousands of kilometers (Meylan, 1999). Reproductive females undertake periodic (usually non-annual) migrations to their natal beach to nest. Movements of reproductive males are less well known, but they are presumed to involve migrations to the nesting beach or to courtship stations along the migratory corridor. Females nest an average of 3-5 times per season, and the mean clutch size is 130 eggs (USDOC, NMFS and USDOI, FWS, 2013b). Immature hawksbills tagged at St. Thomas during long-term, in-water studies appeared to be resident for extended periods (Boulon, 1994). Tag returns were recorded from St. Lucia, the British Virgin Islands, Puerto Rico, U.S. Virgin Islands, and the Dominican Republic (Boulon, 1989; Meylan, 1999; USDOC, NFMS and USDOI, FWS, 2013b).

In addition to the factors threatening all marine turtles (described in the sea turtle introduction above), hybridization with other species has also been identified as a problem for hawksbills

(USDOC, NMFS and USDOI, FWS, 2013b). The primary cause of hawksbill decline has been attributed to centuries of exploitation for tortoiseshell, the beautifully patterned scales that cover the turtle's shell (Parsons, 1972; Mortimer and Donnelly, 2008). International trade in tortoiseshell is now prohibited among all signatories of the Convention on International Trade in Endangered Species; however, some illegal trade continues, as does trade between nonsignatories. Globally, hawksbills are affected in foraging areas and on nesting beaches by climate change and fisheries bycatch (USDOC, NMFS and USDOI, FWS, 2013b).

Critical Habitat

Of all five GOM sea turtles species, the loggerhead is the only sea turtle that has critical habitat established in the GOM (**Figure 4-23**). As described above, the NMFS and FWS are jointly responsible for managing sea turtles. The NMFS designated marine critical habitats in its Final Rule in July 2014, and the FWS designated terrestrial critical habitat in its Final Rule in August 2014 (*Federal Register*, 2014a and 2014c). The offshore marine critical habitat is *Sargassum* and the terrestrial critical habitat is beaches (**Figure 4-23**).

Four of the five species of sea turtles found in the GOM are associated with floating *Sargassum* (Carr, 1987b; Coston-Clements et al., 1991; Schwartz, 1988; Witherington et al., 2012). The hatchlings of loggerhead, Kemp's ridley, green, and hawksbill sea turtles are thought to find the *Sargassum* rafts when actively seeking frontal zones and then utilizing the habitat as foraging grounds and protection during their pelagic "lost years" (juvenile years in which turtle sightings are scarce) (Carr, 1987b; Coston-Clements et al., 1991). Schwartz (1988) reported numerous loggerhead hatchlings during commercial trawling for *Sargassum* in the Atlantic. This provided the largest count of hatchlings on record to date. Witherington et al. (2012) conducted a study on juvenile turtle use of *Sargassum* habitats and further supported that these drifting communities are important areas for young sea turtles (84% of 1,884 turtles were observed within 1 m [3 ft] of floating *Sargassum*). Sea turtle digestive system samples contained mainly marine animals and plants, plastics, wood, and flying insects. Tarballs, oiled plastics, and liquid oil were observed in *Sargassum* drift lines during the surveys (Witherington et al., 2012). Putman and Mansfield (2015) reported that passive-drifting sea turtle juveniles (*Sargassum*-associated stage) were actually active swimmers. Their research used synchronized surface drifter and tagged turtle releases to support that sea turtles in the GOM are able to move independently from and not dispersed solely by currents (Putnam and Mansfield, 2015). Details about *Sargassum* can be found in **Chapter 4.5** (*Sargassum* and Associated Communities).

4.9.2.2 Environmental Consequences

This chapter provides detailed information regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts from activities described in **Chapter 3** and their potential impacts on sea turtles that would potentially result from a single lease sale or the alternatives. This analysis applies to all considered alternatives. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), sea turtles are distributed throughout the planning areas. As such, activities isolated to specific planning areas pose similar potential impacts to populations as do activities occurring in all planning areas. Therefore, because of the free swimming ability and wide distribution of species across the Area of Interest, the level of impacts would be the same for Alternatives A, B, C, and D. However, Alternative E, No Action, would avoid impacts from a proposed lease sale and the related postlease activities as the lease sale would not be held; only impacts from past lease sales and associated postlease activities or other G&G permits would continue. Following this environmental consequences chapter, there will be a summary of the potential impacts as they relate to the other action alternatives.

Routine Activities

Routine activities (described in **Chapter 3.1**) resulting from a proposed action have the potential to harm sea turtles, although this potential is unlikely to rise to a level of significance to the population due to the activity already present in the GOM and mitigations that have been historically applied and discussed below. The routine activities that could have impact-producing factors associated with a proposed action that may affect GOM sea turtles include geological and geophysical activities (**Chapter 3.1.2.1**), transportation (**Chapter 3.1.4**), discharges and wastes (**Chapter 3.1.5**), marine debris (**Chapter 3.1.5.3.4**) decommissioning (**Chapter 3.1.6**), and noise (**Chapter 3.1.9**). Scenario numbers presented in this chapter are for Alternative A, which represents a regionwide lease sale with expected lease stipulations for this and other alternative scenario numbers (refer to **Table 3-2**).

Geological and Geophysical Activities

Seismic operations have the potential to harm sea turtles in close proximity to firing airgun arrays. The Protected Species Stipulation and NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimize the potential of harm from seismic operations to sea turtles that could be within the exclusion zone. These mitigations include, but are not limited to, onboard observers, ramp-up procedures, and the use of a minimum sound source. Noise impacts on turtles from seismic surveys are described in the "Noise" section below.

Further detailed information on seismic surveys and other G&G survey types may be found in **Chapter 3.1.2.1**. More information on sea turtle hearing and sensitivity to acoustic impacts can be found in Appendix I of BOEM's *Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement*, (USDOI, BOEM, 2014a) and Appendix H of the *Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf: Final Programmatic Environmental Assessment*, (USDOI, MMS, 2004b). Noise associated with G&G activities may cause behavioral effects (changes in direction or swimming speed) or auditory masking in sea turtles. Based on current information on sea turtle hearing capabilities, it is not clear whether or not sea turtles rely on sound or would be affected by auditory masking (Popper et al., 2014). For more on noise impacts, refer to the "Noise" section below. In addition, the NMFS, BOEM, and BSEE collaborated to publish National Standards for a Protected Species Observer Program to reduce impacts to protected species from G&G activities by standardizing the variation in and improving the management of the program (Baker et al., 2013).

The only other impact-producing factor to sea turtles that is associated with G&G activities is the potential for gear interaction. Sea turtles can become entangled in some types of lines associated with G&G activities. Entanglement could cause stress, injury, and mortality of sea turtles. The G&G permit applications set conditions of approval with each activity that would minimize specific impacts caused by gear interactions. Sea turtle gear interaction impacts associated with G&G activities are expected to be rare. With the implementation of mitigations, impacts from G&G activities would be expected to be **negligible** to **moderate**.

Transportation

An estimated 29,000-270,000 (highest range under Alternative A) service-vessel roundtrips are expected to occur annually as a result of a proposed action. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter operation round trips are expected to be 87,000-1,928,000 as a result of a proposed action. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles, and there is the possibility of short-term disruption of activity patterns. For noise impacts related to OCS vessel and air traffic activities, refer to the "Noise" section below. Other impacts related to transportation are described in this section.

Vessel strikes are impact-producing factors associated with transportation associated with a proposed action that could affect sea turtles. Sea turtles spend at least 3-6 percent of their time at the surface for respiration and perhaps as much as 26 percent of their time at the surface for basking, feeding, orientation, and mating (Lutcavage et al., 1997). Data show that collisions with all types of commercial and recreational vessels are a cause of sea turtle mortality in the GOM (Lutcavage et al., 1997). Stranding data for the U.S. Gulf 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 (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 would be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic would increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

There have been no documented sea turtle strikes with drilling and service vessels in the GOM; however, collisions with small or submerged sea turtles may go undetected. Based on sea turtle density estimates in the GOM, the encounter rates between sea turtles and vessels would be expected to be greater in water depths <200 m (656 ft) (USDOC, NMFS, 2007b). To further minimize the potential for vessel strikes, NTL 2012-JOINT-G01 was issued; this NTL provides the NMFS guidelines for monitoring procedures related to vessel strike avoidance measures for sea turtles and other protected species. BOEM uses the Protected Species Stipulation, for which guidelines are mandated, in the lease after a proposed lease sale. With the implementation of these measures and the avoidance of potential strikes from OCS vessels, the risk of collisions between oil- and gas-related vessels (including those for G&G, drilling, production, decommissioning, and transport) and sea turtles is appreciably reduced, but strikes may still occur. BOEM and BSEE monitor for any takes that have occurred as a result of vessel strikes and require that any operator immediately report the striking of any animal (NTL 2012-JOINT-G01). Given the scope, timing, and transitory nature of a proposed action and with this established mitigation, the impacts to sea turtles from vessel collisions are expected to be **negligible**; however, if collisions occur, impacts could be **moderate**.

Discharges and Wastes

Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification, but there is uncertainty concerning the possible impacts. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (Kennicutt, 1995; Kennicutt et al., 1996). Any potential impacts from drilling fluids would be indirect as a result of ingestion via the food chain (Neff et al., 1989). Impacts from water degradation are expected to be **negligible** due to rapid dilution of the discharges, which are also regulated by NPDES permits, and due to the wide-ranging movements of sea turtle species in the GOM. Refer to **Chapter 3.1.5** for more information on operational wastes and discharges generated by OCS oil- and gas-related facilities.

Marine Trash and Debris

A wide variety of trash and debris is commonly observed in the GOM. Marine debris remains a continuous threat to sea turtles (Schuyler et al, 2014). 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. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987b; USDOC, NOAA, 1988; Mrosovsky et al., 2009; Santos et al., 2015). 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, 1997). 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.

The marked tendency of leatherbacks to ingest plastic has been attributed to the misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles would 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, 1997). Microplastics are becoming an increasing concern for ingestion by sea turtles and can also decrease maximum temperatures in beach sediments, which can create sexual bias in sea turtles (Bergmann et al., 2015). Weakened animals are then more susceptible to predators and disease; they are also less fit to swim, breed, or nest successfully.

Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi (9-15 mi; 15-24 km) 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. Without mitigation, marine debris impacts would be **negligible** to **moderate**. Operators must comply with the guidelines provided in NTL 2015-BSEE-G03, “Marine Trash and Debris Awareness and Elimination.” Following a lease sale, the NTLs would become mandatory under the Protected Species Stipulation. The BSEE prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR § 250.300). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters. Therefore, expected marine debris impacts to sea turtles from a proposed action should be **negligible**.

Decommissioning

Offshore structures serve as artificial reefs and are sometimes used by sea turtles for foraging and resting (Gitschlag and Herczeg, 1994). Explosive severance of these structures can affect turtles located in the vicinity of the structure during the severance activity. The estimated number of platforms to be decommissioned as a result of a selected alternative is reported in **Chapter 3.1.6**. With the highest range under Alternative A, an estimated 9-193 projects of explosive severance of structure removals are projected to occur (**Table 3-2**).

Decommissioning activities, which are approved by BSEE, are described in detail in *Structure-Removal Operations on the Gulf of Mexico Outer Continental Shelf: Programmatic Environmental Assessment* (USDOI, MMS, 2005), and they are described in **Chapter 3**. The previously issued NTL, “Decommissioning Guidance for Wells and Platforms” (NTL 2010-G05) provides guidelines for offshore operators that specify and reference NMFS’s biological opinion mitigation requirements currently in place for protected species, including sea turtles. In addition, terms and conditions, and reasonable and prudent measures identified during consultation for decommissioning would be required conditions of approval in any decommissioning authorizations. The regulations outline the environmental, monitoring, and mitigation information that operators must submit with plans for exploration, development, and production. This regulation requires OCS energy-related activities to be conducted in a manner that is consistent with the provisions of the ESA. Additionally, the NMFS has implemented a protected species observer program for structure decommissioning. Actual sea turtle impacts from explosive removals in recent years have been small. Though mitigations that are in place would minimize the risk of impacts to sea turtles, there is a possibility of sea turtles going undetected within the zone of explosive impacts. The updated pre- and post-detonation mitigations should ensure that injuries remain extremely rare. Explosive severance could **moderately** impact sea turtles; however, with implementation of specified decommissioning mitigations, impacts to sea turtles from explosive severance are expected to be **negligible**.

Noise

Noise-induced stress has not been well-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 response has been observed for captive loggerhead and green sea turtles (O'Hara and Wilcox, 1990; Moein et al., 1993; Lenhardt, 1994). Loggerhead hearing frequency range is between 50 and 1100 Hz, depending on the size of the turtle (Lavender et al., 2014). Some loggerheads exposed to low-frequency sound responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). The potential direct and indirect impacts of sound on sea turtles include physical auditory impacts (temporary threshold shift), behavioral disruption, long-term impacts, 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). Leatherback hatchlings were shown to detect sounds between 50 and 1,200 Hz underwater and 50 and 1,600 Hz in air with maximum sensitivity between 100 and 400 Hz in water and 50 and 400 in air (Dow Piniak et al., 2012).

For seismic sources, sea turtles have the potential for mortality or injury at or above 210 dB cumulative sound exposure level and above 207 dB peak pressure level (Popper et al., 2014). Sea turtles have been observed noticeably increasing their swimming in response to an operating seismic source at 166 dB in water (McCauley et al., 2000). There is a high potential for recoverable injury, temporary threshold shift (recoverable hearing loss), and behavioral modifications only when the turtle is in close proximity to the source. Mortality and injury caused by shipping and continuous noise are expected to have low levels of relative risk even if a sea turtle is near the source. The risk for temporary threshold shift near the source is moderate, while the risk for masking may be high both at near and intermediate distances from the source, and the risk for behavioral modifications near the source are high and moderate at intermediate distances from the source (Popper et al., 2014). Impacts from any sound source are relative to the source type, distance to the source, frequency, intensity and duration of the source, and distance to the animal. Refer to **Chapter 3.1.2.1** for more information on noise related to G&G activities.

Reactions to aircraft or vessel noise, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided because of noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. There are no systematic studies published of the reactions of sea turtles to aircraft overflights; however, anecdotal reports indicate that sea turtles often react to the sound and/or the shadow of an aircraft by diving. It is projected that 70,000-3,750,000 OCS oil- and gas-related helicopter operations (take-offs and landings) would occur annually in the support of OCS oil- and gas-related activities (**Table 3-2**). The Federal Aviation Administration's Advisory Circular 91-36D (September 17, 2004) encourages pilots to maintain higher than minimum altitudes over noise-sensitive areas. Vessel noise is an impact-producing factor associated with a proposed action that could affect sea turtles. The dominant source of noise from vessels is propeller operation (i.e., cavitation), and the intensity of this noise is largely related to ship size and speed. 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. Vessel noise from activities resulting from a proposed action would produce low levels of noise, generally in the 150- to 170-dB re 1 μPa-m and at frequencies below 1,000 Hz. Vessel noise is transitory and generally does not propagate at great distances from the vessel. 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). 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 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). Oil and gas exploration and extraction occur in sea turtle foraging habitats and generates high-intensity, low-frequency, impulsive sounds within the leatherback hearing range (Dow Piniak et al., 2012).

Chronic sublethal effects (e.g., stress), resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas from noise disturbance such as seismic activities, could cause declines in survival or fecundity and could result in population declines; however, such declines are not expected because of implementation of the Protected Species Stipulation and NTL 2012-JOINT-G02 minimizing potential harm. Overall noise impacts on sea turtles from a proposed action are expected to be **negligible** to **minor** depending on the location of the animal(s) relative to the sound source and the frequency, intensity, and duration of the source. A minor impact would be a behavioral change in response to noise. Refer to **Chapter 3.1.9** for more information on potential noise impact-producing factors associated with a proposed action.

Accidental Events

Reasonably foreseeable accidental events as a result of a proposed action have the potential to harm sea turtles. The major impact-producing factors resulting from the accidental events associated with a proposed action that may affect sea turtles include oil spills and spill-response activities. These have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of low-probability accidents, the ability to respond to accidents, the location and date of accidents, various meteorological and hydrological factors, and life history stages of animals exposed to the hydrocarbons (NRC, 2003; USDOC, NMFS, 2015h).

Oil Spills

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore can occur during any phase of development (i.e., exploratory drilling, development drilling, production, completion, or workover operations [refer to **Chapter 3.2.1** for description of development activities]). Though oil and gas exploration overlaps sea turtles habitats, it is the particular biology and behavior of sea turtles that place them at risk, including a lack of avoidance behavior, indiscriminate feeding in convergence zones, and large pre-dive inhalations (Shigenaka et al., 2010). Oil spills, however, are not the foremost danger to sea turtles, as described above. Impacts would occur as a result of actual contact with the spilled oil, regardless of the source.

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. 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). Significant changes in blood chemistry following contact with hydrocarbons have been reported ranging from changes to blood's oxygen transport system to elevation in white blood cells, indicating stress (Lutcavage et al., 1995). Although disturbances may be temporary, long-term impacts remain unknown, and chronically ingested oil may accumulate in organs. Oil can adhere to the body surface of marine turtles. Oil has been observed to cling to the nares, eyes, and upper esophagus (Overton et al., 1983; Van Vleet and Pauly, 1987; Gramentz, 1988; Lutcavage et al., 1995). Witham (1983) found tar sealed the mouth and nostrils of small turtles. Periocular tissues and other mucous membranes would presumably be most sensitive to contact with hydrocarbons. Turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988; Gramentz, 1988). All structural and biochemical changes in the epidermis of sea turtles have been shown to be minor and reversible. 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).

Contact with hydrocarbons may not cause direct or immediate death but cumulative sublethal impacts, such as salt gland disruption or liver impairment, could impair a sea turtle's ability to function effectively in the marine environment (Vargo et al., 1986; Lutz and Lutcavage, 1989; Camacho et al., 2012). 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). Camacho et al. (2013) conducted blood plasma testing on stranded sea turtles to determine PAH concentrations. Burning fossil fuels and urban runoff, as well as oil spills, were considered as being potential environmental sources of PAHs detected in turtle blood plasma (Camacho et al., 2013). A similar study was conducted by Camacho et al. (2014) on live juvenile turtles and it was determined that the turtles had 34 of 52 organic contaminants. Contrary to previous data (Geraci and St. Aubin, 1983), PAH biomagnification does not occur in sea turtles, suggesting that sea turtles may be able to efficiently metabolize PAHs (Camacho et al., 2014).

Eggs, hatchlings, and small juveniles are particularly vulnerable if contacted (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989; Bjorndal et al., 1994). Sea turtle hatchling exposure to, fouling by, or consumption of tarballs would likely be fatal. Sea turtle eggs are likely to be lethally impacted by contact with spilled oil (USDOI, NPS, 2011a). During nesting, a female turtle might crawl through tar prior to laying her eggs or might push oil mixed with sand into the nest and contaminate the eggs (Chan and Liew, 1988). Assuming a sea turtle's sense of smell is critical, oil fouling of a nesting area might disturb imprinting of hatchling turtles or confuse the turtles on their return migration (Geraci and St. Aubin, 1985; Chan and Liew, 1988). Potential toxic impacts to embryos would 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 impacts. 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. Residue oil may adhere to sand grains where eggs are deposited, later impeding hatchlings from successfully evacuating nests and ultimately leading to their death. Reproductive success could ultimately be impacted.

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, slickets, 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 and/or incidental takes as defined under the ESA. High rates of oil contact in young turtles suggest that bioaccumulation may occur over their potentially long lifespan. 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). Balazs (1985) and Gramentz (1988) found tar to be the most prevalent marine pollution ingested by sea turtles. However, more recent studies have shown contrary findings. Bjorndal et al. (1994) examined digestive tracts from 51 juvenile sea turtles in Florida and found only 1 (<2%) to have tar in the gut. Similarly, Bugoni et al. (2001) found that only 1 turtle out of 50 (approximately 2%) stranded turtles that were analyzed had ingested oil. Some captive sea 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). Therefore, oil might have a more indirect impact on the behavior of sea turtles.

OSRA Modeling

The OSRA modeling results, which show the probabilities of a large spill (≥1,000 bbl) occurring in Federal offshore waters making contact with State offshore waters, are provided in **Figure E-20**. In general terms, coastal waters of the area may be contacted by many, frequent, small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 and <1,000 bbl); and a single large spill (≥1,000 bbl) as a result of a proposed action. Pipelines pose the greatest risk of a large spill occurring in coastal waters compared with platforms and tankers. Spill estimates over a 50-year time period are indicated in **Table 3-17**. According to **Table 3-17**, the majority of estimated spills would be small (<10 bbl). The actual number of spills that may occur in the future could vary from the estimated number. A spill size group for ≥10,000 bbl was not included in **Table 3-17** because the catastrophic *Deepwater Horizon* oil spill (4.9 MMbbl released from the well) was the only spill in this size range during 1996-2010, and such a spill is not reasonably foreseeable in the future; thus, limited conclusions can be made from a single data point. For more information on OSRA, refer to **Chapter 3.2.1.4** (Analysis of Offshore Spills ≥1,000 bbl).

Depending on the timing of a spill's occurrence in coastal waters, its impact and resulting cleanup activities may interrupt sea turtle migration, feeding, mating, and/ or nesting activity for extended periods (i.e., days, weeks, or months). Spills originating in or migrating through coastal waters of Texas or Louisiana may impact any of the five sea turtle species inhabiting the GOM. Kemp's ridley is the most endangered sea turtle species and is strongly associated with the coastal waters of Texas and Louisiana. Aside from the acute impacts 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 mortality from anthropogenic causes. A high incidence of juvenile sea turtle foraging occurs along certain coastal regions of the Gulf Coast. The interruption of mating and nesting activities for extended periods could influence the recovery of sea turtle populations.

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 50-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 would be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the GOM and because of difficulties attributed to estimating when and where oil spills would occur over a 50-year period.

Given the distribution of available leases and pipelines associated with a proposed action and the distribution of sea turtles in the northern GOM, the fate of an oil spill must be considered relative to the region and period of exposure. Projected oil production is 0.211-1.118 BBO and 0.547-4.424 Tcf of gas over 50 years. **Chapter 3.2.1** details the persistence, spreading, and weathering process for offshore spills.

Sea turtles are vulnerable to oil and dispersants at all life stages (i.e., eggs, post-hatchlings, juveniles, sub-adults, and adults), and there is no demonstrated avoidance behavior (Shigenaka et al., 2010). Impacts to sea turtles from OCS oil- and gas-related accidental oil spills are expected to range from **negligible** to **moderate** depending on the timing, size, and location of the spill, as well as new technologies in place to lessen the possibility of an accidental event from occurring. A moderate impact would be a spill contacting an individual and causing injury or mortality.

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. Impact-producing factors might include artificial lighting from night operations, booms, machine and human activity, increased vessel traffic (refer to the “Transportation” section under “Routine Activities” above), 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 because of predation during the increased time required to reach the water (Lutcavage et al., 1997). 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. The strategy for cleanup operations vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). After passage of the Oil Pollution Act of 1990, 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.

Little is known about the effects of dispersants on sea turtles and, in the absence of direct testing, impacts are difficult to predict. Dispersant components absorbed through the lungs or gut may affect multiple organ systems and interfere with digestion, excretion, respiration, and/or salt-gland function. Inhalation of dispersant can interfere with function through the surfactant (detergent) effect. These impacts are likely similar to the empirically demonstrated effects of oil alone (Hoff and Shigenaka, 2003). The impacts to sea turtles from chemical dispersants could include nonlethal injury (e.g., tissue irritation, chemical burns, and inhalation), long-term exposure through bioaccumulation, infection, and potential shifts in distribution from some habitats (USDOC, NOAA, 2015k; Shigenaka et al., 2010). For more information on dispersants, refer to **Chapter 3.2.7.2** (Offshore Response, Containment, and Cleanup Technology).

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. Spill-response activities are expected to have minimal adverse effects on sea turtles based on the short exposure duration of the activities and are more likely to have a positive effect on sea turtles over time given the removal of spilled oil, turtle and nest relocation, and contact prevention efforts. Due to the nature of the response activities, minor impacts could occur by a behavioral change of sea turtles in the immediate area. Therefore, impacts from spill-response activities are expected to be **negligible** to **minor**. There are also mitigations and plans in place (e.g., from the USCG, BSEE, States, NMFS, FWS, NPS) to decrease impacts to sea turtles.

Cumulative Impacts

This cumulative analysis considers the effects of impact-producing factors related to a proposed action along with impacts of other commercial, military, recreational, offshore, and coastal activities that may occur and adversely affect populations of sea turtles in the same general area of a proposed action.

OCS Oil- and Gas-Related Impacts

The major impact-producing factors resulting from cumulative OCS energy-related activities associated with a proposed action that may affect GOM sea turtles and their habitats include those already described under "Routine Activities" and "Accidental Events" sections above, i.e., geological and geophysical activities, transportation, discharges, marine debris, decommissioning, noise, and accidental oil spills and spill response. Chapters providing supporting material for the sea turtle analysis include **Chapters 4.1** (Air Quality), **4.2** (Water Quality), **4.3** (Coastal Habitats), **4.4** (Deepwater Habitats), **4.5** (*Sargassum* and Associated Communities), **3.1** (Offshore Impact-Producing Factors and Scenario), **3.1.7** (Transport), **3.1.9** (Decommissioning), and **5.7** (Endangered Species Act). The cumulative impact of these ongoing OCS energy-related activities on sea turtles is expected to result in a number of chronic and sporadic sublethal effects (i.e., behavioral effects and nonfatal exposure to or intake of OCS oil- and gas-related contaminants or discarded debris) because these activities may stress and/or weaken individuals of a local group or population and may predispose them to infection from natural or anthropogenic sources.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS oil- and gas-related impact-producing factors that may affect sea turtle populations include: accidental oil spills and response (State oil and gas), vessel traffic, commercial fishing (i.e., bycatch and entanglement), dredging and construction, habitat loss, historic overexploitation (that led to the initial listing of the species), marine trash and debris, military operations, natural phenomena including disasters and climate change, noise (i.e., from commercial fishing, recreational vessels, military activities, commercial shipping, tourism, construction), pathogens/disease, scientific research, and transportation and related noise (e.g., commercial shipping and research vessels). With the exception of BOEM's Marine Minerals Program, BOEM does not regulate any of the aforementioned non-OCS oil- and gas-related activities, though some may be mitigated/regulated by other agencies. The factors that may have the largest impacts to sea turtles are outlined below.

The Gulf Coast is a well-populated and growing area, and development of previously unusable land for residential and commercial purposes is common. Increased human activity along the coast and offshore results in increased runoff and dumping. Many areas around the GOM already suffer from high contaminant levels due to river and coastal runoff and discharges. Contaminants may accumulate in species or in prey species. Sea turtles frequent coastal habitats to seek food (such as sponges, jellyfish, crabs, or seagrass) and shelter (Bjorndal, 1997). Coastal areas are also used by juvenile and adult Kemp's ridleys in Louisiana (Ogren, 1989; Shaver et al., 2013). Submerged areas of vegetation may be lost or damaged by activities (e.g., dredging) that alter salinity, turbidity, or natural tidal and sediment exchange.

Accidental oil spills and spill response by State oil and gas activities could occur, and impacts would be similar to those described above for OCS oil- and gas-related activities. Impacts would be mainly dependent on the size and location of the spill, although State oil and gas activities are located in shallow waters closer to the coast, so there may be an increased potential for oil contacting the coastline. Naturally occurring seeps may also be a source of oil that contacts the coast.

Numerous commercial and recreational fishing vessels use areas in the northern GOM. Tanker imports and exports of crude and petroleum products into the GOM are projected to increase. Crude oil would continue to be transported to the Gulf for refining from other areas of the United States (i.e., Alaska, California, and the Atlantic). Recreational pursuits can have an adverse effect on sea turtles through propeller and boat strike damage. Areas closer to shore where sea turtles regularly migrate through, mate, nest, and forage (Shaver et al., 2013; Hart et al., 2010 and 2012) may have an elevated likelihood of vessel strikes or avoidance to aircraft, due to increased transportation in those areas.

Sea turtle bycatch in the GOM is high, specifically for the longline fishery, and can be driven by turtle density, fishing intensity or both (Lewison et al., 2014). For example, the chief areas used by Kemp's ridleys (coastal waters <59 ft [18 m] in depth) overlap with the shrimp fishery (Renaud, 1995; Shaver et al., 2013). A major source of mortality for loggerhead and Kemp's ridleys is capture and drowning in shrimp trawls (Caillouet et al., 1996; Epperly and Teas, 2002; Shaver et al., 2013; USDOC, NMFS and USDOI, FWS, 2015), which accounts for most (up to 98%) of the sea turtle bycatch in the U.S. (Finkbeiner et al., 2011). Crowder et al. (1995) reported that 70-80 percent of turtle strandings were related to interactions with this fishery. Caillouet et al. (1996) found a significant positive correlation between turtle stranding rates and shrimp fishing intensity in the northwestern GOM. The Kemp's ridley population, because of its distribution and small numbers, is at greatest risk. To lessen fishery impacts to turtles, the NMFS has required the use of turtle excluder devices in southeast U.S. shrimp trawls since 1989 and has increased efforts over the years for adequate protection to decrease the number of strandings. The use of turtle excluder devices was believed to reduce hard-shelled sea turtle captures by 97 percent; however, evidence has shown that a large proportion of turtles are too big to fit through the openings (Epperly and Teas, 2002). Since implementing the required use of turtle excluder devices throughout the shrimp fishing industry, gear improvements continue to be introduced nearly annually. Turtles may be accidentally caught and killed in finfish trawls, seines, gill nets, weirs, traps, longlines, and driftnets (Witzell, 1992; Brady and Boreman, 1994; Epperly and Teas, 2002; USDOC, NMFS and USDOI, FWS, 2013a and 2013b). Florida and Texas have banned all but very small nets in State waters. Louisiana, Mississippi, and Alabama have also placed restrictions on gillnet fisheries within State waters, such that very little commercial gillnetting takes place in southeast waters. The State fishery for menhaden in the State waters of Louisiana and Texas is managed by the Gulf States Marine

Fisheries Council and is not federally regulated for sea turtle take. Fishery interactions with sea turtles remain a major source of mortality.

Dredge-and-fill activities occur in many of the coastal areas inhabited by sea turtles and can create impacts, but agencies permitting these activities must consult on the ESA and protective measures would be required to prevent adverse impacts. 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 incidental take (entrainment) and habitat degradation (Michel et al., 2013b). The construction and maintenance of Federal navigation channels, as well as dredging offshore sand resource areas (i.e. borrow areas) to support coastal restoration and beach nourishment projects, have been identified as sources of sea turtle mortality. Hopper dredges can entrain and kill individuals, presumably either by catching sea turtles resting/foraging on the bottom or as the drag arm of the moving dredge overtakes a slower-moving animal. Hopper dredging has caused turtle mortality in coastal areas (Slay and Richardson, 1988). Nearly all sea turtles entrained by hopper dredges are dead or dying when found (NRC, 1990). However, there continues to be engineering of modified turtle excluding devices for hopper dredges to reduce entrainment (Henriksen et al., 2015). 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.

Construction, beach front development, beach vehicle traffic, beach erosion, nest predation, and artificial lighting are activities that disturb sea turtles or their nesting beaches (Garber, 1985; Conant et al., 2009). Vehicles and beach cleaning activities may crush nests, reducing 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 watermark prevent nesting, and breakwalls are the most common and severe type of obstruction. Erosion can result in the loss of habitat, and artificial lighting affects nesting beaches. 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 become disoriented, increasing their vulnerability to terrestrial predators. As part of NRDA's early restoration efforts, there is a project focused on restoring the night sky or identifying and reducing artificial lighting on shorelines. Details on the project can be found on NOAA's Habitat Conservation website (USDOC, NOAA, 2016b). 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 (Mrosovsky et al., 1995). Increased human activities, such as organized turtle watches, on nesting beaches may adversely affect nesting activity (Fangman and Rittmaster, 1994; Johnson et al., 1996). Species that prey on sea turtle nests include fire ants, raccoons, armadillos, and opossums. Sea turtles entering coastal or inshore areas have been affected by entrainment in the cooling water systems of electrical generating plants (NRC, 1990). Deaths can result from injuries sustained in transit through the intake pipe, from drowning in capture nets, and perhaps from other causes before entrainment (Bressette et al., 1998). Thermal effluents from power plants may cause hatchlings to become disoriented and reduce their swimming speed (O'Hara, 1980). These effluents may also degrade important foraging seagrass and reef habitats (Coston-Clements and Hoss, 1983). It has been suggested that power plants could also provide positive impacts by providing warm-water refuge in some areas (McDonald et al., 1994; Turner-Tomaszewicz and Seminoff, 2012).

Sand mining, beach nourishment, and oil-spill cleanup operations may remove sand from the littoral zone and temporarily disturb onshore sand transport, potentially disturbing nesting activities. BOEM has evaluated the use of sand resources for levee, beach, and barrier island restoration projects. For more than 20 years, BOEM has provided over 112 million yd^3 (85 million m^3) of OCS sand for 40 coastal projects, restoring over 269 mi (433 km) of national coastline. As the demand for sand for shoreline protection and restoration increases, OCS sand and gravel has become an increasingly important resource. Use of these resources would require coordination with BOEM for appropriate authorization. Sea turtles are included in the potential impacts identified for sand dredging projects. Mitigating measures include requiring stipulations to protect sea turtles when it is determined that there is a likelihood of sea turtle presence within the area during the dredging operation, and a trailing suction hopper dredge is used. As part of NRDA's early restoration efforts, there are at least three artificial reef projects totaling $7.7 million in the GOM that would provide more shelter and feeding habitat for turtles. Details on these projects can be found on NOAA's website (USDOC, NOAA, 2016c).

Explosive discharges, such as those used for COE structure removals or coastal construction, can cause injury to sea turtles (Duronslet et al., 1986), but they are subject to ESA consultation with the NMFS. Although sea turtles far from the site may suffer only disorientation, those near detonation sites could sustain fatal injuries. Injury to the lungs, intestines, and/or auditory system could occur. Other potential impacts include physical or acoustic harassment. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to explosive detonation are considered to be temporary effects.

Historically, sea turtles were overexploited by the poaching of eggs and individuals, and with the added pressures of other historic non-OCS oil- and gas-related impact-producing factors described in this section (e.g., commercial fishing), the NMFS determined there was a need to list them under the ESA. Human consumption of turtle eggs, meat, or byproducts still occurs worldwide and depletes turtle populations (Conant et al., 2009; USDOC, NMFS and USDOI, FWS, 2007b and 2013b). Commercial harvests are no longer permitted within continental U.S. waters, and Mexico has banned such activity (Aridjis, 1990).

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 environments, creating the potential for bioaccumulation of heavy metals, pesticides, and other contaminants (Davenport et al., 1990; Lutz and Lutcavage, 1989) in their tissues. Organochlorine pollutants (pesticides) have been documented in eggs, juveniles, and adult turtles (Rybitski et al., 1995). The DDE from DDT is the pesticide present in the greatest concentrations in sea turtles (Camacho et al., 2013). Contaminants could stress the immune system of sea turtles or act as carcinogens indirectly by disrupting neuroendocrine functions (Colborn et al., 1993; Camacho et al., 2012).

Numerous sources of aircraft fly over the coastal and offshore areas and create noise that may cause behavioral responses in sea turtles as described in the "Noise" section above. The air space over the GOM is used extensively by DOD for conducting various air-to-air and air-to-surface operations. Eleven military warning areas and five water test areas are located within the GOM, as stated in NTL 2014-BOEM-G04, "Military Warning and Water Test Areas" (**Figure 2-7**). Additional activities, including vessel operations, discharges associated with military activities, and ordnance detonation, also may affect sea turtles. Subject to the Federal Aviation Administration's guidelines, private and commercial air traffic further traverse these areas and have the potential to cause impacts to sea turtles.

Natural catastrophes, including storms, floods, droughts, and hurricanes, can also substantially damage nesting beaches and coastal areas used by sea turtles (Agardy, 1990; Fish et al., 2015). Abnormally high tides and waves generated by storms may exact heavy mortality on sea turtle nests 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 through 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. Natural phenomena could result in numerous impacts to sea turtles as well. Rising sea levels could further diminish available nesting beach habitat. Changing ocean temperatures may alter distribution patterns for sea turtle prey (i.e., jellyfish for leatherbacks). This could impact adult survivability as well as nesting success. Warming temperatures may change the sex ratios of hatchlings as sex is determined by nest temperature. Larger, more frequent storms can physically impact nesting beaches. These are just a few examples of potential effects of global climate change (Intergovernmental Panel on Climate Change, 2016).

Noise from non-OCS oil- and gas-related activities may impact sea turtles and is described in **Chapter 3.3.2.8**. Areas closer to shore normally have higher noise levels (more human-use), and levels typically drop off moving into deeper water. Non-OCS noise sources include, but are not limited to, commercial fishing vessels, recreational vessels, scientific vessels, tourism vessels and watercraft, military operations, lightning, aircraft, State oil and gas activities, etc. Sea turtles have a high potential for recoverable injury from temporary hearing loss (i.e., temporary threshold shift) and behavioral modifications only when they are close in proximity to the source. Mortality and injury caused by shipping and continuous noise are expected to have low levels of relative risk even if a sea turtle is relatively near the source. The risk for temporary threshold shift near the source is moderate, while the risk for masking may be high both at near and intermediate distances from the source, and the risk for behavioral modifications near the source are high and moderate at intermediate distances from the source. Effects from sound are relative to the source type, distance to the source, frequency, intensity and duration of the source, and distance to the animal.

Sea turtles are affected by pathogens and disease, which may be secondary infections following other stressors, such as an entanglement injury or nutritional deficiencies. Some of these diseases are described in the affected environment and include fibropapillomatosis (believed to be caused by a herpes virus); viral, bacterial, and mycotic (fungal) infections; parasites (internal or external); and other environmental health problems (e.g., hypothermic stunning). Van Houtan et al. (2014) found fibropapillomatosis could be linked, at least in part, to eutrophication.

Scientific research may impact sea turtles. Many studies require the attachment of equipment to turtle shells that could reduce fitness, and often turtles must be caught and/or held captive for a period of time before being released back into their natural environment. This could cause stress to a turtle; however, research is typically seen as an overall positive impact due to learning more about life histories of turtles and, therefore, allowing for better species management. The incremental contribution to cumulative impacts on sea turtles, even when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors and the minimization of OCS oil- and gas-related impacts through lease stipulations and regulations, would be expected to be **negligible** as a result of a proposed action.

Incomplete or Unavailable Information

Unavailable information, such as impacts following an oil-spill response and the population variation due to naturally occurring events such as hurricanes and heightened stranding numbers, provides challenges in understanding the baseline conditions and changes within sea turtle populations. As previously discussed, the impacts of tropical storms and hurricanes in the GOM, and on the listed species and critical habitat in particular, have never been determined and, ultimately, the impacts remain very difficult to quantify. Unavailable information on the impacts to sea turtles from the *Deepwater Horizon* explosion, oil spill, and response (and thus changes to the sea turtle baseline in the affected environment) makes an understanding of the cumulative impacts less defined. The Deepwater Horizon NRDA Trustee Council has released the *Deepwater Horizon Oil Spill Draft Programmatic Damage Assessment and Restoration Plan and Draft Programmatic Environmental Impact Statement*. However, the information collected during the NRDA process that the draft assessment, plan, and EIS used as a basis for their determinations are not yet publicly available (e.g., NRDA technical working group reports). The final plan may address much of what has been currently unavailable with regard to impacts to the environment from the *Deepwater Horizon* explosion, oil spill, and response. The status of sea turtle populations after the *Deepwater Horizon* explosion, oil spill, and response remains unclear and may be difficult or impossible to discern from other factors. BOEM used existing information and reasonably accepted scientific methodologies to extrapolate from publicly available information on sea turtles in completing the relevant analysis of sea turtle populations.

There are existing leases in the GOM with ongoing or the potential for exploration, drilling, and production activities. In addition, non-OCS oil- and gas-related activities would continue to occur in the GOM irrespective of a proposed action (e.g., fishing, military activities, and scientific research). Sea turtles that may occur in the GOM and within areas affected by the spill are unlikely to have experienced population-level impacts from the *Deepwater Horizon* explosion, oil spill, and response given their wide-ranging distribution and behaviors. Therefore, BOEM concludes that the unavailable information from these events may be relevant to foreseeable significant adverse impacts to sea turtles because the full extent of impacts on sea turtles is not known, but BOEM has determined that the information is not essential to a reasoned choice among alternatives for this Multisale EIS (including the No Action and Action Alternatives).

4.9.2.2.1 Alternative A, B, C, and D

With respect to sea turtles, the effects associated with selection of any of the action alternatives would be equivalent because of the diversity and distribution of sea turtles throughout the potential Area of Interest. The preceding analyses assumed a wide distribution of species and considered impacts to sea turtles occurring in a wide range of habitats across all planning areas. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), sea turtles are widely distributed throughout the planning areas. As such, activities isolated to specific planning areas pose similar potential impacts to populations as do activities occurring in all planning areas. Therefore, a similar mix of species would be exposed to the analyzed impact-producing factors, regardless of the specific action alternative selected. The activities proposed under Alternatives A, B, C, and D would directly impact sea turtles within the GOM and would contribute incrementally to the cumulative effects on these species.

Sea turtles of all five species are present throughout the northern GOM; however, only Kemp's ridley and loggerheads nest on beaches in the GOM. Individual animals make migrations into nearshore waters as well as other areas of the Gulf of Mexico, Atlantic Ocean, and the Caribbean Sea. Historically, intense harvesting of eggs, loss of suitable nesting beaches, and fishery-related mortality led to rapid declines of sea turtle populations.

Anthropogenic actions continue to pose the greatest threat to sea turtles. Ingestion of ocean debris and entanglement in nondegradable debris such as trash and discarded fishing gear continue to pose threats and lead to turtle deaths each year. Young turtles in their pelagic phase are dependent on ocean driftlines for habitat and food (Witherington et al., 2012). Young turtles feeding in driftlines have been documented to ingest plastics, styrofoam, balloons, and tar; mortalities have been attributed to ingestion of plastics and tar (Witherington et al., 2012; Carr, 1987b; Witham, 1978).

Sea turtles are adversely impacted by many fisheries activities, including trawl fisheries, gillnet fisheries, hook-and-line fisheries, pelagic longline fisheries, pound nets, fish traps, lobster pots, whelk pots, long-haul seines, and channel nets. The NMFS continues to modify the turtle excluder device design to reduce sea turtle mortality in trawl fisheries. Sea turtles entangled in fishing gear generally have a reduced ability to feed, dive, surface to breathe, or perform any other activities that are essential to survival (Balazs, 1985). They may be more susceptible to boat strikes if they are forced to remain at the surface, and entangling lines can constrict blood flow, resulting in necrosis and potential loss of limbs.

Declines in sea turtle populations also result from nonfishery impacts, such as power plant intakes; marine pollution; direct harvesting of eggs and adults in foreign countries; oil and gas exploration, development, and transportation; underwater explosions; dredging; offshore artificial lighting; marina and dock construction and operation; boat collisions; and poaching. Sea turtle critical habitat and nesting sea turtles are threatened with climate change, natural disasters, beach erosion, armoring, nourishment, artificial lighting, beach driving and cleaning, increased human presence, human response to disasters, coastal development, recreational beach use including equipment and furniture, exotic dune and beach vegetation, natural habitat obstructions, military testing and training activities, poaching, and nest predation.

Although there would always be some level of incomplete information relevant to the impacts from activities under a proposed action on GOM sea turtles, BOEM does not believe it is essential to a reasoned choice among alternatives. To date, there is no peer-reviewed scientific information available supporting that any impacts expected from a proposed action would be expected to rise to the level of reasonably foreseeable population-level impacts. BOEM acknowledges that impacts from routine activities or accidental events could be greater on individuals or populations already affected by other OCS oil- and gas-related or non-OCS oil- and gas-related impact-producing factors. Nevertheless, routine activities are ongoing in a proposed action area as a result of active leases and related activities. Further, activities that could result in an accidental spill in the GOM would be ongoing whether or not a proposed action occurred.

In order to minimize potential interactions and impacts to sea turtles, operators are required to follow all applicable lease stipulations and regulations, as clarified by NTLs. The operator's compliance with NTL 2012-JOINT-G01 ("Vessel-Strike Avoidance and Injured/Dead Protected Species Reporting") and NTL 2015-BSEE-G03 ("Marine Trash and Debris Awareness Elimination"), as well as the limited scope, timing, and geographic location of a proposed action, would result in a minimized impact from a proposed action on sea turtles. In addition, NTL 2012-JOINT-G02, "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program," minimizes the potential of harm from seismic operations to sea turtles and marine mammals; these mitigations include onboard observers, airgun shut-downs for whales in the exclusion zone, ramp-up procedures, and the use of a minimum sound source.

Because of the mitigations (e.g., BOEM and BSEE's proposed compliance with NTLs) described above, routine activities and accidental events related to a proposed action are not expected to have long-term adverse effects on the size and productivity of any sea turtle species or populations in the northern GOM. Lethal impacts could occur from chance collisions with OCS service vessels or ingestion of accidentally released plastic materials from OCS vessels and facilities, which would be considered **moderate** impacts. However, there have been no reports to date on such incidences. Most OCS oil- and gas-related routine activities and accidental events are then expected to have **negligible** impacts.

BOEM is unable to determine at this time, based on best available science, what impact the *Deepwater Horizon* explosion, oil spill, and response had on sea turtles. Further, the data on the impacts may still take years to acquire and analyze to make those determinations. Impacts from the *Deepwater Horizon* explosion, oil spill, and response may be difficult or impossible to discern from other factors. While the impact-producing factors associated with a proposed action could potentially impact sea turtles if unmitigated, the incremental contribution to cumulative impacts on sea turtles, even when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors and the minimization of OCS oil- and gas-related impacts through lease stipulations and regulations, would be expected to be **negligible** as a result of a proposed action. Within the GOM, there is a long-standing and well-developed OCS Program (more than 50 years), and population-level impacts to sea turtles are not anticipated.

4.9.2.2.2 Alternative E—No Action

Under Alternative E, there would be no lease sale held and therefore no postlease activities related to such a lease sale to impact sea turtles. However, there would be continuing impacts to sea turtles related to previous OCS oil- and gas-related development and non-OCS oil- and gas-related activities. Sea turtles move in the GOM over great spatial scales and they would be expected to move in and out of the previously leased blocks. In addition, many of these blocks already have OCS oil- and gas-related development, and sea turtles would continue to be impacted by routine activities and accidental events from pre-existing OCS development.

4.9.3 Beach Mice (Alabama, Choctawhatchee, Perdido Key, and St. Andrew)

The following four subspecies of beach mouse (*Peromyscus polionotus*) occupy restricted habitats in the mature coastal dunes of Florida and Alabama and are federally listed as endangered: Alabama (*P.p. ammobates*), Perdido Key (*P.p. trisyllepsis*), and Choctawhatchee (*P.p. allophrys*) subspecies (listed June 6, 1985) (*Federal Register*, 2006b) and St. Andrew (*P.p. peninsularis*) subspecies (listed December 18, 1998) (*Federal Register*, 1998). Current critical habitat is included in the critical habitat map (**Figure 4-23**). Populations of the listed subspecies have fallen to levels approaching extinction. These four subspecies of beach mice are similar in appearance but can be identified by pelage color and location (Bowen, 1968). The approach of this analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define impact-level measures for each impact-producing factor (refer to **Table 4-13** in **Chapter 4.9**).

4.9.3.1 Description of the Affected Environment

Beach mice are restricted to the coastal barrier sand dunes along coastal Alabama and the Florida panhandle, and they are nocturnal herbivores that forage on sea oats and beachgrass but may occasionally consume invertebrates (Ehrhart, 1978; Moyers, 1996). For a detailed description of dunes, refer to **Chapter 4.3.2.1** (Coastal Barrier Beaches and Associated Dunes, “Description of the Affected Environment”). Optimal overall beach mouse habitat is currently thought to be comprised of a heterogeneous mix of interconnected habitats including frontal dunes, scrub (tertiary) dunes farther inland, and interdunal areas between these dune habitats. Beach mice dig burrows mainly in the frontal dunes and interior scrub dunes where the vegetation provides suitable cover. Their burrows are important for avoiding predators, storing food, and providing cover during the day and inclement weather conditions.

Critical habitat for the four subspecies of beach mouse extend from Baldwin County, Alabama, to Gulf County, Florida. The beach and dunal areas that are associated with beach mouse habitat include the coastal regions associated with the CPA and EPA. Complete descriptions of current critical habitat can be found in USDOI, FWS (2010a) and **Figure 4-23**. Due to the dynamic nature of mouse populations that fluctuate with environmental conditions, abundance estimates are unreliable and trends are determined using percent area occupied. Efforts to monitor this metric are ongoing for each of the beach mouse subspecies.

4.9.3.2 Environmental Consequences

This chapter provides detailed information regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts from the activities described in **Chapter 3** that are associated with non-OCS and OCS oil- and gas-relate activities. This analysis applies to all considered alternatives. Because of the diversity and distribution of species in the Area of Interest, the level of impacts would be the same generally for Alternatives A, B, and D. Alternative C would have no impacts since no beach mice habitat is near the WPA proposed lease sale area. However, Alternative E, No Action, would only have impacts associated with the continuing impacts from past lease sales and non-OCS oil- and gas-related activities. Following the environmental consequences chapter, there is a summary of the potential impacts as they relate to the action alternatives.

Routine Activities

The major impact-producing factors associated with routine activities that may affect beach mice include activities that could occur in their habitat include marine trash and debris (**Chapter 3.1.5.3.4**) and pipeline emplacement and construction (**Chapters 3.1.3.3 and 3.1.4.1**).

Impacts to beach mice may occur directly to the animal or its habitat. Marine trash and debris could affect beach mice due to the potential to ingest and/or become entangled. The BSEE has addressed the marine debris issue by imposing marine debris awareness and prevention measures on the oil and gas industry through NTL 2015-BSEE-G03 (formerly NTL 2012-BSEE-

G01), which provides guidance to industry operators regarding the reduction of trash and debris elimination into the marine environment and informs operators of regulations set by other regulatory agencies (i.e., USEPA and USCG). Historically, NTL 2015-BSEE-G03 has been made a binding part of leases through the Protected Species Stipulation. The OCS oil- and gas-related proposed activities may contribute minimal marine debris or disruption to beach mouse areas, but the impacts would be **negligible**. Due to the proximity of the beach mouse habitat to any OCS oil- and gas-related activity, any debris as a result of OCS oil- and gas-related activities would not likely reach beach mouse habitat.

Pipeline emplacement or construction for routine activities could cause temporary degradation of beach mouse habitat, but it is not likely to occur in areas of designated critical habitat. Pipelines and construction would not be expected in the vicinity of beach mouse habitat; the impacts from pipeline emplacement and coastal construction associated with routine activities would therefore be **negligible**. For more information on the associated impacts of routine activities on the larger scale of the beach environment, refer to **Chapter 4.3.2.2** (Coastal Barrier Beaches and Associated Dunes, “Environmental Consequences").

Accidental Events

The major impact-producing factors resulting from accidental events reasonably expected to be associated with the OCS oil- and gas-related activities that may affect beach mice include coastal and offshore oil spills and spill-response activities.

Direct contact with spilled oil can cause skin irritation and/or cause the fur to mat, resulting in the loss of its insulative properties for thermoregulation. Other direct toxic impacts may result from oil ingestion, absorption, or respiratory effects from the inhalation of fumes. Indirect impacts may include contamination and depletion of food supply, destruction of habitat, and fouling of burrows. There is no definitive information on the persistence of oil in the event that a spill was to contact beach mouse habitat. In Prince William Sound, Alaska, after the *Exxon Valdez* spill in 1989, buried oil has been measured in the intertidal zone of beaches, but no effort has been made to search for residual buried oil above high tide. Similarly, NRC (2003) makes no mention of studies of oil left above high tide after a spill. Regardless of the potential for persistence of oil in beach mouse habitat, a slick cannot wash over the foredunes unless carried by a heavy storm swell. The oiling of beach mouse populations could result in local extinction, but this is unlikely given that the chance of a spill occurring and contacting the habitat is between <0.5 and 1 percent after 10 or 30 days of a spill, and the area of viable habitat is broad relative to the area potentially contacted by a large spill according to the OSRA model (refer to **Chapter 3.2.1.5**).

Impacts can also occur from spill-response activities. Vehicle traffic and other activities associated with oil-spill cleanup can degrade preferred habitat and crush burrows, resulting in displacement of mice from these areas. These impacts could be reduced if personnel are properly trained to identify and avoid sensitive habitat (which may be on short notice if under emergency conditions). Impacts from an accidental oil spill and cleanup efforts would be **negligible**. For more information on habitat impacts from accidental events, refer to **Chapter 4.3.2.3** (Coastal Barrier Beaches and Associated Dunes).

Cumulative Impacts

This cumulative analysis considers factors that affect beach mice, including oil spills, alteration and reduction of habitat, predation (especially from feral or free-roaming domestic cats) and competition, ingestion and entanglement of beach trash and debris, beach development, coastal spills, and natural catastrophes (i.e., hurricanes and tropical storms).

OCS Oil- and Gas-Related Activities

Oil spills that are related to the importing and transporting of oil resulting from prior and future lease sales are not expected to contact beach mice or their habitats because the species lives above the intertidal zone where contact is less likely. For more information on impacts to the dune habitat, refer to **Chapter 4.3.2.3** (Coastal Barrier Beaches and Associated Dunes). Therefore, the expected incremental contribution of OCS oil- and gas-related activities to the cumulative impacts is **negligible**, given the proximity of beach mouse habitat and the relatively small likelihood that a reasonably foreseeable spill would reach their habitat.

Non-OCS Oil- and Gas-Related Activities

The greatest impacts to beach mice are based on impacts to their habitat. Non-OCS oil- and gas-related activities may also incur negative impacts to the habitat or directly by interactions with other species. Cumulative impacts from coastal development, State oil and gas activities, predation, recreational beach use, trash and debris, disease, hurricanes, and the effects of global climate change may affect the protected subspecies of beach mice. For a full list of cumulative impacts to beach habitat, refer to **Chapter 4.3.2** (Coastal Barrier Beaches and Associated Dunes).

Habitat Alteration and Reduction

Coastal development is the greatest threat to beach mouse survival. Habitat reduction and fragmentation have affected the ability of beach mice to quickly recover following tropical storms. Habitat fragmentation also reduces genetic diversity by limiting gene flow within contiguous habitat. Critical habitat provides an area of protected refugia for these subspecies of beach mouse and is important to sustain each population.

Predation and Competition

Non-native predators such as red fox and domestic cats pose a threat to beach mice. Feral cats may pose one of the greatest threats to beach mice (Bowen, 1968; Humphrey and Barbour, 1981; Moyers, 1996). Gore and Schaeffer (1993) showed a significant correlation between the presence of cat tracks and beach mouse tracks on Santa Rosa Island. Predation by cats in conjunction with other threats may result in significant adverse impacts to beach mice (*Federal Register*, 1998). The recovery plans for these four subspecies of beach mice include a component of managing feral and free-ranging cats near beach mouse habitat by educating the public and control measures to eliminate feral cat populations near dune habitats. Predation and competition is a serious concern for beach mice with impacts to populations. The cumulative impacts are negligible to major

Hurricanes

Population viability analysis is essentially a demographic modeling exercise to predict the likelihood that a population would continue to persist over time (Groom and Pascual, 1998). The objective of a population viability analysis for beach mice is to determine how large and what configuration of habitat is necessary to reasonably assure that the species would survive to recover. The most recently revised model, which includes data from hurricanes, projects a risk of extinction of 26.8 ± 1.0 percent over the next 100 years. Falcy (2011) used modeling to show recovery of Alabama beach mouse populations during the 4 years after Hurricane Ivan (2004) and Hurricane Katrina (2005). Further modeling showed that increasing the rate of population growth in a refuge, like interior dunes after a hurricane, would have a much larger impact on population persistence than increasing the rate of recovery of damaged habitat, like foredunes after a hurricane. Yuro (2011) studied Hurricanes Ivan and Katrina and showed that the Alabama beach mouse has the ability to survive hurricanes if they are not successive. Therefore, the expected incremental contribution of strong hurricanes is negligible.

Incomplete or Unavailable Information

BOEM has determined that there is no incomplete or unavailable information regarding the listed beach mice relevant to the potential impacts from a proposed action or alternatives, and no such information was essential to a reasoned choice among alternatives. BOEM used existing information and reasonably accepted scientific methodologies to extrapolate from available information on beach mice in completing the relevant analysis of impacts.

4.9.3.2.1 Alternative A—Regionwide OCS Proposed Lease Sale (The Preferred Alternative)

An impact from the OCS oil- and gas-related routine activities associated with a proposed action (i.e. proposed regionwide lease sale) on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. Impacts may result from ingestion or entanglement in beach trash and debris that could be accidentally lost, despite mitigations typically applied through the lease and NTLs. Because OCS oil- and gas-related routine activities would deposit only a small portion of the total debris that would reach the habitat, the impacts related to a proposed lease sale under Alternative A would be **negligible**.

The oiling of beach mouse populations caused by one or more of the reasonably foreseeable accidental events as a result of a proposed action could result in local extinctions. Oil-spill response and cleanup activities could also have a substantial impact to beach mice and their habitat if all cleanup personnel are not adequately trained to avoid areas where beach mouse burrows are present. However, potential spills that could result from OCS oil- and gas-related activities are not expected to contact beach mice or their habitats. Onshore facilities are unlikely to be located in close proximity to beach mouse habitat. A review of the available information shows that reasonably foreseeable impacts on beach mice from accidental impacts associated with OCS oil- and gas-related activities would be **negligible**.

Cumulative activities have the potential to harm or reduce the numbers of the four listed subspecies of beach mouse. Those activities include oil spills, alteration and loss of habitat, predation and competition, ingestion and entanglement in beach trash and debris, and natural catastrophes (hurricanes and tropical storms). Most spills that may occur as a result of the proposed activities are not expected to contact beach mice or their habitats because they use areas above the intertidal zone where contact is less likely. Within the last 30-40 years, the combination of habitat loss due to beachfront development, the isolation of remaining beach mouse habitat areas and populations, and the destruction of remaining habitat by tropical storms and hurricanes have increased the threat of extinction of several subspecies of beach mice. Given these other cumulative factors and their relative impacts on the beach mouse and their habitat, the expected incremental contribution of OCS oil- and gas-related activities from a proposed lease sale under Alternative A to the cumulative impacts is **negligible**.

4.9.3.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

The impacts of this alternative would be the same as those identified in Alternative A, as portions of the proposed lease sale area under both alternatives (i.e., the CPA/EPA) are near beach mouse habitat. Reasonably foreseeable impacts are expected to be **negligible** for the reasons provided under Alternative A. The beach mouse subspecies included in the analysis are distributed across coastal Alabama and the Florida panhandle, and are adjacent to the EPA and CPA. Impacts from activity in the WPA are not expected due to the distance from beach mouse habitat. The WPA is approximately 380 mi (612 km) from known beach mouse habitat; OSRA reports calculated a <0.05 to 1 percent chance of oil contacting beach mouse habitat 30 days post-spill.

4.9.3.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

The impacts of Alternative C would yield **negligible** impacts to beach mice as a result of any new leases in the WPA and related Gulfwide postlease activities since the subspecies distributions are limited to coastal Alabama and the Florida panhandle as described in Alternative A.

4.9.3.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

The impacts of this alternative would be the same as those identified in either Alternative A, B, or C because the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations do not directly affect the beach mouse or its habitat and because of the small number of blocks subject to these stipulations and their distance from beach mice habitat. Reasonably foreseeable impacts would be **negligible**.

4.9.3.2.5 Alternative E—No Action

If a proposed lease sale does not occur, then there would be no additional impacts to beach mice as there would be no lease sale held, thus leading to no new impacts from OCS oil- and gas-related activities resulting from a lease sale. There would be no incremental contribution to cumulative impacts on the species or habitat; however, other past lease sales, postlease activities related to those other lease sales, or other authorized OCS oil- and gas-related activities may continue and have an incremental increase on the impacts on these subspecies of beach mouse.

4.9.4 Protected Birds

The analyses of the potential impacts of routine activities and accidental events associated with a GOM proposed action and a proposed action's incremental contribution to the cumulative impacts to ESA-listed birds are presented in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define impact-level measures for each impact-producing factor (refer to **Table 4-13** in **Chapter 4.9**).

4.9.4.1 Description of the Affected Environment

The protected birds analyzed in this Multisale EIS include those species that use the OCS or coastal counties/parishes along the Gulf of Mexico during any part of their lifecycle and are listed under the Endangered Species Act as threatened or endangered. Other species that met these criteria were excluded if their habitats were more upland or away from the coast (**Appendix F**). All of the following protected bird species are also protected under the Migratory Bird Treaty Act. The impact-producing factors that could affect protected birds are outlined in **Table 4-13** in **Chapter 4.9**. A review of a description of associated impact-producing factors for these species is discussed in detail and can be referenced from **Chapter 4.8** (Birds). However, similar impact-producing factors that may affect protected species may have greater impacts to protected species populations due to their smaller population size. Those impacts are considered in the following analysis.

The habitats of the protected bird species described in this Multisale EIS vary from upland habitat, freshwater wetlands, estuarine, coastal beaches, and tidal flats to offshore migration and foraging; impacts to the physical aspects of the coastal habitats are identified in **Chapter 4.3** (Coastal Habitats). Critical habitat is presented in **Figure 4-23.**

Collectively, the bird species included in this analysis are distributed across the GOM region from southern Florida to eastern Texas as year-round residents or migratory with a strong seasonal component. Many of the migratory bird species are less abundant along the GOM during the season when they are on their breeding grounds and have higher densities and/or wider distributions during migration and non-breeding season.

Cape Sable Seaside Sparrow

The Cape Sable Seaside Sparrow (*Ammodramus maritimus mirabilis*) was originally federally listed as endangered on March 11, 1967. A South Florida Multi-Species Recovery Plan was completed on May 18, 1999. A Five-Year Status Review was completed on August 18, 2010, indicating continued declines; therefore, there was no change to its status. The average estimated population size for all six subpopulations from 2005 to 2009 was 3,021 individuals (USDOI, FWS 2010b). A final rule for critical habitat designations was issued in 2007 (*Federal Register*, 2007).

It is a resident species associated with marl prairie and ephemeral wetlands, and is distributed in six small isolated populations in southern Florida, including Collier, Miami-Dade, and Monroe Counties along the Gulf Coast. These populations are located in areas where OCS oil- and gas-related activities would rarely occur. Habitat loss and fragmentation through wetland drainage, tilling, diking, controlled burns, agriculture activities, and commercial and private development in its preferred habitat are likely the primary causes for its original listing. The species appears to have highly variable nest success and survival (Boulton et al., 2009), which is problematic for a species with such low population numbers. Overall, this population appears to be limited by available nesting habitat and the "normal" onset of summer rains that result in decreased productivity later in the nesting season (Nott et al., 1998; Elderd and Nott, 2008) rather than restricted dispersal due to fragmented habitat (Van Houtan et al., 2010).

Piping Plover

Two populations of piping plover (*Charadrius melodus*) winter along the Gulf Coast and are recognized under the ESA: the Great Lakes (endangered) and the Great Plains (threatened) populations (*Federal Register*, 1985). The Great Plains population breeds primarily along the Missouri River system and its tributaries, as well as alkali wetlands and lakes in the Dakotas, Montana, and in prairie Canada; this population winters primarily along the GOM (Haig et al., 2005; Roche et al., 2010). The Great Lakes population breeds primarily along the shores and cobble beaches and associated islands with similar substrate in the Great Lake States and Canadian provinces (Stucker et al., 2010); the population winters primarily along the south Atlantic Coast with the greatest densities between St. Catherine's Island, Georgia, and Jacksonville, Florida, but it can be found as far west as the Laguna Madre, Texas (Stucker and Cuthbert, 2006; Gratto-Trevor et al., 2009). As much as 75 percent of all breeding piping plovers may winter along the GOM, spending up to 8 months on the wintering grounds (February-October).

The latest Five-Year Review was published on September 29, 2009, with recommendations that their status remain unchanged. Habitat loss and degradation due to commercial, residential, and recreational developments on both breeding and wintering areas is the likely cause for declines. The piping plover is considered a State Species of Conservation Concern in all Gulf Coast States.

The piping plover population estimates indicate declines for at least two of three populations at their breeding grounds (Great Lakes and Atlantic) (Haig et al., 2005; Roche et al., 2010).

In order to protect migratory birds, it is important to consider all seasonal habitats in the area of potential impacts that are used during the life cycle of the species. The habitats used by wintering birds along the GOM 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. It has been hypothesized that, because of habitat attributes (i.e.., foraging and roosting opportunities), specific wintering habitat may attract the largest concentrations of piping plovers because of a preferred prey base and/or because the substrate color provides protection from aerial predators due to cryptic blending camouflage color (Nicholls and Baldassarre, 1990).

Rufa Red Knot

The rufa red knot (*Calidris canutus rufa*) subspecies is a small, migratory shorebird that was recently listed as threatened in January 2015 (*Federal Register*, 2014d). There is currently no established critical habitat or recovery plan for rufa Red Knot.

Three of the six subspecies of red knot occur in North America, all three of which breed in the Arctic; the rufa subspecies occurs along the coast of the Gulf of Mexico. The rufa Red Knot is a long distance migrant that traverses the North and South America continents via the Atlantic Coast or a mid-continental route, roughly 9,300 mi (15,000 km). During spring and fall migration, it uses coastal beaches, bays, tidal flats, salt marshes, and lagoons primarily along the Atlantic and Gulf Coasts, which may serve as the final wintering destination for some birds.

Habitats used by red knots in migration and wintering are similar in character. For wintering, they generally use coastal marine and estuarine habitats with large areas of exposed intertidal sediments. In North America, red knots are commonly found along sandy, gravel, or cobble beaches, tidal mudflats, salt marshes, shallow coastal impoundments and lagoons, and peat banks. The supra-tidal (above the high tide) sandy habitats of inlets provide important areas for roosting, especially at higher tides when intertidal habitats are inundated. In wintering and migration habitats, red knots commonly forage on bivalves, gastropods, and crustaceans.

Within the GOM region, wintering birds are found primarily in Florida and Texas, but the species has also been observed in Louisiana, Alabama, and Florida. The red knot uses salt marsh, brackish lagoons, tidal mudflats, mangrove areas, and beach habitats. In Lee County, on Florida’s Gulf Coast, during fall migration, the red knot used intertidal substrates on ocean beaches at inlets. Along the Texas coast, red knots forage on beaches, oyster reefs, and exposed bay bottoms, and they roost on high sandflats, reefs, and other sites protected from high tides.

Based on the best available information, there is currently no precise population estimate for this subspecies; however, since 2000, declines of 70-75 percent have been recorded in Tierra del

Fuego for the wintering birds and in Delaware Bay during the spring migration. Harvesting of horseshoe crabs in Delaware Bay has reduced their availability as a major food source near Delaware Bay, resulting in negative effects to the population. This is an important source of nutrition for the migrating birds that stop to refuel during their transition between wintering and breeding grounds. Declines have also been observed in the population that departs the central Canadian Arctic in August.

Roseate Tern

The North American subspecies of roseate tern (*Sterna dougallii dougallii*) is separated into two distinct population segments according to the location of the breeding areas: the Northeastern population (along the Atlantic Coast from Nova Scotia to North Carolina and Bermuda) fluctuating around 3,500 breeding pairs, which is listed as endangered; and the Southeast U.S./Caribbean population (including Florida, Puerto Rico, and the Virgin Islands) with between 4,000 and 5,000 breeding pairs, which is listed as threatened (Gochfeld et al., 1998). Both populations were listed on November 11, 1987, due to habitat loss as well as increased competition and predation (*Federal Register*; 1987). Recovery plans for the Northeast and Caribbean populations were completed on September 24, 1993, and November 5, 1998, respectively.

The Northeastern population breeds in the northeastern United States and eastern Canada (Kirkham and Nettleship, 1987) with migratory routes over the open ocean to the West Indies and South America. Migratory information for the Caribbean population is less understood, but information for the Florida breeders indicates peak arrival in mid-April to mid-May and peak departure in mid-August to mid-September. By the 1990's, there were two remaining nesting sites in Florida: Pelican Shoal and the rooftop of the Marathon Government Building in Monroe County, Florida (Zambrano et al., 2000). These sites are in the Florida Keys and far from potential interactions from proposed OCS oil- and gas-related activities. In Florida, approximately 350 breeding pairs are estimated, with 15-225 pairs in the Dry Tortugas (USDOI, FWS, 2010c). Terns are seabirds that forage by plunge diving for small fish in coastal and pelagic waters. The roseate tern is considered a State Species of Conservation Concern in Florida and is protected by the Migratory Bird Treaty Act.

Mississippi Sandhill Crane

The population of Mississippi sandhill crane (*Grus canadensis pulla*) has a nonmigratory, resident population with an extremely limited distribution (Jackson County, Mississippi). This subspecies was listed as endangered on June 4, 1973 (*Federal Register*, 1973b), due to a small population size, restricted distribution, habitat loss, and habitat fragmentation (consisting of wet pine savanna). This species is presently reproductively isolated and persists primarily due to augmentation from a captive-breeding program. In February 2015, there were 126 cranes in the wild population; annual reports are provided for updates on the FWS's website (USDOI, FWS, 2015). At present, much of its habitat is protected in the Mississippi Sandhill Crane National Wildlife Refuge. Three separate critical habitat designations were completed in the 1970's (*Federal Register*, 1975, 1977a, and 1977b). The I-10 corridor jeopardized the existence of this population, but a settlement agreement resulted in the Mississippi Department of Transportation purchasing 1,960 ac (793 ha) to be set aside as habitat, and an interchange was built (USDOI, FWS, 1991). The Mississippi Sandhill Crane National Wildlife Refuge in Jackson County, Mississippi, represents 74 percent of the total acres of critical habitat (USDOI, FWS, 1991).

The sandhill crane feeds primarily on land or in shallow emergent wetlands. In fall and winter, Mississippi sandhill cranes roost mainly in the Pascagoula Marsh (Tacha et al., 1992), thus making them vulnerable to coastal or offshore oil spills if a spill reached their roosting habitat within estuarine marshes.

Whooping Crane

The Whooping Crane (*Grus americana*) was federally listed as endangered on March 11, 1967, primarily due to overhunting and habitat loss (*Federal Register*, 1976). In 1941, only 15 whooping cranes remained. Critical habitat (established in 1978) along the Gulf Coast is within the Aransas National Wildlife Refuge in Texas (*Federal Register*, 1978).

The Whooping Crane currently exists in the wild as one self-sustaining wild population (i.e., the Aransas-Wood Buffalo National Park Population) and the released, experimental, nonessential populations including Florida, Louisiana, Wisconsin, Colorado, Idaho, Wyoming, New Mexico, and Utah (*Federal Register*, 2011c). There are 12 captive sites that contribute to the captive breeding and release program (USDOI, FWS, 2012). The self-sustaining Aransas-Wood Buffalo population spans across Kansas, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas during migration. As of February 2015, the three wild populations were estimated at 442 individuals (USDOI, FWS, 2015). This includes the only self-sustaining population, i.e., the Aransas-Wood Buffalo population, which is estimated at 308 birds from the FWS 2014-2015 annual survey of their wintering grounds in Texas (USDOI, FWS, 2015). This population nests in Wood Buffalo National Park and adjacent areas in Canada, and it winters in coastal marshes in Texas. The majority of the Aransas-Wood Buffalo National Park population migrates down through the Dakotas, Nebraska, Kansas, and Oklahoma before arriving on the wintering grounds in the coastal marshes and estuarine habitats in the Aransas National Wildlife Refuge in Texas where they typically arrive by late October to mid-November and depart in late March to mid-April. As of February 2015, there were 603 whooping cranes in the total North America wild and captive populations.

Whooping cranes have a strong tendency to show site fidelity to previously used locations for breeding, migrating, and roosting sites. Preferred roosting habitat includes open areas with sand and gravel bars or shallow water in rivers and lakes (*Federal Register*, 1978). Coastal Texas has a low probability of impact from proposed OCS oil- and gas-related activities.

Wood Stork

The wood stork (*Mycteria americana*) is the largest breeding wading bird and the only stork native to the U.S. The U.S. breeding population of the wood stork was listed as endangered on February 28, 1984 (*Federal Register*, 1984). The species was formally downlisted to threatened on

July 30, 2014, as a result of a population increase and expansion of the breeding range (*Federal Register*, 2014e). It was originally listed as a result of three potentially interacting factors: loss of preferred wetland habitats and associated available nesting sites; lack of protection at nest sites; and loss of preferred foraging habitats and/or prey (Brooks and Dean, 2008). The wood stork population in the southeastern U.S. appears to be stable or increasing (Borkhataria et al., 2008; Brooks and Dean, 2008). The wood stork is considered a State species of Conservation Concern in all Gulf Coast States except Louisiana. No critical habitat rules have been published for this species.

Its distribution is restricted to freshwater and estuarine wetlands in the southeastern U.S., including North and South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana, although it is no longer considered to breed in the latter three states (Coulter et al., 1999). For more information regarding coastal habitats and proposed OCS oil- and gas-related activities, refer to **Chapter 4.3** (Coastal Habitats). Breeding locations often change annually due to variation in wetland conditions and because of the ability of breeding pairs to track resource availability (i.e., wetland conditions and food); not all colonies are occupied every year (Kushlan and Frohring, 1986; Bryan et al., 2008). Birds located at the northern edge of the breeding range tend to migrate south to winter in southern Georgia and Florida (USDOI, FWS, 2007). Though storks breed throughout Florida, it appears the center of the traditional breeding range has shifted northward primarily into north and central Florida, Georgia, and South Carolina (Kushlan and Frohring, 1986; Ogden et al., 1987; Rodgers et al., 2008). There is evidence of relatively major post-breeding dispersal with large numbers of birds frequently observed in the Mississippi River Valley; some mixing of U.S. and Mexican populations may occur (Bryan et al., 2008).

4.9.4.2 Environmental Consequences

This chapter provides detailed information regarding the impact-producing factors from routine activities, accidental events, and cumulative impacts from activities described in **Chapter 3** and their potential effects that would potentially result from a single lease sale or the alternatives. This analysis applies to all considered alternatives. Because of the distribution of the different protected bird species in the Area of Interest, the level of impacts would vary from Alternatives A, B, C, and D. However, Alternative E, No Action, would only have impacts associated with continuing effects from past lease sales and non-OCS oil- and gas-related activities. This chapter will include a summary of the potential impacts as they relate to the action alternatives and the protected bird species. The analyses of applicable impact-producing factors are the same as those for birds in general (refer to **Chapter 4.8.2,** Birds); however, the resulting level of impact would differ, as defined under the protected species impact criteria.

Routine Activities

The major impact-producing factors associated with routine activities include those that may affect birds found in coastal areas, including beaches, wetlands and mudflats, or offshore. For more details on impacts to birds in general, refer to **Chapter 4.8.2** (Birds). Also, since many of these birds are found in coastal areas, refer to **Chapter 4.3.2** (Coastal Habitats) for information on impacts from the proposed activities on coastal habitats. The Red Knot, Piping Plover, and Roseate Tern are the only protected bird species that may be found offshore during migration or foraging. The Mississippi Sandhill Crane, Whooping Crane, and Wood Stork use wetland areas that are associated with coastal marshes. The Cape Sable Seaside Sparrow and Roseate Tern are only in extreme south Florida. The Piping Plover and rufa Red Knot use beach and mudflat areas across the Gulf of Mexico at suitable wintering and stop-over locations.

Routine impacts include discharges and wastes, air and water quality (**Chapters 4.1 and 4.2**), structure presence, lighting, noise, and marine debris. Waste discharges to air or water produced as a result of routine activities are regulated by the USEPA and BOEM and result in reduced potential impacts. Due to precautionary requirements and monitoring, and that most of the protected birds are in coastal areas away from many of the discharge and waste associated with a proposed action, the impacts to protected birds would be **negligible**.

Structure presence and lighting could impact bird species by collision and behavioral changes that may lead to mortality. In the Gulf of Mexico, Russell reported that many species of songbirds, shorebirds, wading birds, and raptors were involved in collisions or circulating events (Russell, 2005). The Red Knot, Piping Plover, and Roseate Tern would be the only protected bird species to use the offshore environment since the Piping Plover and Red Knot migrate across the Gulf and the Roseate Tern forages offshore; however, only the knot was detected during Russell's study. The impacts of offshore structures to protected birds would be **negligible** to **moderate** since most of the protected bird activity is associated with coastal habitats and is not near the offshore structures. Moderate impacts would occur if a protected bird species changes its normal migratory behavior due to artificial lighting or if there is a collision with a platform.

Operational noise from OCS oil- and gas-related helicopters and vessel traffic (including G&G activities) may cause temporary disturbance to any bird that is near the flight path or landing areas. Due to the short-term nature of the impact and that many of these birds would not be in the area of known flight paths, the impact would be **negligible**.

Marine debris produced by OCS oil- and gas-related activities as a result of accidental disposal into the water may affect protected birds by entanglement or ingestion. Due to the regulations prohibiting intentional disposal of items, impacts would be **negligible** to **moderate**. Impacts would be negligible through beach-cleaning efforts to remove debris from certain locations and the use of marine debris awareness and prevention measures on the oil and gas industry through NTL 2015-BSEE-G03 (formerly NTL 2012-BSEE-G01), which provides guidance to industry operators regarding the reduction of trash and debris elimination into the marine environment and which informs operators of regulations set by other regulatory agencies (i.e., the USEPA and USCG). Implementation of BSEE's Marine Trash and Debris NTL is required through ESA consultation with the FWS and is expected to be applied by the oil and gas industry for associated OCS oil- and gas-related activity. **Moderate** impacts would occur if one of the protected bird species has a negative interaction with trash or debris, leading to mortality.

Accidental Events

The major impact-producing factors resulting from accidental events associated with proposed OCS oil- and gas-related activities that may affect protected birds include accidental oil spills and response efforts. All species of protected birds in the potentially affected area could be impacted by an accidental oil spill and response activities. In the case of an accidental oil spill, impacts would be **negligible** to **moderate** depending on the magnitude of the oil spilled and spatiotemporal proximity of such an event to the particular species of protected birds. These impact levels would also be related to the possible response activities. The impacts would depend on the seasonal timing related to migration or breeding seasons where birds may be absent or present in higher densities. Impacts from oil spill on birds are discussed in **Chapter 4.8.2** (Birds), but oil spills may have a greater impact on protected species due to their ESA listing criteria.

During the *Deepwater Horizon* explosion, oil spill, and response, there were at least 100 species of birds directly affected by oil or associated with oil-affected habitats. Due to the timing and location of the spill, Piping Plovers were the only ESA-listed species that incurred mortality and loss of productivity (Deepwater Horizon Natural Resource Damage Assessment Team, 2016).

Cumulative Impacts

The cumulative impacts of the OCS oil and gas program that could affect protected birds are impacts to air and water quality, noise, G&G activities, platform presence and lighting, and construction. Mortality associated with collision with offshore structures has been reported in the Gulf of Mexico (Russell, 2005). Behavioral changes have also been observed with lighting associated with offshore structures. Migratory birds may become disoriented with the lights, expending energy in excessive circular flight. This can lead to exhaustion and mortality for individuals that are already metabolically compromised due to the energy expense of migratory flight. Accidental events include oil spills and related cleanup, impacts of which are discussed in detail in **Chapter 4.8.2** (Birds).

As for non-OCS oil- and gas-related events, State oil- and gas-related activities would have the same general impact-producing factors as the OCS oil- and gas-related activities discussed above; however, the activities would be in closer proximity to protected bird species' coastal habitat. The Mississippi River watershed contributes nutrients, causing a seasonal population explosion of phytoplankton, which creates a hypoxic or anoxic area. This can decrease fauna in the upper water column and decrease chances of successful forging for birds, leading to changes in behavior and decreased health condition; therefore, impacts are expected to be negligible to moderate. Wetland and beach loss would continue in the foreseeable future and would have a major impact to protected birds. Most of the coastal habitats used by protected birds are regulated and mitigated by different Federal and State agencies; however, continued coastal erosion and wetland loss is expected along the Gulf of Mexico. As noted earlier, piping plover population estimates indicate declines for at least two of three populations at their breeding grounds (Haig et al., 2005; Roche et al., 2010). Emerging infectious diseases such as the West Nile virus, Avian influenza, and Newcastle disease may impact protected birds, and impacts would be expected to be major if protected species populations were affected by such pathogens. Non-OCS impacts overall are expected to be **negligible** to **major** depending on the degree of impact

When considering the cumulative impacts to the protected bird species, the incremental contribution to impacts would be **negligible** from a proposed action. A proposed action would yield a much smaller impact proportionately when compared with the impacts from multiple sources as noted above.

4.9.4.2.1 Alternative A—Regionwide OCS Proposed Lease Sale (The Preferred Alternative)

The impact-producing factors associated with the Alternative A would include all those listed above. The mitigations would be the same for protected birds across the GOM. The impacts from a proposed action are expected to be **negligible** to **moderate** because of current and ongoing mitigations that are in place and applied during postlease activity reviews. Moderate impacts are not expected but may occur if a protected bird species suffers mortality as a result of encountering marine debris or an accidental oil spill and cleanup activities.

4.9.4.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

The impacts of Alternative B would be the same as Alternative A for all previously specified protected bird species, with the exception of the whooping crane with the listed population in Texas and outside of the CPA or EPA. Wintering Whooping Crane critical habitat is near Port Aransas, Texas, along a coastal area of the WPA. The expected impacts to the whooping crane would be **negligible**, but the impacts may be **moderate** in the unlikely event (which is seasonally dependent according to the timing of the incident and the presence of the species at the time) of an oil spill in the CPA/EPA, resulting in the death of at least one bird.

4.9.4.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

The impacts of this alternative would be the same as Alternative A for the species that occur in the WPA. The Cape Sable seaside sparrow, roseate tern, and the Mississippi sandhill crane are not found off Texas; therefore, they would not be impacted by a proposed lease sale in the WPA. Existing lease activity in the CPA and EPA and new activity in the WPA could yield **negligible** to **moderate** impacts. Moderate impacts may occur if a protected bird species is affected by an accidental oil spill and/or response.

4.9.4.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

The impacts of this alternative would be the same as Alternative A, B, or C because these stipulations are specific to areas that do not have any impact on ESA-protected bird species or their habitats.

4.9.4.2.5 Alternative E—No Action

The impacts of Alternative E would yield no additional impacts to protected birds. There would be no additional incremental contribution to the cumulative impacts to ESA-protected bird species or their habitats.

4.9.5 Protected Corals

This chapter provides detailed information regarding the protected coral species. However, the impact-producing factors and impact levels on these species are the same as those described in **Chapter 4.6.1** (Topographic Features) and the respective **Table 4-8**; therefore, they are summarized here. A full impact analysis for corals may be found in **Chapters 4.6** (Live Bottom Habitats).

4.9.5.1 Description of the Affected Environment

Corals in the GOM that are protected under the ESA include those listed in **Table 4-13**. Distribution of the listed species within the jurisdiction of the United States ranges from the State of Florida, Flower Garden Banks National Marine Sanctuary, and the U.S. territories of Puerto Rico, U.S. Virgin Islands, and Navassa Island. Critical habitat was designated for the elkhorn (*Acropora palmata*) and staghorn (*Acropora cervicornis*) coral species by the NMFS in 2008 and includes four counties in the State of Florida (Palm Beach, Broward, Miami-Dade, and Monroe Counties), as well as the U.S. territories of the U.S. Virgin Islands (St. John/St. Thomas and St. Croix) and Puerto Rico (*Federal Register*, 2008d). However, this designated critical habitat is located outside of the GOM and is not expected to be affected by a proposed action, as seen in **Figure 4-23** in **Chapter 4.9**. Though the listed species are protected, they would have the same potential impacts from a proposed action as other coral species. For a detailed description and impact analysis of corals in the GOM, refer to **Chapter 4.6**.

Elkhorn coral and staghorn coral were listed as threatened under the ESA in 2006 (*Federal Register*, 2006c). Both corals naturally occur on spur and groove, bank reef, patch reef, and transitional reef habitats, as well as on limestone ridges, terraces, and hard bottom habitats (Goldberg, 1973; Gilmore and Hall, 1976; Cairns, 1982; Davis, 1982; Jaap, 1984; Wheaton and Jaap, 1988; Miller et al., 2008). During the 1970's and 1980's, both elkhorn and staghorn corals underwent swift declines in abundance throughout their ranges. Although data suggest that white-band disease, a disease that affects acroporid corals and is distinguishable by the white band of dead coral tissue that it forms, was the primary cause of initial decline in Atlantic/Caribbean elkhorn and staghorn coral abundances, other threats, such as elevated seawater temperatures, ocean acidification, and physical damage from hurricanes, are credible and potentially significant impediments to recovery of these species (USDOC, NMFS, 2015i). Additionally, anthropogenic physical damage (e.g., vessel groundings, anchors, divers, and snorkelers), coastal development, competition, and predation were deemed by the NMFS to be moderate threats to both corals in the recent recovery plan (USDOC, NMFS, 2015i).

On September 10, 2014, the *Federal Register* published a final rule listing the boulder star coral (*Orbicella franksi*), lobed star coral (*Orbicella annularis*), and mountainous star coral (*Orbicella faveolata*) as threatened under the ESA (*Federal Register*, 2014b). This Orbicella species complex occurs in the western Atlantic and greater Caribbean, including the Flower Garden Banks. It has historically been a dominant component on Caribbean coral reefs, characterizing the so-called “buttress zone” and “annularis zone” in the classical descriptions of Caribbean reefs. The species complex has also become the major reef-builder in the greater Caribbean since the die-off of Acropora spp. (USDOC, NMFS, 2015i).

The species complex has high susceptibility to negative impacts from ocean warming, acidification, disease, sedimentation, and nutrients; some susceptibility to trophic effects of fishing and sea-level rise; and low susceptibility to predation (USDOC, NMFS, 2015i).

Between 1999 and 2009, overall cover of the *Orbicella* species complex in the Florida Keys declined, but it differed by habitat type (Ruzicka et al., 2013). Percent cover declined on the deep and shallow fore-reefs but remained stable on patch reefs (Ruzicka et al., 2013). In 2010, a cold-water bleaching event occurred in the Florida Keys where water temperatures dropped into the upper 40’s and lower 50’s, which is about 20 ºF (-7 ºC) lower than the typical temperatures in the upper 60’s (USDOC, NMFS, 2015i). This event reduced cover of the *Orbicella* species complex from 4.4 percent to 0.6 percent on four patch reefs in the upper and middle Florida Keys. However, random surveys between 2002 and 2006 in the Flower Garden Banks found that the *Orbicella* species complex (predominantly *O. franksi*) was the dominant coral, comprising between 27 and 40 percent benthic cover (Hickerson et al., 2008).

4.9.5.2 Environmental Consequences

The impact-producing factors and impact levels on these species are generally the same as those described in **Chapter 4.6.1** and **Table 4-8** and, therefore, are summarized here. The activities as a result of a proposed lease sale could directly impact protected coral habitat within the GOM. Because of the similarity and overlap of the effects of many activities that occur in the OCS, all possible impact-producing factors result from bottom-disturbing activities and the potential release of drilling muds and contaminants.

Routine Activities

Potential routine impact-producing factors on protected corals are the same as those analyzed and described in **Chapter 4.6.1**. Impacts resulting from all of the routine activities are mitigated through the Topographic Features Stipulation, and the protective measures are summarized and detailed in NTL 2009-G39. The site-specific survey information and distancing requirements described in NTL 2009-G39 would allow BOEM to identify and protect live bottom features (which protected corals may inhabit) from harm by proposed OCS oil- and gas-related activities during postlease reviews. Further, many of the protected corals either occur in the Flower Garden Banks National Marine Sanctuary, which is currently excluded from future leasing, or are far from the area of proposed activities. Assuming adherence to all expected lease stipulations and other postlease, protective restrictions and mitigations, along with site-specific reviews of proposed activities, the routine activities related to a proposed action are expected to have **negligible** impacts.

Accidental Events

While accidental events have the potential to cause severe damage to specific coral communities, the number of such events is expected to be small. Impacts resulting from bottom-disturbing activities, as described under "Routine Activities" in **Chapter 4.6.1**, are largely the same for accidental events. If the spill occurs close to a protected coral community, those communities may become smothered by the particles and exposed to hydrocarbons, which have the potential to severely impact protected corals via mortality, loss of habitat, change in community structure, and failed reproductive success. Beyond the area of spilled oil, impacts are expected to be less severe as particles are biodegraded and become more widely dispersed. Many of the protected corals either occur in the Flower Garden Banks National Marine Sanctuary, which is currently excluded from future leasing, or are far from the area of proposed activities. Therefore, impacts from reasonably foreseeable accidental events are expected to be **negligible** to **minor,** short in duration, and limited to the area where the accident occurs. A **negligible** impact would be largely undetectable and may cause slight, localized changes to a protected coral species community where recovery from the impact is expected. A **minor** impact would be detectable and could result in noticeable changes to a protected coral species community, but impacts would be spatially localized, short term in duration, and recovery from the impact would be expected.

Cumulative Impacts

Proposed OCS oil- and gas-related activities would contribute incrementally to the overall OCS and non-OCS cumulative impacts experienced by corals. A variety of non-OCS oil- and gas-related activities, including fishing and anchoring, along with shifting natural conditions such as invasive species and climate change, may have a considerable impact on these habitats in the future. These alternatives would also do little to increase the cumulative impacts since many blocks near the features are already leased and non-OCS oil- and gas-related activities are not expected to decrease. BOEM recognizes these impacts and has determined that a proposed action would not increase the cumulative effects on protected corals beyond what they are currently experiencing. Overall, impacts of non-OCS oil- and gas-related activities are expected to range between **negligible** to **moderate** depending on the amount of activity in the vicinity of the protected coral community. For example, climate change may have a **moderate** impact to a protected coral community, causing changes in community structure and ecological functioning. As such, the incremental contribution of OCS oil- and gas-related activities to the overall cumulative impacts of a proposed action, combined with non-OCS oil- and gas-related activities, is expected to be **negligible**.

4.9.5.2.1 Alternatives A, B, and C

Under Alternatives A, B, and C, the proposed activities would have the same impact levels to coral habitats whether they occur in the WPA, CPA, or EPA. While the WPA is a smaller area with less projected activity than is proposed for the CPA/EPA (refer to **Chapter 3**), many of the protected corals either occur in the Flower Garden Banks National Marine Sanctuary, which has no leasing, or are far from the area of proposed activities. Additional protection is provided through current and ongoing mitigations that are restated during postlease activity reviews. Because protected corals occur far from the area of proposed activities and are further protected through current and ongoing mitigations, impacts from reasonably foreseeable routine activities and accidental events are both expected to be **negligible** to **minor**. A **minor** impact would be detectable and could result in noticeable changes to a protected coral species community, but impacts would be spatially localized, short term in duration, and recovery from the impact would be expected.

4.9.5.2.2 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Under Alternative D, should the blocks subject to the Topographic Features and Live Bottom (Pinnacle Trend) Stipulations be excluded, protected corals would be further protected by distancing OCS oil- and gas-related activities farther from these habitats, thereby reducing the probability of potential impacts from routine activities or accidental events. Blocks subject to the Topographic Features Stipulation include any available unleased block in which a No Activity Zone or Shunting Zone may be applied. A total of 207 blocks within the CPA and 160 blocks in the WPA are affected by the Topographic Features Stipulation. The exclusion of any of the other blocks subject to the Blocks South of Baldwin County, Alabama, Stipulation is not expected to change the impacts to protected corals because of the small number of blocks and their distance from these corals. For additional information related to the specific blocks that would be excluded, refer to **Appendix D**. Because protected corals occur far from the area of proposed activities and are further protected through current and ongoing mitigations, impacts from reasonably foreseeable routine activities and accidental events are both expected to be **negligible** to **minor**. A **minor** impact would be detectable and could result in noticeable changes to a protected coral species community, but impacts would be spatially localized, short term in duration, and recovery from the impact would be expected. However, under Alternative D, it would be very unlikely that protected corals would encounter any impact-producing factor from OCS oil- and gas-related activities if the blocks subject to the Topographic Features and/or the Live Bottom (Pinnacle Trend) Stipulations are excluded.

4.9.5.2.3 Alternative E—No Action

Under Alternative E, a proposed lease sale would not occur; therefore, no impacts to protected corals as a result of a proposed lease sale would occur. There would, however, be ongoing cumulative impacts to the resources associated with previous OCS oil- and gas-related activities and non-OCS oil- and gas-related activities. Development of oil and gas would, in all likelihood, be postponed to a future lease sale decision; in that case, the overall level of OCS oil- and gas-related activity would be delayed, not reduced, at least in the short term. It would take several cancelled lease sales before there would likely be a noticeable decrease in postlease activities from previous oil and gas lease sales.

4.10 COMMERCIAL FISHERIES

The analyses of the potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts to commercial fisheries are presented in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define the impact-level measures for each impact-producing factor (**Table 4-15**). The analysis in this chapter relies on the analysis and conclusions reached in **Chapter 4.7** (Fish and Invertebrate Resources). This chapter describes the cause and effect analysis to the social endpoint for commercial fisheries. Therefore, in general, the impact-producing factors identified in **Chapter 4.7** would have the potential to impact commercial fisheries as well.

Table 4-15. Commercial Fisheries Impact-Producing Factors.

Commercial Fisheries	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Fish Population	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Space-Use Conflicts	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Production Structure Emplacement and Removal	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	None
Accidental Impacts					
Oil Spills	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Cumulative Impacts					
OCS Oil and Gas	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Non-OCS Oil and Gas	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible

Impact-Level Definitions

In this chapter (and in the analyses of the alternatives), the impact measures are defined in terms of the intensity, duration, and geographical extent of the impacts to the human uses of commercial fisheries along the Gulf Coast. In particular, the impacts of each impact-producing factor are summarized in **Table 4-15**, using the impact-level measures below.

- **Beneficial** – Impacts would be positive.
- **Negligible** – Little or no detectable impact.
- **Minor** – Impacts are detectable but less than severe.
- **Moderate** – Impacts are severe but are short term and/or not extensive.
- **Major** – Impacts are long term, extensive, and severe.

4.10.1 Description of the Affected Environment

The Gulf of Mexico is home to a large and complex commercial fishing industry. There were $762.5 million in finfish and shellfish landings in the Gulf of Mexico in 2012, which comprised 15 percent of total U.S. landings (USDOC, NMFS, 2014a). Some of the most economically important commercial fisheries in the Gulf of Mexico are white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), eastern oysters (*Crassostrea virginica*), Gulf menhaden (*Brevoortia patronus*), blue crab (*Callinectes sapidus*), red grouper (*Epinephelus morio*), red snapper (*Lutjanus campechanus*), and tunas (*Thunnus* spp.). Fisheries are managed by NOAA Fisheries (NMFS), as advised by the regional fisheries management councils. Commercial fisheries are regulated by various mechanisms, including permitting, closures, quotas, and gear restrictions; details regarding these mechanisms are described by the Gulf of Mexico Fishery Management Council (2015). This source also describes the allowable gear types for each fishery. Some of the most common gear types are trawls (for shrimp), purse seines (for menhaden), dredges (for oysters), traps (for blue crab), and longlines (for various finfish). The biological aspects of the affected environment for the targeted species are discussed in **Chapter 4.7.1**, the "Description of the Affected Environment" for **Chapter 4.7** (Fish and Invertebrate Resources).

Landings Revenues

Panel A of **Table 4-16** presents the total landings revenues for key GOM fisheries, while Panels B through F present the landings revenues for the key fisheries in each Gulf Coast State from 2009 through 2012. There were $762,514,000 in landings revenues in 2012, compared with $643,880,000 in 2009; $638,900,000 in 2010; and $818,505,000 in 2011. Fisheries offshore of Louisiana accounted for the most fisheries revenue in 2012, followed (in descending order) by Texas, West Florida, Mississippi, and Alabama. Shrimp species (particularly white shrimp and brown shrimp) account for the most landings revenues ($392,239,000 in 2012) in the Gulf of Mexico. Shrimp are caught offshore of all states, particularly Texas and Louisiana, in Federal and State waters. Menhaden landings accounted for the second most landings revenue ($87,376,000) in 2012. Menhaden accounts for the most pounds (1.28 billion pounds in 2012) landed in the Gulf of Mexico (USDOC, NMFS, 2014a). However, the average price per pound of menhaden is much lower than for other species. Menhaden is primarily caught in State and Federal waters offshore of Louisiana and Mississippi. Oysters ($73,662,000) and blue crab ($52,879,000) accounted for the third and fourth highest landings revenues in 2012. These species are caught in State waters of all Gulf Coast States. Red snapper and tunas are primarily caught in Federal waters offshore various states. Stone crab (*Menippe mercenaria*) and Caribbean spiny lobster (*Panulirus argus*) are primarily caught offshore Florida.

Table 4-16. Landings Revenues: Landings Revenue by Species and State.

Panel A: Regionwide						Panel B: Louisiana				
Species/Year	2009	2010	2011	2012		Species/Year	2009	2010	2011	2012
Shrimp	327,263	339,228	441,266	392,239		Shrimp	121,477	107,362	133,670	147,616
Menhaden	69,456	66,019	103,519	87,376		Menhaden	51,405	57,600	93,547	64,861
Oysters	73,473	55,088	65,098	73,662		Blue crab	37,306	30,325	36,784	43,097
Blue crab	45,476	41,264	48,605	52,879		Oysters	50,959	24,989	41,652	41,592
Stone crab	17,690	23,384	24,518	23,760		Crawfish	15,547	13,971	9,914	8,287
Groupers	17,291	13,580	18,988	23,427		Tunas	6,338	1,649	3,369	7,890
Red snapper	7,984	10,202	11,233	13,702		Red snapper	2,185	2,311	2,261	2,571
Tunas	8,180	2,688	5,298	10,655		King mackerel	1,184	1,149	1,594	1,475
Total Revenue	643,880	638,900	818,505	762,514		Total Revenue	296,778	247,831	334,789	331,165
Panel C: Texas						Panel D: West Florida				
Species/Year	2009	2010	2011	2012		Species/Year	2009	2010	2011	2012
Shrimp	135,643	173,556	216,382	159,534		Stone crab	17,586	23,335	24,427	23,750
Oysters	9,376	19,144	12,789	21,302		Shrimp	23,314	27,554	28,339	22,430
Red snapper	2,398	3,009	3,254	4,448		Lobsters	12,179	32,752	33,872	21,132
Blue crab	2,454	3,134	2,845	2,876		Red grouper	10,488	8,992	14,531	16,737
Black drum	1,377	1,573	1,448	1,486		Oyster	6,968	6,298	8,408	7,919
Vermilion snapper	1,233	1,337	1,274	1,434		Red snapper	2,980	4,552	5,237	6,141
Atlantic croaker	484	531	622	740		Blue crab	4,183	6,706	7,530	5,139
Groupers	641	356	549	723		Mullets	5,069	4,188	8,567	5,032
Total Revenue	155,074	203,795	240,566	194,044		Total Revenue	115,127	139,045	161,949	141,671
Panel E: Mississippi						Panel F: Alabama				
Species/Year	2009	2010	2011	2012		Species/Year	2009	2010	2011	2012
Shrimp	12,689	8,293	18,514	23,803		Shrimp	34,140	22,463	44,361	38,856
Menhaden	17,987	8,378	9,871	22,394		Oysters	77	390	1,322	1,253
Oysters	6,094	4,268	928	1,596		Mullets	765	594	687	1,204
Blue crab	573	366	318	724		Spanish mackerel	301	499	582	1,149
Red snapper	158	N/A	168	226		Blue crab	961	732	1,128	1,044
Total Revenue	38,033	21,895	30,291	49,295		Total Revenue	38,869	26,335	50,910	46,340

[1]Landings are presented in thousands of dollars.

Source: USDOC, NMFS, 2014a.

Fisheries Supply Chain

The fisheries landings discussed above are brought to shore at various ports along the Gulf Coast. Some of the leading commercial fishing ports, along with the fisheries revenues received in 2012 at these ports, are Empire-Venice, Louisiana ($79.7 million); Galveston, Texas ($74.3 million); Dulac-Chauvin, Louisiana ($64 million); Brownsville-Port Isabel, Texas ($53.6 million); Port Arthur, Texas ($47.4 million); Intracoastal City, Louisiana ($43.9 million); and Bayou La Batre, Alabama ($37.5 million) (USDOC, NMFS, 2015j). Fish landings then proceed through supply chains that include dealers, processors, distributors, markets, and restaurants. Economic modeling techniques were used to estimate the supply chain impacts of fisheries landings (USDOC, NMFS, 2014a). The NMFS's estimates of the number of jobs and the amount of value-added supported by fisheries landings in each Gulf Coast State are listed below. The large impacts in Florida are due to its high numbers of seafood importers, wholesalers, distributors, and retailers.

- Texas (25,911 jobs; $ 1,036,657,000)
- Louisiana (33,391 jobs; $920,873,000)
- Mississippi (8,532 jobs; $193,349,000)
- Alabama (9,947 jobs; $229,316,000)
- Florida (82,141 jobs; $5,532,209,000)

4.10.2 Environmental Consequences

The impacts from routine activities and accidental events, and the cumulative impacts to commercial fisheries that would arise from projected activities from a proposed action are analyzed in this chapter. While there are some differences in the amount of activities associated with the alternatives, many of the impacts associated with the alternatives are similar. Therefore, this chapter will describe the impacts that are expected to apply to all alternatives, while any deviations from these impact conclusions will be discussed in **Chapters 4.10.2.1-4.10.2.5**.

Routine Activities

Routine operations (such as seismic surveys [**Chapter 3.1.2.1**], drilling activities [**Chapters 3.1.2.2 and 3.1.3.1**], service-vessel traffic [**Chapter 3.1.4.4**], and production structure emplacement [**Chapter 3.1.3.3**], and decommissioning [**Chapter 3.1.6**]) can impact commercial fisheries by impacting the fish populations that support commercial fishing or by impacting fishermen's access to those fish populations. The impacts to fish populations that support commercial fishing are described in **Chapter 4.7**, which describes the impacts of anthropogenic sound, bottom-disturbing activities, and habitat modification on fish populations. The impacts to commercial fishing from routine activities would depend on the types and scales of commercial fishing activities in an impacted area, which are discussed in **Chapter 4.10.1**. Shrimp, menhaden, red snapper, tunas, and groupers are the fishes and invertebrates most often sought by commercial fishermen in Federal waters and would therefore be most directly impacted by a proposed action. Disturbances to those populations would have proportionate impacts on the seafood supply chain. However, since the impacts to fish populations from routine OCS oil- and gas-related activities would be **negligible** or **minor** (determined in **Chapter 4.7**), the corresponding impacts to commercial fisheries would also be **negligible** or **minor**. This is because disruptions to fish populations would proportionately reduce commercial fishing revenues, as well as the impacts on the seafood supply chain.

Space-use conflicts with commercial fishing can arise from routine operations such as service-vessel traffic, seismic surveys, pipeline emplacement, drilling, and production structure emplacement and removals. The nature of space-use conflicts from these activities depend on the durations of the activities, as well as the locations and species affected. For example, structure emplacement prevents trawling in the associated area and, thus, could impact the shrimp fishery. However, the amount of area closed to trawling would be minimal relative to the vast areas where shrimp trawling occur (refer to **Chapter 3.1.3.4.2**). On the other hand, production platforms can facilitate fishing for reef fish such as red snapper and groupers. Scott-Denton et al. (2011) present observational data regarding the geographic distribution of various reef fish in the Gulf of Mexico, where structure production emplacement can enhance commercial fishing. The eventual decommissioning of a platform would reverse the effects of structure emplacement unless the structure were reefed in place or moved to an artificial reef site. Due to the small scale of a proposed action (**Chapter 3**), the impacts of space-use conflicts and structure emplacement and eventual decommissioning are expected to range from **beneficial** to **minor**. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access.

Accidental Events

Accidental events, such as oil spills (**Chapter 3.2.1**), can impact commercial fisheries by impacting the fish populations that support commercial fishing activities, by impacting fishermen's access to those fish populations, or by impacting the seafood supply chain. The impacts of oil spills on fish populations that support commercial fishing are described in **Chapter 4.7**, describes the impacts of potential sediment displacement due to a spill, as well as the potential lethal and sublethal impacts to fish and shellfish species. The corresponding impacts to commercial fishing would depend on the types and scales of commercial fishing activities in an impacted area, which are discussed in **Chapter 4.10.1**. Oil spills in Federal waters would be most likely to affect fisheries for coastal or oceanic species (such as shrimp, menhaden, reef fish, tunas, and groupers), and accidental spills in State waters would be most likely to affect coastal and inshore fisheries (e.g., shrimp, menhaden, oysters, and blue crab). Most commercially valuable species in the Gulf of Mexico have planktonic eggs and/or larvae. These early life stages are generally more vulnerable to impacts resulting from acute exposure to oil and could be affected if a spill coincides with a spawning event or impacts nursery habitat (e.g., Coastal Habitats [**Chapter 4.3**] or *Sargassum* and Associated Communities [**Chapter 4.5**]).

The area surrounding a spill could be closed to commercial fishing for some period of time. However, fishing closures would likely be limited in size and duration. Commercial fishermen would likely have numerous alternate fishing sites for the duration of a closure. Oil spills can have other impacts to the supply or demand of seafood. Greater New Orleans, Inc. (2011) provides information regarding how the various impacts to commercial fisheries evolved subsequent to the *Deepwater Horizon* oil spill, which provides insights regarding the potential impacts of future spills. For example, an oil spill could cause seafood safety concerns, which would reduce the demand for the affected species. An oil spill could also cause certain fishermen to stop fishing to participate in the cleanup operations or for economic reasons. However, the oil spills that could arise from a proposed action are forecast to be small. Therefore, an oil spill would likely have limited impacts on fish populations, as well as limited impacts on the supply and demand for seafood. Therefore, the impacts of oil spills arising from a proposed action would be **negligible** to **minor**. The exact impacts would depend on the locations of oil spills, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access.

Cumulative Impacts

The cumulative impacts to commercial fisheries would be determined by the cumulative impacts to fish populations, which are discussed in **Chapter 4.7**. The impacts to fish populations would impact commercial fishing in proportion to the intensity of commercial fishing for a particular species in a particular location. The cumulative impacts to commercial fisheries would also be determined by other factors that could affect access to fishing sites or by impacts that could affect the supply and demand for seafood.

OCS Oil- and Gas-Related Impacts

A proposed action would contribute to the impacts from the routine activities and accidental events of the overall OCS Program. **Chapter 4.7** discusses the cumulative impacts to fish populations from OCS oil- and gas-related sound, bottom-disturbing activities (**Chapter 3.3.1.5**), and habitat modification. These impact-producing factors could cause displacement, physical harm, or fatalities. The associated cumulative impacts to commercial fisheries would be determined by the intensity of commercial fishing for each species in an affected area (described in **Chapter 4.10.1**). In particular, impacts to fish populations could lead to decreased fishing landings and revenues, which would impact jobs and incomes throughout the seafood supply chain. A proposed action would also contribute to the space-use conflicts (**Chapter 3.1.3.4.2**) and the potential for accidental events (which are discussed above) arising from the OCS Program. Finally, the *Deepwater Horizon* oil spill may still have some lingering impacts on commercial fisheries. Long-term impacts to fish populations as a result of past oil spills in the GOM have not been described, but impacts could be masked by natural variations in populations or may not be evident for several years. **Chapter 4.10.1** describes that landings revenues for most species have generally recovered since the spill. However, there could still be minor lingering impacts for some fisheries (Greater New Orleans, Inc., 2011).

A proposed lease sale would be relatively small when compared with all past, present, and future lease sales (**Table 3-23**). Therefore, the incremental cumulative impacts of a proposed action relative to the overall OCS Program would range from **beneficial** to **minor**. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access.

Non-OCS Oil- and Gas-Related Impacts

The non-OCS oil- and gas-related impacts that could have an effect on commercial fisheries including anthropogenic sound (**Chapter 3.3.2.7**) and habitat modifications, state oil and gas activities (**Chapter 3.3.2.1**), space-use conflicts, and various economic forces.

Chapter 4.7 discusses the impacts of anthropogenic sound and habitat modifications on fish resources. These impacts would impact commercial fishing to the extent that landings of certain species were impacted, which would likely occur in proportion to the scale of commercial fishing in an area (**Chapter 4.10.1**).

State oil and gas activities also have impacts on commercial fisheries. For example, State oil and gas activities could lead to space-use conflicts with commercial fisheries and could lead to accidental events. State oil and gas platforms could also support reef fish populations important to commercial fishermen. The nature of these impacts would be similar to those of a proposed action, although the affected species may be different. For example, oysters and blue crab are primarily fished in State waters and thus could be impacted by the associated State oil and gas routine and accidental impacts.

Commercial fishermen also encounter space-use conflicts with recreational, commercial, and military vessels that temporarily restrict access to fishing areas. Although tropical storm events are a part of the natural environment and not considered to adversely impact fish populations, severe events could affect various types of infrastructure (e.g., vessels, fish houses, and suppliers) that support commercial fishing. Storms could also temporarily prevent fishermen from fishing in certain areas.

A proposed action should also be viewed in light of various economic forces affecting commercial fisheries. Participants in the GOM seafood industry compete with participants in various other domestic and international markets. The USDOC, NMFS (2015k) presents various statistics regarding these markets. For example, GOM shrimp competes with a large import market. In 2013, there were $5.3 billion of shrimp imports into the U.S., $4 billion of which came from Asian countries. Demand for GOM seafood is also positively correlated with the overall state of the economy; information regarding the expected progression of the economy is presented in **Chapter 4.14.2**. The cumulative impacts to commercial fisheries would also be influenced by the management strategies employed by the NOAA, the Gulf of Mexico Fishery Management Council, and various State agencies. For example, the NOAA and the Texas Parks and Wildlife Department annually close Federal and State waters to shrimp fishing for 45-90 days in late spring to ensure a healthy shrimp population (USDOC, NFMS, 2015l). Fisheries managers also develop strategies for species, such as red snapper, that are important to recreational and commercial fishing (USDOC, NFMS, 2015m). Finally, the NMFS has published the final rule for mechanisms to manage aquaculture in the Federal

Gulf of Mexico (*Federal Register*, 2016a). The NFMS has published a programmatic EIS for its Gulf of Mexico aquaculture management plan (USDOC, NMFS, 2009). **Chapter 3.3.2.11** provides more information regarding aquaculture in the Gulf of Mexico. These various management strategies would likely sustain healthy commercial fisheries during the life of a proposed action.

A proposed action would be relatively small when compared with the non-OCS oil- and gas-related factors discussed above (refer to **Chapter 3**). Therefore, the incremental cumulative impacts of a proposed action relative to these non-OCS oil- and gas-related factors would range from **beneficial** to **minor**. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access.

Incomplete or Unavailable Information

BOEM has determined that there is incomplete or unavailable information related to commercial fisheries. Some of this incomplete or unavailable information relates to fish populations that support commercial fishing, which is discussed in **Chapter 4.7**. There is also incomplete or unavailable information regarding the long-term impacts of acute and chronic exposure to oil on commercial fisheries. This information is unavailable because these impacts would only become evident through time. In lieu of the incomplete or unavailable information, BOEM used various data sources and studies to estimate the affected environment and impacts of OCS oil- and gas-related and non-OCS oil- and gas-related activities for commercial fishing. BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among alternatives because existing data sources are sufficient for BOEM to reasonably estimate impacts.

4.10.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

The impacts of Alternative A would correspond to the impacts discussed in **Chapter 4.10.2**. Alternative A could affect commercial fisheries by affecting fish populations or by affecting the socioeconomic aspects of commercial fishing. The impacts of a proposed action on fish populations are presented in **Chapter 4.7**. Routine activities such as seismic surveys, drilling activities, and service-vessel traffic can cause space-use conflicts with fishermen. Structure emplacement could have positive or negative impacts, depending on the location and species. Accidental events, such as oil spills, could cause fishing closures and have other impacts on the supply and demand for seafood. However, accidental events that could arise from a proposed action would likely be small and localized. Alternative A should also be viewed in light of the overall OCS Program, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternative A on commercial fisheries are expected to range from **beneficial** to **minor**, largely due to the limited scale of a proposed action. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access.

4.10.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Alternative B entails leasing a subset of the area considered in Alternative A. Therefore, the analysis of Alternative A covers the potential impacts of Alternative B. There are some differences (described in **Chapter 4.10.1**) in the scales of commercial fishing in the CPA/EPA compared with the WPA. For example, menhaden and blue crab comprise larger percentages of landings revenues in the CPA/EPA (particularly in Louisiana) compared with the WPA. However, the impact conclusions for Alternatives A and B are the same.

The impacts of Alternative B would correspond to the impacts discussed in **Chapter 4.10.2**. Alternative B could affect commercial fisheries by affecting fish populations or by affecting the socioeconomic aspects of commercial fishing. The impacts of a proposed action on fish populations are presented in **Chapter 4.7**. Routine activities such as seismic surveys, drilling activities, and service-vessel traffic can cause space-use conflicts with fishermen. Structure emplacement could have positive or negative impacts, depending on the location and species. Accidental events, such as oil spills, could cause fishing closures and have other impacts on the supply and demand for seafood. However, accidental events that could arise from a proposed action would likely be small and localized. Alternative B should also be viewed in light of the overall OCS Program, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternative B on commercial fisheries are expected to range from **beneficial** to **minor**, largely due to the limited scale of a proposed action. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access.

4.10.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Alternative C entails leasing a subset of the area considered in Alternative A. Therefore, the analysis of Alternative A covers the potential impacts of Alternative C. There are some differences (described in **Chapter 4.10.1**) in the scales of commercial fishing in the CPA/EPA compared with the WPA. For example, menhaden and blue crab comprise larger percentages of landings revenues in the CPA/EPA (particularly in Louisiana) compared with the WPA. Alternative C would also entail less overall activity than Alternative A. However, the impact conclusions for Alternatives A and C are the same.

The impacts of Alternative C would correspond to the impacts discussed in **Chapter 4.10.2**. Alternative C could affect commercial fisheries by affecting fish populations or by affecting the socioeconomic aspects of commercial fishing. The impacts of a proposed action on fish populations are presented in **Chapter 4.7**. Routine actions such as seismic surveys, drilling activities, and service vessel traffic can cause space-use conflicts with fishermen. Structure emplacement could have positive or negative impacts, depending on the location and species. Accidental events, such as oil spills, could cause fishing closures and have other impacts on the supply and demand for seafood. However, accidental events that could arise from a proposed action would likely be small and localized. Alternative C should also be viewed in light of the overall OCS Program, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternative C on commercial fisheries are expected to range from **beneficial** to **minor**, largely due to the limited scale of a proposed action. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access.

4.10.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D entails leasing a subset of the area considered in Alternatives A, B, or C by making blocks that would normally be subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations unavailable for lease. Therefore, the analyses for those alternatives (described above) cover the potential impacts of Alternative D, generally to commercial fisheries. . In addition, Alternative D would not exclude large areas to commercial fishing. This is particularly true since fishermen would probably not use certain gear types, such as bottom trawls, near topographic features for fear of entangling and damage to gear. Therefore, the impact conclusions (which are discussed below) remain the same, though there may be a slight offsetting effect to commercial fishing in the excluded blocks, as it would reduce any potential conflict with OCS oil- and gas-related activities but would similarly prevent the potential for beneficial effects from new platforms or other fish attractions in the blocks.

The impacts of Alternative D would correspond to the impacts discussed in **Chapter 4.10.2**. Alternative D could affect commercial fisheries by affecting fish populations or by affecting the socioeconomic aspects of commercial fishing. The impacts of a proposed action on fish populations are presented in **Chapter 4.7**. Routine actions such as seismic surveys, drilling activities, and service vessel traffic can cause space-use conflicts with fishermen. Structure emplacement could have positive or negative impacts, depending on the location and species. Accidental events, such as oil spills, could cause fishing closures and have other impacts on the supply and demand for seafood. However, accidental events that could arise from a proposed action would likely be small and localized. Alternative D should also be viewed in light of the overall OCS Program, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternative D on commercial fisheries are expected to range from **beneficial** to **minor**, largely due to the limited scale of a proposed action. The exact impacts would depend on the locations of activities, the species affected, the intensity of commercial fishing activity in the affected area, and the substitutability of any lost fishing access.

4.10.2.5 Alternative E—No Action

Alternative E would prevent the **beneficial** to **minor** impacts discussed in **Chapter 4.10.2**. However, commercial fisheries would still be subject to the impacts from the OCS Program, as well as the impacts from the non-OCS oil- and gas-related sources discussed above.

4.11 Recreational Fishing

The analyses of the potential impacts of routine activities and accidental events associated with a proposed lease sale and a proposed lease sale's incremental contribution to the cumulative impacts to recreational fishing are presented in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as the accidental events and cumulative impacts, and to define the impact-level measures for each impact-producing factor. The analysis in this chapter relies on the analysis and conclusions reached in **Chapter 4.7** (Fish and Invertebrate Resources). This chapter carries the cause and effect analysis to the social endpoint for recreational fishing. Therefore, in general, the impact-producing factors identified in **Chapter 4.7** would have the potential to impact recreational fishing as well.

In this chapter (and in the analyses of the alternatives), the impact measures are defined in terms of the intensity, duration, and geographical extent of the impacts to the human uses of recreational fisheries along the Gulf Coast. In particular, the impacts of each impact-producing factor are summarized in **Table 4-17** using the impact-level measures below.

Impact-Level Definitions

- **Beneficial** – Impacts would be beneficial.
- **Negligible** – Little or no detectable impact.
- **Minor** – Impacts are detectable but less than severe.
- **Moderate** – Impacts are severe but are short term and/or not extensive.
- **Major** – Impacts are long term, extensive, and severe.

Table 4-17. Recreational Fishing Impact Producing Factors.

Recreational Fishing	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Anthropogenic Sound	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Bottom-Disturbing Activities	Negligible	Negligible	Negligible	Negligible	None
Space-Use Conflicts	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None
Production Structure Emplacement and Removal	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	None
Accidental Impacts					
Oil Spills	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	None

Recreational Fishing	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Cumulative Impacts					
OCS Oil and Gas	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Non OCS Oil and Gas	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible

4.11.1 Description of the Affected Environment

Recreational fishing is a popular pastime in many parts of the Gulf of Mexico. The GOM's extensive estuarine habitats (**Chapter 4.3.1**), live bottom habitats (**Chapter 4.6**), and artificial substrates (including artificial reefs, shipwrecks, and oil and gas platforms) support several valuable recreational fisheries. Fisheries are managed by NOAA Fisheries (NMFS), as advised by the regional fisheries management councils; details regarding the most recent regulatory mechanisms relevant to recreational fishing are described by the Gulf of Mexico Fishery Management Council (2015). Recreational landings and effort data for Louisiana, Mississippi, Alabama, and Florida are provided by the NMFS; recreational fishing data for Texas is provided by the Texas Parks and Wildlife Department. Although a proposed lease sale is a regionwide lease sale, the data from these two sources are presented separately to allow for methodological differences between them. These data, along with data on the economic impacts of recreational fishing, are presented in subsequent sections. The biological aspects of the affected environment are discussed in **Chapter 4.7** (Fishes and Invertebrate Resources).

CPA/EPA Catch and Effort Data

The NMFS collects and provides public access to data on recreationally targeted species, landings, and angler effort (USDOC, NMFS, 2014b). The NMFS also publishes annual reports summarizing these data and the economic impacts to the Gulf Coast States (USDOC, NMFS, 2014a). **Table 4-18** present data on the number of angler trips taken in Louisiana, Mississippi, Alabama, and West Florida from 2008 to 2013. The total number of angler trips in these four states declined from 2008 through 2010, but then gradually increased from 21 million trips in 2010 to 25.2 million trips in 2013. In 2013, there were 15.9 million angler trips in West Florida, 4.7 million angler trips in Louisiana, 2.9 million angler trips in Alabama, and 1.8 million angler trips in Mississippi. **Tables 4-18** also breaks down these trips by location and mode. The three geographic locations for each state are inland, State ocean waters, and Federal ocean waters. The three modes of fishing are shore fishing, charter fishing, and private/rental fishing. The last column in **Table 4-18** present the percentage of recreational fishing in 2013 broken down by location and mode. The least amount of recreational fishing occurs in Federal waters, where most OCS oil- and gas-related activities occur. In the four states combined in 2013, 59.7 percent of recreational fishing occurred in inland waters, 32.7 percent occurred in State ocean waters, and 7.6 percent occurred in Federal ocean waters. In 2013, 53.5 percent of recreational fishing occurred on private or rental boats, 42.9 percent occurred from shore, and 3.6 percent occurred on charter boats.

Table 4-18. CPA and EPA Effort Data: Angler Trips in the Gulf of Mexico.

Area	2008	2009	2010	2011	2012	2013	% of State Total in 2013
Alabama							
Shore Ocean (< 3 nmi)	249,893	322,126	447,041	603,546	750,159	1,250,811	43.70%
Shore Inland	452,192	449,470	365,234	598,700	461,221	515,982	18.03%
Charter Ocean (<3 nmi)	9,967	9,166	8,860	19,874	15,785	20,615	0.72%
Charter Ocean (>3 nmi)	38,046	36,259	17,424	48,616	28,340	56,145	1.96%
Charter Inland	7,700	10,656	7,221	6,351	14,536	12,976	0.45%
Private/Rental Ocean (<3 nmi)	247,876	131,997	114,816	191,563	137,321	118,801	4.15%
Private/Rental Ocean (>3 nmi)	74,074	134,411	69,335	188,994	131,897	278,821	9.74%
Private/Rental Inland	624,197	618,502	656,226	825,821	766,027	608,280	21.25%
Total	1,703,945	1,712,587	1,686,157	2,483,465	2,305,286	2,862,431	
West Florida							
Shore Ocean (< 9 nmi)	3,076,591	2,688,011	1,610,807	1,982,194	2,199,810	3,745,909	23.49%
Shore Inland	3,704,990	3,793,756	4,034,208	3,862,665	4,016,544	3,191,414	20.01%
Charter Ocean (<9 nmi)	187,810	196,753	159,317	179,880	242,666	199,908	1.25%
Charter Ocean (>9 nmi)	255,300	262,005	203,201	236,088	307,121	322,185	2.02%
Charter Inland	127,801	113,842	98,440	119,826	149,315	161,479	1.01%
Private/Rental Ocean (<9 nmi)	3,624,073	2,605,196	2,257,349	1,901,217	2,087,991	2,572,325	16.13%
Private/Rental Ocean (>9 nmi)	1,242,935	751,869	681,551	500,067	755,470	1,136,161	7.12%
Private/Rental Inland	5,277,665	5,265,888	5,221,323	5,118,740	5,021,267	4,619,920	28.97%
Total	17,497,165	15,677,320	14,266,196	13,900,677	14,780,184	15,949,301	
Louisiana							
Shore Ocean (< 3 nmi)	62,712	38,930	11,664	48,893	152,094	247,502	5.31%
Shore Inland	870,042	730,053	717,006	1,073,035	978,657	1,101,517	23.63%
Charter Ocean (<3 nmi)	10,468	3,931	2,762	6,937	3,646	5,058	0.11%
Charter Ocean (>3 nmi)	32,805	21,173	8,106	15,742	19,827	15,373	0.33%
Charter Inland	135,915	157,692	68,018	90,057	91,192	101,935	2.19%
Private/Rental Ocean (<3 nmi)	97,797	81,008	59,347	77,986	116,854	82,512	1.77%
Private/Rental Ocean (>3 nmi)	89,859	99,352	11,568	80,952	88,503	65,730	1.41%
Private/Rental Inland	3,320,459	2,995,875	2,984,016	3,182,645	2,685,791	3,041,527	65.25%
Total	4,620,057	4,128,014	3,862,487	4,576,247	4,136,564	4,661,154	

Area	2008	2009	2010	2011	2012	2013	% of State Total in 2013
Mississippi							
Shore Ocean (< 3 nmi)	0	143	0	0	811	0	0.00%
Shore Inland	359,438	309,612	596,544	760,788	947,075	763,983	43.39%
Charter Ocean (<3 nmi)	4,286	2,803	904	3,123	1,628	2,190	0.12%
Charter Ocean (>3 nmi)	718	330	949	221	125	153	0.01%
Charter Inland	8,229	7,656	4,989	7,891	9,738	8,911	0.51%
Private/Rental Ocean (<3 nmi)	12,056	16,962	12,419	18,682	4,116	6,124	0.35%
Private/Rental Ocean (>3 nmi)	28,007	26,316	4,626	12,974	41,137	53,886	3.06%
Private/Rental Inland	555,951	715,505	612,162	811,711	945,819	925,512	52.56%
Total	968,685	1,079,327	1,232,593	1,615,390	1,950,449	1,760,759	
Gulf Total CPA and EPA Effort Data							
Shore Ocean (< 3 nmi)	3,389,196	3,049,210	2,069,512	2,634,633	3,102,874	5,244,222	20.78%
Shore Inland	5,386,662	5,282,891	5,712,992	6,295,188	6,403,497	5,572,896	22.09%
Charter Ocean (<3 nmi)	212,531	212,653	171,843	209,814	263,725	227,771	0.90%
Charter Ocean (>3 nmi)	326,869	319,767	229,680	300,667	355,413	393,856	1.56%
Charter Inland	279,645	289,846	178,668	224,125	264,781	285,301	1.13%
Private/Rental Ocean (<3 nmi)	3,981,802	2,835,163	2,443,931	2,189,448	2,346,282	2,779,762	11.02%
Private/Rental Ocean (>3 nmi)	1,434,875	1,011,948	767,080	782,987	1,017,007	1,534,598	6.08%
Private/Rental Inland	9,778,272	9,595,770	9,473,727	9,938,917	9,418,904	9,195,239	36.44%
Total	24,789,852	22,597,248	21,047,433	22,575,779	23,172,483	25,233,645	

Source: USDOC, NMFS, 2014a.

Table 4-19 presents data on the most commonly landed species by recreational fishermen in Louisiana, Mississippi, and Alabama combined from 2008 to 2013. Some of the most popular recreational species in these states are spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), Atlantic croaker (*Micropogonias undulatus*), sand seatrout (*Cynoscion arenarius*), Spanish mackerel (*Scomberomorus maculatus*), and black drum (*Pogonias cromis*). In 2013, landings of most species were similar to landings observed in prior years. However, there were noticeable increases in landings of red drum, black drum, and red snapper; there were noticeable decreases in landings of sand seatrout and Spanish mackerel.

Table 4-19. CPA and EPA Catch Data: Fish Species Caught by Recreational Anglers from 2008 through 2013 in Louisiana, Mississippi, and Alabama Combined.

Species/Year	2008	2009	2010	2011	2012	2013
Atlantic Croaker	4,648,460	4,696,500	4,907,698	7,461,690	4,757,605	4,562,458
Black Drum	1,819,040	1,645,416	1,544,695	1,768,605	1,629,633	2,472,942
Blackfin Tuna	57,274	59,046	1,793	33,008	64,007	35,705
Cobia	31,484	21,575	3,519	50,263	25,105	40,448
Dolphins	96,899	7,200	2,174	911	9,418	31,524
Gag	45,383	42,835	10,274	13,523	12,939	20,573
Gray Snapper	233,841	255,943	33,479	142,062	451,724	375,596
Great Amberjack	29,728	28,422	16,982	56,163	15,962	30,410
King Mackerel	35,373	82,508	38,069	70,898	124,839	124,211
Little Tuny	18,529	9,520	14,175	28,660	40,005	17,172
Pinfishes	474,606	454,356	521,732	1,460,956	1,101,630	1,227,257
Red Drum	7,292,431	6,467,215	7,486,800	6,809,940	6,305,267	9,009,223
Red Grouper	12	774	2,296	0	168	2,326
Red Snapper	905,870	894,732	368,901	851,662	607,516	1,743,402
Sand Seatrout	4,052,323	5,294,998	5,715,702	7,115,540	5,194,418	3,768,286
Sheepshead	1,643,546	1,422,352	1,183,531	1,966,957	1,163,684	1,334,601
Southern Flounder	557,809	825,776	982,237	964,675	1,016,969	1,320,715
Southern Kingfish	1,350,161	1,190,382	1,045,644	1,075,935	760,688	1,180,114
Spanish Mackerel	196,011	200,662	397,247	541,435	844,101	2,525,453
Spotted Seatrout	24,013,172	21,657,958	15,118,683	19,843,879	20,452,196	22,327,595
Striped Mullet	322,245	293,375	866,308	1,412,632	1,163,763	1,623,070
White Grunt	0	1,084	0	0	0	0

Source: USDOC, NMFS, 2014a.

Table 4-20 presents data on the species most commonly landed by recreational fishermen in West Florida from 2008 to 2013. These species include pinfish (*Lagodon rhomboides*), spotted seatrout, gray snapper (*Lutjanus griseus*), Spanish mackerel, white grunt (*Haemulon plumieri*), and red grouper (*Epinephelus morio*). In 2013, landings of most species were similar to landings observed in prior years. However, there were noticeable increases in landings of dolphins, gray snapper, and Spanish mackerel; there were noticeable decreases in landings of sand seatrout and spotted seatrout.

Table 4-20. CPA and EPA Catch Data: Fish Species Caught by Recreational Anglers from 2008 through 2013 in West Florida.

Species/Year	2008	2009	2010	2011	2012	2013
Atlantic Croaker	372,271	333,201	429,614	488,456	468,451	437,425
Black Drum	156,391	125,064	218,938	115,842	112,817	219,579
Blackfin Tuna	80,613	25,933	30,354	20,821	44,190	56,765
Cobia	128,670	64,532	58,880	59,124	69,045	71,391
Dolphins	543,588	394,692	267,944	455,918	359,146	1,922,167

Species/Year	2008	2009	2010	2011	2012	2013
Gag	4,511,351	2,926,723	2,250,467	1,255,515	1,112,826	1,382,809
Gray Snapper	7,082,879	4,190,312	2,418,388	2,658,705	4,073,840	6,618,012
Great Amberjack	219,182	183,807	365,690	194,791	151,623	327,080
King Mackerel	338,965	591,022	252,995	173,914	242,302	291,727
Little Tuny	185,031	158,836	126,299	173,102	296,492	157,557
Pinfishes	15,637,922	9,422,451	9,893,857	7,390,804	12,258,510	9,675,256
Red Drum	3,017,880	1,665,659	2,231,738	3,182,220	2,713,322	2,560,823
Red Grouper	3,105,147	3,171,464	2,240,450	2,009,532	2,009,920	3,166,786
Red Snapper	1,883,804	2,046,716	1,400,636	1,189,850	1,408,331	2,322,435
Sand Seatrout	1,282,681	1,337,450	613,338	1,152,573	2,157,703	899,277
Sheepshead	1,412,235	1,489,548	1,700,583	1,882,258	1,805,203	1,608,128
Southern Flounder	37,117	11,332	9,522	23,120	33,346	28,887
Southern Kingfish	240,040	227,140	404,764	87,367	74,894	93,384
Spanish Mackerel	3,742,003	2,938,091	3,643,511	2,934,531	2,434,336	4,986,910
Spotted Seatrout	11,127,967	9,042,259	9,584,787	12,856,960	12,545,581	9,165,609
Striped Mullet	1,083,471	674,022	925,554	801,743	1,395,641	1,555,565
White Grunt	3,721,050	2,283,923	2,494,075	2,852,807	3,405,536	4,701,436

Source: USDOC, NMFS, 2014a.

WPA Catch and Effort Data

Table 4-21 provides data on the number of recreational fishing trips in Texas bays, State waters, and the Exclusive Economic Zone during each season of 2009-2014 (Fisher, official communication, 2015). There were 1,069,125 angler trips in 2014, down from 1,159,187 in 2012 and 1,149,597 in 2013. The least amount of recreational fishing occurs in Federal waters, where most OCS oil- and gas-related activities occur. In 2014, 96.4 percent of fishing occurred in bays, 2.4 percent occurred in State ocean waters (Texas Territorial Sea), and 1.2 percent occurred in Federal ocean waters. The percentage of fishing in Federal waters has been declining during recent years. Texas divides its data into two fishing seasons: Season A (November 21-May 14) and Season B (May 15-November 20). In 2014, 69.3 percent of angler trips occurred in Season B, and 12.9 percent of trips occurred by charter boats. In recent years, fishing during Season A has been gradually declining, while fishing during Season B has been relatively stable.

Tables 4-21 and 4-22 provide data regarding the individual species caught by anglers in Texas during 2009-2014. Panel A presents overall catch data in Texas, while Panels B, C, and D present catch data for Texas bays, State waters, and the Exclusive Economic Zone. The most popular species in bays include spotted seatrout, red drum, black drum, and Atlantic croaker. Red snapper (*Lutjanus campechanus*) and king mackerel (*Scomberomorus cavalla*) are the most popular species in Federal waters. The 2014 landings of most species were in the ranges observed in prior years, although landings of spotted seatrout were noticeably lower in 2014 than during prior years.

Table 4-21. Texas Effort Data: Number of Angler Trips from 2009 through 2014.

2009									
	Season A			Season B			Annual Total		
Area	Private	Charter	Total	Private	Charter	Total	Private	Charter	Total
Bay	291,400	33,256	324,655	573,978	82,242	656,220	865,377	115,498	980,875
TTS	3,804	431	4,235	29,060	2,394	31,454	32,864	2,825	35,689
EEZ	252	0	252	20,874	3,336	24,211	21,127	3,336	24,463
Total	295,456	33,687	329,143	623,912	87,972	711,885	919,368	121,659	1,041,027
2010									
	Season A			Season B			Annual Total		
Area	Private	Charter	Total	Private	Charter	Total	Private	Charter	Total
Bay	255,995	23,570	279,565	567,522	93,650	661,171	823,517	117,220	940,737
TTS	3,250	2,187	5,437	22,837	2,052	24,888	26,087	4,239	30,326
EEZ	744	0	744	14,129	1,602	15,731	14,873	1,602	16,475
Total	259,989	25,758	285,747	604,487	97,303	701,791	864,476	123,061	987,537
2011									
	Season A			Season B			Annual Total		
Area	Private	Charter	Total	Private	Charter	Total	Private	Charter	Total
Bay	330,461	29,842	360,303	576,735	122,855	699,590	907,196	152,697	1,059,893
TTS	14,830	4,779	19,609	24,372	2,988	27,360	39,202	7,767	46,969
EEZ	1,424	850	2,274	15,138	1,126	16,264	16,562	1,976	18,538
Total	346,715	35,471	382,186	616,245	126,969	743,214	962,960	162,440	1,125,400
2012									
	Season A			Season B			Annual Total		
Area	Private	Charter	Total	Private	Charter	Total	Private	Charter	Total
Bay	331,889	87,696	419,585	563,656	134,502	698,158	895,545	222,198	1,117,743
TTS	7,563	1,172	8,735	15,375	1,622	16,997	22,938	2,794	25,732
EEZ	1,270	0	1,270	12,668	1,774	14,442	13,938	1,774	15,712
Total	340,722	88,868	429,590	591,699	137,898	729,597	932,421	226,766	1,159,187
2013									
	Season A			Season B			Annual Total		
Area	Private	Charter	Total	Private	Charter	Total	Private	Charter	Total
Bay	350,918	39,054	389,972	613,508	101,135	714,643	964,426	140,189	1,104,615
TTS	5,193	111	5,304	18,559	2,269	20,828	23,752	2,380	26,132
EEZ	989	575	1,564	15,695	1,592	17,286	16,684	2,166	18,850
Total	357,100	39,740	396,840	647,761	104,996	752,757	1,004,861	144,735	1,149,597
2014									
	Season A			Season B			Annual Total		
Area	Private	Charter	Total	Private	Charter	Total	Private	Charter	Total
Bay	292,988	30,722	323,710	605,314	101,802	707,116	898,302	132,524	1,030,826
TTS	3,550	127	3,677	18,886	2,664	21,550	22,436	2,791	25,227
EEZ	510	0	510	10,403	2,159	12,562	10,913	2,159	13,072
Total	297,048	30,849	327,897	634,603	106,625	741,228	931,651	137,474	1,069,125

EEZ = Exclusive Economic Zone; TTS = Texas Territorial Sea
(1) Season A is November 21 - May 14 and Season B is May 15 - November 20.
(2) These data are presented in terms of person-trips. This means that if multiple people go fishing at the same time on the same boat that is counted as multiple trips.
Source: Fisher, official communication, 2015.

Table 4-22. Texas Catch Data: Top Species Landed by Recreational Fishermen.

Panel A: Total Landings								Panel B: Landings in Bays						
Species	2009	2010	2011	2012	2013	2014		Species	2009	2010	2011	2012	2013	2014
Atlantic Croaker	117	124	156	157	152	117		Atlantic Croaker	117	124	154	156	151	117
Black Drum	98	165	129	256	150	139		Black Drum	97	164	127	256	150	139
King Mackerel	16	6	9	9	10	13		King Mackerel	–	–	–	–	–	–
Red Drum	285	264	347	323	269	246		Red Drum	277	261	344	321	266	245
Red Snapper	31	33	36	34	47	40		Red Snapper	–	–	–	–	–	–
Sand Seatrout	111	127	226	177	151	146		Sand Seatrout	108	126	220	169	150	145
Sheepshead	34	49	57	143	84	39		Sheepshead	34	49	57	143	84	39
Southern Flounder	47	30	92	96	92	71		Southern Flounder	47	30	92	96	92	71
Spotted Seatrout	810	732	1,137	810	795	590		Spotted Seatrout	789	721	1,119	798	789	585
Panel C: Landings in State Waters								Panel D: Landings in the Exclusive Economic Zone						
Atlantic Croaker	–	–	2	1	–	–		Atlantic Croaker	–	–	–	–	1	–
Black Drum	1	–	2	–	–	–		Black Drum	–	1	–	–	–	–
King Mackerel	7	5	5	4	4	6		King Mackerel	9	1	4	5	6	7
Red Drum	8	–	3	2	2	1		Red Drum	1	3	–	–	1	–
Red Snapper	13	12	22	21	30	33		Red Snapper	19	21	14	13	17	7
Sand Seatrout	2	1	5	8	1	1		Sand Seatrout	1	1	1	–	–	–
Sheepshead	–	–	–	–	–	–		Sheepshead	–	–	–	–	–	–
Southern Flounder	–	–	–	–	–	–		Southern Flounder	–	–	–	–	–	–
Spotted Seatrout	14	–	18	11	6	5		Spotted Seatrout	8	10	–	1	–	–

(1) Fish landings are presented in thousands of fish.
(2) The TPWD presents data in terms of two seasons: Season A is November 21 - May 14 and Season B is May 15 - November 20. Therefore, the annual data reflects combined catch for Seasons A and B. For example, the catch data for 2013 reflect catch from November 21, 2012, to November 20, 2013.

Source: Fisher, official communication, 2015.

Economic Impacts of Recreational Fishing

Recreational fishing can affect regional economies in various ways. Most directly, anglers affect the economy through spending on fishing-related goods and services. This direct spending includes trip expenditures and expenditures on durable equipment. Direct angler spending supports firms in related industries along an economy's supply chain. In addition, spending by fishermen serves as income to other actors in an economy, which supports overall spending patterns. The NMFS conducted an analysis that quantified this dependence of regional economies on recreational fishing activity (USDOC, NMFS, 2014a); this analysis utilized the techniques of an earlier study by Gentner and Steinback (2008). These studies utilized input-output economic models, which create multipliers that predict the sales, value-added, and jobs that result from direct angler spending. The levels of value-added and employment supported by recreational fishing in each Gulf Coast State in 2012 are listed below.

- West Florida ($5,259,726,000; 75,268 jobs)
- Louisiana ($1,099,216,000; 16,972 jobs)
- Texas ($1,005,040,000; 13,944 jobs)
- Alabama ($425,328,000; 7,501 jobs)
- Mississippi ($85,497,000; 1,649 jobs)

4.11.2 Environmental Consequences

The impacts from routine activities and accidental events, and the cumulative impacts to recreational fishing that would arise from projected activities from a proposed lease sale are analyzed in this chapter. While there are some differences in the amount of activities associated with the alternatives, many of the impacts associated with the alternatives are similar. Therefore, this chapter will describe the impacts that are expected to apply to all alternatives, while any deviations from these impact conclusions will be discussed in **Chapters 4.11.2.1-4.11.2.5**.

Routine Activities

Routine OCS oil and gas operations (such as anthropogenic sound, bottom disturbances service-vessel traffic, and production structure emplacement) can affect recreational fisheries by impacting populations of recreationally targeted species. The impacts of anthropogenic sound and short-term bottom disturbances on fish populations are discussed in **Chapter 4.7** (Fish and Invertebrate Resources). The corresponding impacts of anthropogenic sound on recreational fishing would be **negligible** to **minor** because disruptions to fish populations could reduce landings in proportion to the amount of recreational fishing activities in an area (refer to **Chapter 4.11.1**). The exact impacts would depend on the locations of activities, the species affected, the intensity of recreational fishing activity in the affected area, and the substitutability of any lost fishing access. The impacts of short-term bottom disturbances on recreational fishing are expected to be **negligible** because the impacts to fish populations would similarly be **negligible** and because most recreational fishing does not target bottom-dwelling species that are more likely to be impacted by these disturbances.

The OCS oil- and gas-related vessel traffic could also cause space-use conflicts with recreational fishermen. The OCS vessel traffic would occur between ports that service the offshore industry and drilling and production facilities in Federal waters. However, there is limited spatial overlap between recreational fishing and oil and gas ports. In addition, most recreational fishing activities in the Gulf of Mexico occur inland or in State waters. Finally, recreational vessels can often easily avoid temporary OCS vessel traffic. Therefore, the impacts of OCS oil- and gas-related vessel traffic on recreational fishing are expected to be **negligible** to **minor**. The exact impacts would depend on the locations of activities, the species affected, the intensity of recreational fishing activity in the affected area, and the substitutability of any lost fishing access.

The installation of production platforms can enhance recreational fishing opportunities because platforms often attract recreationally important species. Hiett and Milon (2002) estimate that 20.2 percent of private boat fishing, 32.2 of charter boat fishing, and 50.9 percent of party boat fishing in Texas, Louisiana, Mississippi, and Alabama combined occur within 300 ft (91 m) of an oil or gas structure in State or Federal waters. However, the removal of a platform would preclude its use for recreational fishing unless it is redeployed as artificial reef substrate as part of an artificial reef program (**Chapter 3.1.9.1**). The BSEE presents more information regarding the status of Rigs-to-Reefs activities in the Gulf of Mexico (USDOI, BSEE, 2015h). Ajemian et al. (2015) analyze the fish community structures at operational platforms, decommissioned platforms that were reefed using a variety of methods, and Liberty Ships (World War II era ships that now serve as artificial reefs) offshore Texas. This study found that recreationally important species such as red snapper were prevalent among all types of platform structures, suggesting that the reefing of a platform could maintain some of the properties desired by recreational fishermen. A proposed lease sale would likely have **negligible** to **minor** impacts on recreational fishing because of the limited amount of activity that occurs in Federal waters (**Chapter 4.11.1**) and because the positive and negative effects of routine OCS oil- and gas-related activities that modify habitat (i.e., infrastructure emplacement and decommissioning) would partially offset each other.

Accidental Events

Oil spills can arise from accidents with respect to vessels, pipelines, drilling operations, or production operations. Oil spills can lead to localized fishing closures that could directly impact fishermen's access to fish resources. The potential impacts of oil spills on fish populations that support recreational fishing are described in **Chapter 4.7** (Fish and Invertebrate Resources). The corresponding impacts to recreational fishing would depend on the types and scales of recreational fishing activities in an impacted area, which are discussed in **Chapter 4.11.1**. For example, red snapper is a popular recreational species that is prevalent near oil and gas platforms. Therefore, an oil spill that occurred near a platform could impact recreational fishing for red snapper and other reef fish, at least in the short term. An oil spill could also dissuade anglers if it affected the aesthetics of fishing in an area. For example, anglers could be dissuaded by perceived oil in water, tainted fish populations, or response activities. Reductions in recreational fishing could also impact the various firms that supply goods and services to anglers. Gentner Consulting Group (2010) presents a methodology for estimating the economic impacts of an oil spill in the Gulf of Mexico that entails estimating State-level recreational fishing levels and then scaling these levels by the size and duration of a closure area. However, these economic impacts would likely be **negligible** to **minor** because an oil spill arising from a proposed lease sale would likely be small and localized, leaving recreational fishermen numerous alternative fishing sites. The exact impacts would depend on the locations of oil spills, the species affected, the intensity of recreational fishing activity in the affected area, and the substitutability of any lost fishing access. In addition, as shown in the effort and landings data above, recreational fishing activity recovered fairly quickly in the aftermath of the *Deepwater Horizon* explosion, oil spill, and response which was a much larger spill than is anticipated to arise from a proposed lease sale.

Cumulative Impacts

A proposed lease sale would contribute to the impacts of the overall OCS Program, as well as the impacts of various non-OCS sources. The cumulative analysis will describe these various impacts, and will then reach impact conclusions regarding the incremental impacts of a proposed lease sale relative to these OCS and non-OCS sources.

OCS Oil- and Gas-Related Impacts

A proposed lease sale would add to the impacts to fish populations from sound and short-term bottom disturbances (refer to **Chapter 4.7**, Fish and Invertebrate Resources). As discussed above, these would have impacts to recreational fishing to the extent that angler effort and species' landings are impacted. A proposed lease sale would also add to the space-use conflicts with recreational fishermen that arise from the OCS Program. The proposed lease sale would also add to the potential for accidental events, such as oil spills, arising from the OCS Program. The scales of these impacts are similar as to those discussed above, but they would be proportionally higher to the larger scale of the OCS Program compared with a proposed lease sale.

As discussed above, oil and gas platforms generally enhance opportunities for recreational fishing. Conversely, structure removals prevent the use of those structures for recreational fishing. The number of platforms in the Federal Gulf of Mexico fell from a peak of 4,049 in 2001 to 2,634 in 2013, which has reduced opportunities for recreational fishing in certain areas (USDOI, BSEE, 2015i). However, anglers still have numerous places to fish, including artificial reefs (some of which have been created out of decommissioned platforms) and natural habitat features. The baseline for this cumulative analysis corresponds to the case in which a proposed lease sale does not occur. A proposed lease sale would initially have positive incremental impacts on recreational fishing because more structures would be installed than if the lease sale did not occur. The eventual removals would offset those impacts unless some structures were maintained through Rigs-to-Reefs programs (discussed above and in **Chapter 3.1.9.1**).

Relative to the overall OCS Program (i.e., all past, present, and future lease sales), a proposed lease sale would have **beneficial** (due to fish attraction at platforms and the potential use of decommissioned platforms as rigs-to-reefs) to **minor** incremental impacts (due to space-use conflicts and impacts to fish populations) on recreational fishing activities because of the limited amount of activity and because the positive and negative effects would partially offset each other.

Non-OCS Oil- and Gas-Related Impacts

A proposed lease sale would contribute to the impacts of oil and gas activities in State waters, which are described in **Chapter 3.3.2.1**. The nature of these impacts would be similar to activities in Federal waters, although the impacts on recreational fishing depend on the intensity and species sought in a particular area. As discussed in **Chapter 4.11.1**, 1.3 percent of recreational fishing in Texas occurs in Federal waters, while 7.6 percent of angler effort in the four other Gulf Coast States combined occurs in Federal waters.

Recreational fishing in the Gulf of Mexico also encounters space-use conflicts with recreational, commercial, and military vessels. Marinevesseltraffic.com (2015) provides maps of current and historical vessel traffic in the Gulf of Mexico. There is a large amount of vessel traffic in the Gulf of Mexico, particularly near major ports. This vessel traffic causes various localized conflicts with recreational fishermen.

Hurricanes can impact boats and other infrastructure that support recreational fishing. Recreational fishing would also be affected by any impact-producing factor, such as a non-OCS oil- and gas-related accidental event, that affects the aesthetics of a particular fishing site. Recreational fishing would also be positively correlated with general trends in tourism (discussed in **Chapter 4.12**, Recreational Resources) and the overall economy (discussed in **Chapter 4.14.2**, Economic Factors). Finally, recreational fishing regulations (discussed in **Chapter 4.11.1**) would likely maintain stable recreational fishing activities during the life of a proposed lease sale.

A proposed lease sale would have **beneficial** (due to fish attraction at platforms and the potential use of decommissioned platforms as rigs-to-reefs) to **minor** (due to space-use conflicts and impacts to fish populations) incremental impacts on recreational fishing activities because it would be small relative to these broader issues impacting recreational fishing.

Incomplete or Unavailable Information

BOEM has identified incomplete or unavailable information regarding the extent to which recreational fishing is dependent upon OCS platforms, as well as on the site-specific determinants of this dependency. BOEM is planning to undertake a study to examine these issues, although the results from this study project would not be released in the timeline contemplated in the NEPA analysis for this Multisale EIS. In lieu of this incomplete or unavailable information, BOEM used existing information and reasonably accepted scientific methodologies. For example, BOEM used data on recreational fishing activity provided by the Texas Parks and Wildlife Department and the NMFS to examine trends in recreational fishing in various areas. BOEM has also used information from Heitt and Milon (2002) and Ajemian et al. (2015), which provide some information on the scale and location of platform-dependent recreational fishing. BOEM does not expect the incomplete or unavailable information to significantly change its estimates of the impacts of the OCS Program on recreational fishing activity because BOEM still has enough baseline data to reasonably estimate impacts. Therefore, BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among alternatives.

4.11.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

The impacts of Alternative A would correspond to the impacts discussed in **Chapter 4.11.2**. Namely, a proposed lease sale could affect recreational fishing by affecting fish populations or by affecting the socioeconomic aspects of recreational fishing. The impacts of Alternative A on fish populations are presented in **Chapter 4.7** (Fish and Invertebrate Resources) and include impacts due to anthropogenic sound, short-term bottom disturbances, and habitat modifications. Vessel traffic arising from the Alternative A could cause space-use conflicts with anglers. Structure emplacement generally enhances recreational fishing, although this positive effect would be offset during decommissioning unless a structure was maintained as an artificial reef. Accidental events, such as oil spills, could cause fishing closures and affect the aesthetics of fishing in an area. However, accidental events that could arise from Alternative A would likely be negligible or minor and would be localized. Alternative A should also be viewed in light of overall trends in OCS platform decommissioning, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternative A on recreational fisheries are expected to be **negligible** to **minor** because of the relatively small scale of a proposed lease sale and because the positive and negative effects would partially offset each other. The exact impacts would depend on the locations of activities, the species affected, the intensity of recreational fishing activity in the affected area, and the substitutability of any lost fishing access.

4.11.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Alternative B entails leasing only in the CPA/EPA, which is a subset of the area considered in Alternative A. Therefore, the analysis of Alternative A covers the potential impacts of Alternative B. There are some differences (described in **Chapter 4.11.1**) in the types and scales of recreational fishing in the WPA compared with the CPA/EPA. For example, 1.2 percent of recreational fishing in Texas occurs in Federal waters, while 7.6 percent of recreational fishing in the other Gulf Coast States combined occurs in Federal waters. However, these differences are not large enough to change the impact conclusions (discussed below) for Alternatives A and B. This is because Alternative B entails conducting most of the OCS oil- and gas-related activities proposed under Alternative A.

A proposed lease sale under Alternative B could affect recreational fishing by affecting fish populations or by affecting the socioeconomic aspects of recreational fishing. The impacts of Alternative B on fish populations are presented in **Chapter 4.7** (Fish and Invertebrate Resources); these include impacts due to anthropogenic sound, short-term bottom disturbances, and habitat modifications. Vessel traffic arising from Alternative B could cause space-use conflicts with anglers. Structure emplacement generally enhances recreational fishing, although this positive effect would be offset during decommissioning unless a structure were maintained as an artificial reef. Accidental events, such as oil spills, could cause fishing closures and affect the aesthetics of fishing in an area. However, accidental events that could arise from Alternative B would likely be negligible or minor and would be localized. Alternative B should also be viewed in light of overall trends in OCS platform decommissioning, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternative B on recreational fisheries are expected to be **negligible** to **minor** because of the relatively small scale of a proposed lease sale and because the positive and negative effects to recreational fishing would partially offset each other. The exact impacts would depend on the locations of activities, the species affected, the intensity of recreational fishing activity in the affected area, and the substitutability of any lost fishing access.

4.11.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Alternative C entails leasing only in the WPA, which is a subset of the area considered in Alternative A. Therefore, the analysis of Alternative A covers the potential impacts of Alternative C. There are some differences (described in **Chapter 4.11.1**) in the types and scales of recreational fishing in the WPA compared with the CPA/EPA. For example, 1.2 percent of recreational fishing in Texas occurs in Federal waters, while 7.6 percent of recreational fishing in the other Gulf Coast States combined occurs in Federal waters. In addition, a proposed WPA lease sale would likely entail less oil and gas activities than a proposed CPA lease sale. However, these differences are not large enough to change the impact conclusions (discussed below) for Alternatives A and C. In particular, while there would be fewer OCS oil- and gas-related activities associated with Alternative C than with Alternative A, there could still be detectable (but less than severe) impacts under Alternative C.

A proposed lease sale under Alternative C could affect recreational fishing by affecting fish populations or by affecting the socioeconomic aspects of recreational fishing. The impacts of Alternative C on fish populations are presented in **Chapter 4.7** (Fish and Invertebrate Resources) and include impacts due to anthropogenic sound, short-term bottom disturbances, and habitat modifications. Vessel traffic arising from Alternative C could cause space-use conflicts with anglers. Structure emplacement generally enhances recreational fishing, although this positive effect would be offset during decommissioning unless a structure were maintained as an artificial reef. Accidental events, such as oil spills, could cause fishing closures and affect the aesthetics of fishing in an area. However, accidental events that could arise from Alternative C would likely be negligible or minor and would be localized. Alternative C should also be viewed in light of overall trends in OCS platform decommissioning, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternative C on recreational fisheries are expected to be **negligible** to **minor** because of the relatively small scale of a proposed lease sale under Alternative C and because the positive and negative effects to recreational fishing would partially offset each other. The exact impacts would depend on the locations of activities, the species affected, the intensity of recreational fishing activity in the affected area, and the substitutability of any lost fishing access.

4.11.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D entails leasing a subset of the area considered in Alternatives A, B, or C by making blocks that would normally be subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations unavailable for lease. Alternative D would not exclude large areas to recreational fishing or exclude large areas from leasing (refer to **Chapter 4.12.1**). Therefore, the analyses for those alternatives (described above) cover the potential impacts of Alternative D, generally to recreational fisheries. Therefore, the impact conclusions (which are discussed below) for Alternatives A and D remain the same, though there may be a slight offsetting effect to recreational fishing in the excluded blocks, as it would reduce any potential conflict with OCS oil- and gas-related activities but would similarly prevent the potential for beneficial effects from new platforms or other fish attractions in the blocks.

A proposed lease sale could affect recreational fishing by affecting fish populations or by affecting the socioeconomic aspects of recreational fishing. The impacts of Alternative D on fish populations are presented in **Chapter 4.7** (Fish and Invertebrate Resources) and impacts due to anthropogenic sound, short-term bottom disturbances, and habitat modifications. Vessel traffic arising from Alternative D could cause space-use conflicts with anglers. Structure emplacement generally enhances recreational fishing, although this positive effect would be offset during decommissioning unless a structure were maintained as an artificial reef. Accidental events, such as oil spills, could cause fishing closures and affect the aesthetics of fishing in an area. However, accidental events that could arise from Alternative D would likely be negligible or minor and would be localized. Alternative D should also be viewed in light of overall trends in OCS platform decommissioning, State oil and gas activities, overall vessel traffic, hurricanes, economic factors, and Federal and State fisheries management strategies. The incremental impacts of Alternative D on recreational fisheries are expected to be **negligible** to **minor** because of the relatively small scale of a proposed lease sale and because the positive and negative effects would partially offset each other. The exact impacts would depend on the locations of activities, the species affected, the intensity of recreational fishing activity in the affected area, and the substitutability of any lost fishing access.

4.11.2.5 Alternative E—No Action

Alternative E would prevent the **beneficial** to **minor** impacts associated with a proposed lease sale, as discussed above. Beneficial impacts of fish attraction to new platforms or decommissioned platforms turned into reefs would be avoided. Similarly, negligible to minor impacts, such as space-use conflicts, oil spills, or direct harm to fish populations, would be avoided. However, recreational fisheries would still be subject to the impacts from other ongoing activities related to previous lease sales under the OCS Program, as well as the impacts from the non-OCS oil- and gas-related sources discussed above.

4.12 Recreational Resources

The analyses of the potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts to recreational resources are presented in this chapter. The approach of the analysis is to focus on the potential impact-producing factors from OCS oil- and gas-related routine activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts, and to define the impact-level measures for each impact-producing factor.

Impact-Level Definitions

In this chapter (and in the analyses of the alternatives) the impact measures are defined in terms of the intensity, duration, and geographical extent of the impacts to the human uses of recreational resources along the Gulf Coast. In particular, the impacts of each impact-producing factor are summarized in **Table 4-23** using the impact-level measures below.

- **Beneficial** – Impacts would be beneficial.
- **Negligible** – Little or no detectable impact.
- **Minor** – Impacts are detectable but less than severe.
- **Moderate** – Impacts are severe but are short term and/or not extensive.
- **Major** – Impacts are long term, extensive, and severe.

Table 4-23. Recreational Resources Impact-Producing Factors.

Recreational Resources	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Impacts					
Marine Debris	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Space-Use Conflicts	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Structure Emplacement and Removal	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Visual Impacts	Negligible to Minor	Negligible to Minor	Negligible	Negligible to Minor	Negligible
Indirect Econoic Impacts	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible

Recreational Resources	Magnitude of Potential Impact				
Impact-Producing Factors	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Accidental Impacts					
Oil Spills	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Cumulative Impacts					
OCS Oil and Gas	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible
Non-OCS Oil and Gas	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Beneficial to Minor	Negligible

4.12.1 Description of the Affected Environment

The GOM is home to various resources that support recreational activities. These include ocean-based resources as well as resources in counties and parishes along the Gulf of Mexico. The overall scales of recreation and tourism are discussed in the following section. The resources that support recreational activities are presented in subsequent sections and are organized according to the type of recreational resource.

Scales of Recreation and Tourism

Eastern Research Group (2014a) developed methodologies for estimating the amount of employment supported by recreation and tourism activities in a particular area. This entailed defining which industries comprise recreation and tourism, as well as estimating the percent of each industry that supports tourism. For example, the hotel industry is primarily supported by tourists, while the restaurant industry is supported by both tourists and local residents. BOEM has identified 23 Economic Impact Areas (EIAs), which are critical to understanding how a proposed action would affect human resources across the Gulf of Mexico (illustrated in **Figure 4-27** in **Chapter 4.14**). **Table 4-24** presents data regarding the scales of direct employment and value-added in the EIAs, which cover the geographical extents of the impacts to recreational resources. **Table 4-24** was derived by applying data from IMPLAN Group, LLC. (2015) to the methodologies developed in Eastern Research Group (2014a). As can be seen, the recreation and tourism industries are sizable in many areas along the Gulf Coast. The areas with the largest recreation and tourism industries are TX-3 (which includes Houston and Galveston), LA-6 (which includes New Orleans), and various EIAs along the Florida coast. Parts of coastal Mississippi and Alabama also have sizeable recreational economies, which are supported by parks, beaches, and casinos.

Table 4-24. Recreational and Tourism Employment and Value-Added in BOEM's Economic Impact Areas in 2013.

EIA	Recreational Employment	Recreational Value-Added	Tourism Employment	Tourism Value-Added
TX-1	68,769	2,596,402,975	19,081	1,203,931,388
TX-2	48,362	1,868,401,512	15,225	739,484,187
TX-3	366,048	15,331,216,510	123,709	8,466,549,982
TX-4	5,033	188,869,415	1,227	100,190,697
TX-5	18,829	709,291,174	4,763	395,566,972
TX-6	1,417	53,257,782	387	23,864,658
LA-1	14,399	683,645,908	6,149	293,572,508
LA-2	2,799	105,494,355	775	46,049,357
LA-3	32,869	1,315,185,525	9,639	566,173,408
LA-4	17,725	788,255,437	6,269	274,186,740
LA-5	50,188	2,028,801,718	14,122	975,127,188
LA-6	89,036	4,458,755,918	34,493	1,976,234,240
LA-7	23,637	948,326,917	6,577	379,903,898
MS-1	33,103	1,560,781,492	14,167	545,645,437
MS-2	1,475	54,100,278	391	19,098,912
AL-1	37,649	1,274,887,170	10,477	681,999,085
AL-2	3,483	120,034,728	873	73,873,691
FL-1	72,212	2,756,594,208	24,852	1,233,121,800
FL-2	31,357	1,173,072,208	10,300	445,046,333
FL-3	7,954	278,409,013	2,438	114,397,442
FL-4	67,758	2,497,491,474	18,301	1,153,527,693
FL-5	254,735	11,239,013,764	80,319	4,948,465,196
FL-6	115,642	5,472,107,011	45,683	2,263,684,576
State Totals				
Texas EIAs	508,457	20,747,439,369	164,393	10,929,587,884
Louisiana EIAs	230,653	10,328,465,778	78,023	4,511,247,338
Mississippi EIAs	34,578	1,614,881,770	14,558	564,744,348
Alabama EIAs	41,132	1,394,921,898	11,349	755,872,776
Florida EIAs	549,658	23,416,687,679	181,891	10,158,243,038
All EIAs	1,364,478	57,502,396,493	450,215	26,919,695,385

EIA = Economic Impact Area.

Sources: Eastern Research Group, Inc.(2014a) and IMPLAN Group, LLC (2015).

Beaches

Beach visitation is one of the most popular activities along the Gulf Coast. The USEPA's "National List of Beaches" (USEPA, 2015e) is an online tool that lists and provides information regarding the beaches in any county or parish along the Gulf Coast. Texas and West Florida have the most number of beaches, although there are various beach areas in Louisiana, Mississippi, and Alabama. The National Survey on Recreation and the Environment estimates the following number of Americans age 16 and older that visit the beaches in each Gulf Coast State annually: Florida (21,989,300); Texas (4,929,700); Alabama (1,527,900); Mississippi (956,700); and Louisiana (578,500) (Betz, official communication, 2010).

Wildlife Viewing

A variety of information regarding the scales of wildlife tourism in various Gulf Coast areas is presented in Lowe and Stokes (2013). For example, this report finds that over 1,100 wildlife guide businesses support over 11,000 dining and lodging businesses. This report estimated that wildlife tourism along the Gulf Coast supports over $19 billion in spending and generates over $5 billion in Federal, State, and local tax revenues. The three primary forms of wildlife tourism are fishing (which supports $8 billion in spending), wildlife watching (which supports $6.5 billion in spending), and hunting (which supports $5 billion in spending). Wildlife tourism supports the most spending in Florida ($8 billion) and Texas ($5 billion); wildlife tourism supports approximately $2 billion in spending each in Louisiana, Mississippi, and Alabama.

Artificial Reefs

Activities such as recreational fishing and diving are supported by various artificial reef structures in the Gulf of Mexico. Oil and gas platforms are particularly supportive of recreational fishing and diving activities; more information regarding the affected environment for recreational fishing is presented in **Chapter 4.11.1** (Recreational Fishing). The locations of oil and gas platforms in the GOM can be accessed on the, Energy Information Administration's online tool that lists all energy infrastructure in the GOM (USDOE, Energy Information Administration, 2015f). The Gulf Coast States also have programs to develop artificial reef structures (including decommissioned oil and gas structures) to support biological diversity and recreational activities. Details regarding these programs, including the locations of reef sites, are described in Fikes (2013).

Marine Protected Areas

The GOM is home to many marine protected areas that support recreational activities such as wildlife viewing, nature experiences, and beach visitation. The marine protected areas in the GOM include various Federal and State entities, such as parks, wildlife refuges, national marine sanctuaries, and national seashores. A map of all of the marine protected areas in the Gulf of Mexico can be found on the NOAA's website (USDOC, NOAA, 2015l). Estimates of the number of visitors, amount of spending, number of jobs, and amount of income in 2014 supported by each national park along the Gulf Coast are provided in Cullinane-Thomas et al. (2015). The number of visitors and the amount of visitor spending supported by parks along the Gulf Coast are listed below.

- Padre Island National Seashore (Texas) (578,814 visitors; $23,892,700)

- Jean Lafitte National Historical Park and Preserve (Louisiana) (445,524 visitors; $24,986,300)
- Gulf Islands National Seashore (Mississippi and Florida) (4,455,240 visitors; $185,611,000) (About 25 percent of these impacts occur in the Mississippi District.)
- De Soto National Memorial (Florida) (342,039 visitors; $19,182,600)
- Big Cypress National Preserve (Florida) (1,192,856 visitors; $91,111,200)
- Everglades National Park (Florida) (1,110,900 visitors; $104,476,500)
- Dry Tortugas National Park (Florida) (64,865 visitors; $3,783,600)

National seashores are expanses of sea coast maintained for the study of wildlife and for public recreational use. Additional details regarding the two national seashores in the Gulf of Mexico are presented below.

Gulf Islands National Seashore

The Gulf Islands National Seashore consists of two mainland portions and four barrier island portions in the northwest Florida panhandle, and a mainland section and six barrier islands in Mississippi (**Figure 4-24**). The Gulf Islands National Seashore was established by Congress in 1971 to preserve the outstanding natural and recreational values of these areas. In particular, these areas are used for diverse recreational activities such as swimming, camping, wildlife-watching, and wilderness experiencing. In 1978, Horn and Petit Bois Island were designated as having wilderness status. This status reflects the pristine and undeveloped nature of these islands. The Final General Management Plan of the Gulf Islands National Seashore provides detailed information regarding the recreational opportunities in various locations (USDOI, NPS, 2014a).

Padre Island National Seashore

The Padre Island National Seashore consists of a portion of Padre Island along the southern Gulf Coast of Texas. The Padre Island National Seashore was established in 1962 to protect the largest stretch of undeveloped barrier island in the world. The Padre Island National Seashore offers excellent opportunities for beach visitation, swimming, fishing, birdwatching, and windsurfing. More information regarding the recreational opportunities at the Padre Island National Seashore is provided in *Beach Vehicle Environmental Assessment for Padre Island* (USDOI, NPS, 2011b).

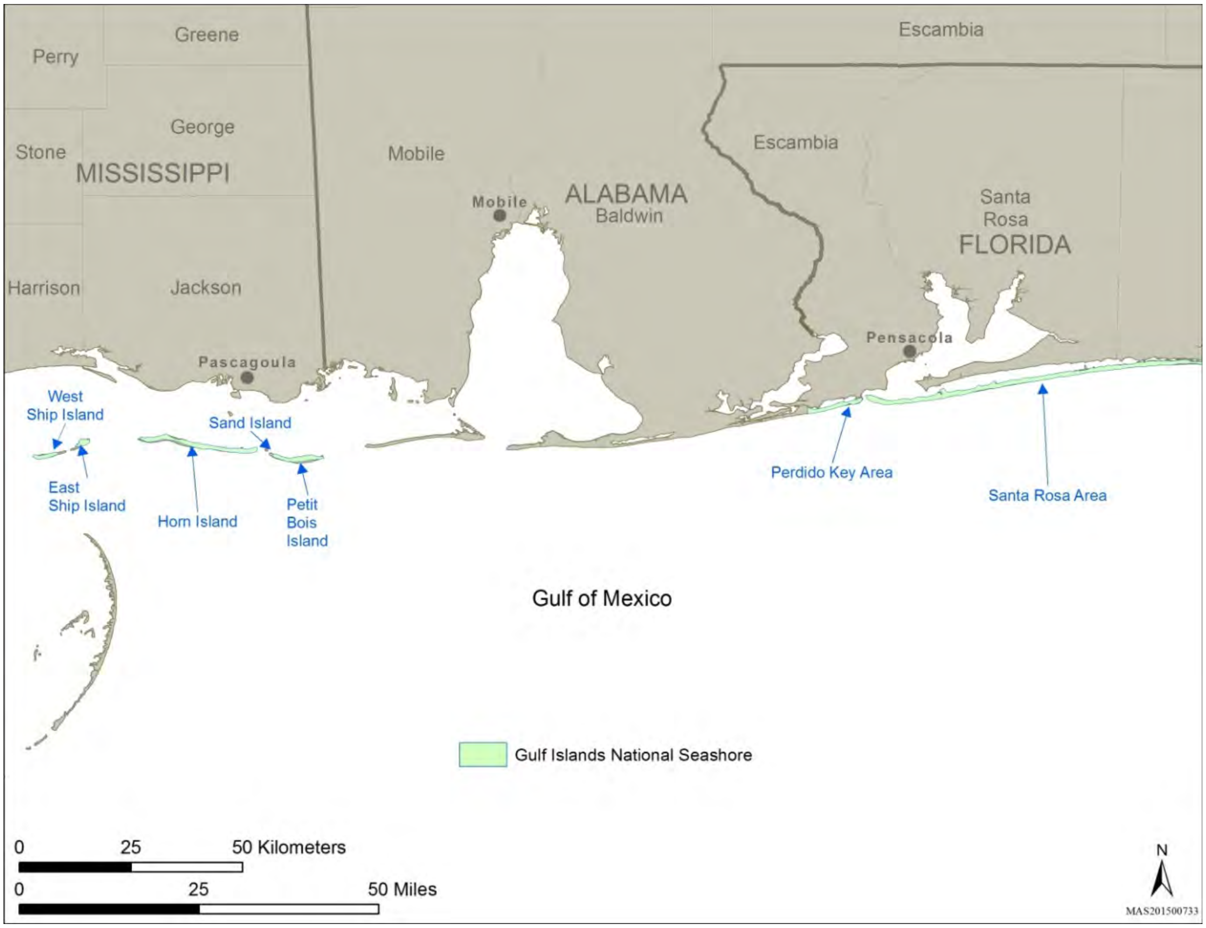

Figure 4-24. Gulf Islands National Seashore.

4.12.2 Environmental Consequences

The impacts from routine activities and accidental events, and the cumulative impacts to recreational resources that would arise from projected activities from a proposed action are analyzed in this chapter. While there are some differences in the amount of activities associated with the alternatives, many of the impacts associated with the alternatives are similar. Therefore, this chapter describes the impacts that are expected to apply to all alternatives, while any deviations from these impact conclusions are discussed in **Chapters 4.12.2.1-4.12.2.5**.

Routine Activities

The following routine OCS oil-and gas-related activities associated with a proposed action would potentially affect recreational resources: marine trash and debris (**Chapter 3.1.5.3.4**), vessel traffic (**Chapter 3.1.4.4**), platforms serving as artificial reefs (**Chapter 3.1.6.2**), visibility of OCS platforms (**Chapter 3.1.3.4.3**), and economic factors.

Accidental discharges of marine debris from OCS oil- and gas-related vessels and facilities could reach beaches and other coastal resources, which could affect the aesthetics of these areas. The discharge of marine debris is subject to a number of laws and treaties. These include the

Marine Debris Research, Prevention, and Reduction Act; the Marine Plastic Pollution Research and Control Act; and the MARPOL-Annex V Treaty. Regulation and enforcement of these laws is conducted by a number of agencies such as the U.S. Environmental Protection Agency, NOAA, and the U.S. Coast Guard. The BSEE provides information on marine debris and awareness and requires training of all OCS personnel through the “Marine Trash and Debris Awareness and Elimination” NTL (NTL 2015-BSEE-G03). This NTL instructs OCS operators to post informational placards on production facilities and drilling rigs that outline the legal consequences and potential ecological harms of discharging marine debris. This NTL also states that OCS workers should complete annual marine debris prevention training; operators are also instructed to develop a certification process for the completion of this training by their workers. Compliance with this NTL would become mandatory if the Protected Species Stipulation were applied. These various laws, regulations, and NTL would likely lead the potential damage to recreational resources from the discharge of marine debris from OCS operations to be **negligible** to **minor**.

The OCS vessel traffic can also affect the aesthetics of recreational experiences in certain areas. The OCS vessel traffic can also cause space-use conflicts with recreational vessels. However, OCS vessels move between onshore support bases (which are typically not near recreational areas) and production areas far offshore, meaning any potential impact would likely be temporary. In addition, a proposed action would add only a small amount of vessel traffic. **Chapters 3.1.7 and 4.14.1.1.1** provide more information regarding OCS vessel traffic. Therefore, impacts from space-use conflicts would likely be **negligible** to **minor.**

The OCS platforms serve as artificial reefs and, thus, often have positive impacts on recreational fishing and diving (Hiett and Milon, 2002). The extent to which a particular platform supports recreational activities would depend on numerous factors, such as its distance from shore, the fish populations it supports, and the aesthetics of an area (Ditton et al., 2002). The positive effects of platforms would be reversed at decommissioning unless a platform is maintained as an artificial reef through a Rigs-to-Reefs program. Details regarding these programs, including the locations of reef sites, are described in Fikes (2013).

The visibility of OCS platforms can also affect the aesthetics of certain recreational areas. These impacts depend on the type of recreational area and on the extent to which platforms are visible. For example, OCS platforms could detract from the nature experiences in certain Gulf Coast parks. The size and location 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. The extent to which a platform is visible depends on various factors, such its distance, elevation, size, weather conditions, air pollution, and lighting (Bounds, 2012). Federal OCS waters are 9 nmi (10.36 mi; 16.67 km) from the Texas shore, and only under good weather conditions would a platform be visible to a person standing at the shoreline or to a person in a multi-story building. Federal OCS waters are 3 nmi (3.5 mi; 5.6 km) from Louisiana, Mississippi, and Alabama. In a study conducted by the Geological Survey of Alabama (1998), several facets of the visibility of offshore structures were analyzed. This study 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 2-story house, or in a 30-story condominium) and the viewer's expectations and perceptions.

During scoping for recent EISs, the NPS raised questions regarding the potential visual impacts from OCS platforms to Horn and Petit Bois Islands. Horn and Petit Bois Islands are federally designated wilderness areas and are sensitive to disruptions to nature experiences. Cole (2012) is a literature review of various types of wilderness experiences. For example, the NPS is concerned regarding the impacts from OCS platforms on the sky-viewing experiences on these islands, particularly at night. The NPS provided BOEM with baseline data regarding the overall scales of natural and anthropogenic light at Horn and Petit Bois Islands (USDOI, NPS, 2014a). This data found that the anthropogenic light ratio is 537 percent higher than baseline conditions at Horn Island and 510 percent higher than baseline conditions at Petit Bois Island. However, these data do not distinguish between OCS oil and gas and non-OCS light sources. The U.S. Dept. of Homeland Security, Coast Guard (2008) provides more information regarding the lighting requirements for OCS structures, such as the number and orientation of lights, to ensure maritime safety.

Historical experiences offer some insights into the potential visual impacts of platforms near Horn and Petit Bois Islands. Bounds (2012) offers evidence that oil and gas development near Dauphin Island (Alabama) caused negative impacts to tourism. The visibility of oil and gas structures near Texas and Louisiana appear to have more limited (and in some cases positive) impacts (USDOI, NPS, 2001; Nassaur and Benner, 1984), although the visual impacts of platforms arising from a proposed action would be subjective depending on the location and people in question. For example, platform lighting can detract from some nature experiences but it can also improve visibility and add contrast to the landscape. However, the most relevant historical analogy is that of offshore development near Mississippi. **Figure 4-25** presents information regarding the current and historical locations of structures in the vicinity of Horn and Petit Bois Islands. The OCS structures have existed close to Petit Bois Island. Most of these have been removed; a few structures remain 7-10 mi (11-16 km) away. No studies have analyzed the impacts of the historical OCS structures on visitor experiences. **Figure 4-26** is a photograph of the remaining OCS structures taken from Petit Bois Island. **Figure 4-26** also shows a ship passing through the major shipping fairway near Petit Bois Island; the location of this shipping fairway is shown in **Figure 4-25**. This shipping fairway would continue to be used regardless of a proposed action. In **Figure 4-26**, the platforms are barely visible and have less of an impact on the viewshed than the passing ship.

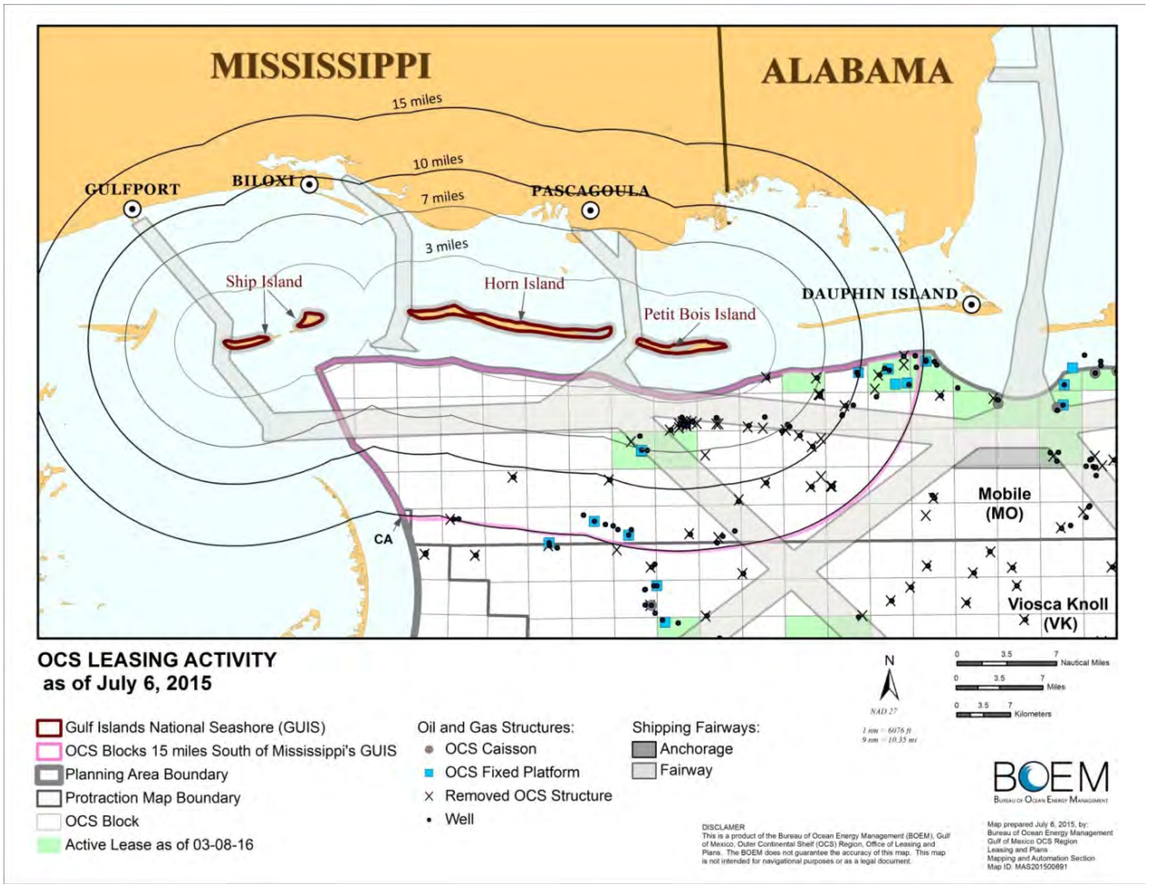

Figure 4-25. Historical Structure Locations near Horn and Petit Bois Islands.

Figure 4-26. Photograph of Remaining OCS Structures taken from Petit Bois Island Looking South (modified and reprinted with permission from Bob Marsh, [official communication, 2016]). (Petit Bois Island is within the Gulf Islands National Seashore and is a National Park Service-designated wilderness area.)

An analysis of the visual impacts of a proposed action depends importantly on the locations of the structures likely to arise. Less than 1 percent of the total oil and gas reserves in the GOM Federal OCS are estimated to exists offshore Mississippi (USDOI, BOEM, 2013b). This makes it unlikely that a production platform would arise near Horn and Petit Bois Islands in the foreseeable future, particularly given the low current energy prices. In particular, the remaining energy resources offshore Mississippi are likely natural gas (USDOI, BOEM, 2013b). The Henry Hub spot price for natural gas has fallen from an annual average of $8.86/MMBtu (million British thermal units) in 2008 to a monthly average of $2.84/MMBtu in July 2015, in part due to the development of U.S. onshore natural gas resources (USDOE, Energy Information Administration, 2015g). Therefore, even if there were a lease near Horn or Petit Bois Island, it would probably be developed using minimal structures that tie back to existing platforms due to cost considerations. In addition, BOEM developed the Information to Lessees and Operators (ITL) that provides for NPS consultation on a lessee's plans (excerpt from past ITL below), as appropriate, and began adding the ITL to the Notices of Sale for proposed CPA lease sales beginning with CPA Lease Sale 231. The lease blocks that have previously been included the Gulf Islands National Seashore ITL are illustrated in **Figure 2-6**. BOEM would expect this ITL to be applied to any future GOM lease sales encompassing all or a portion of the CPA. For these reasons, potential impacts to these islands would likely be **negligible** to **minor**.

> (q) <u>Gulf Islands National Seashore</u>. Potential bidders are hereby notified that postlease plans submitted by lessees of whole and partial lease blocks located within the first 12 miles of Federal waters near the Gulf Islands National Seashore (State of Mississippi Barrier Island Chain Map, enclosed with ITL) may be subject to additional review in order to minimize visual impacts from development operations on these blocks. BOEM will review and make decisions on a lessee's plans for these blocks in accordance with applicable Federal law and regulations, and BOEM policies, to determine if visual impacts are expected to cause serious harm and if any additional mitigative action is required. Mitigations may include, but are not limited to, requested changes in location, modifications to design or direction of proposed structures, pursuing joint use of existing structures on neighboring blocks, changes in color design, or other plan modifications. BOEM may consult with the State of Mississippi and/or the State of Alabama and with the National Park Service, Southeast Regional Office, during such reviews as appropriate.
>
> The following whole and partial blocks, are specifically identified for this ITL: Chandeleur Area – 1; Mobile – 765-767, 778, 779, 809-823, 853-867, 897-910, 942-954, 987-997; and Viosca Knoll – 24-27.

The OCS oil- and gas-related activities can also affect recreational resources indirectly due to economic factors. First, increased coastal infrastructure necessary to support offshore activities can create space-use conflicts. However, even if a space-use conflict was to arise in a particular instance, it is likely that a number of substitute recreational sites would be available. The OCS oil- and gas-related activities also have the potential to increase or decrease the demand for recreational resources in certain communities. Increased demand for recreational resources has the potential to attract new recreational firms to a community; however, increased demand also has the potential to lessen the enjoyment of a particular resource by some community members. The OCS structures could also affect property values in nearby areas. However, as discussed in **Chapter 3.1.2.1**, the existing oil and gas infrastructure would likely be sufficient to handle the amount of activity associated with a proposed action. Thus, there would likely be no noticeable increase in such impacts. In addition, there is sufficient land in the analysis area to handle any new development. Therefore, these indirect economic impacts would likely be **negligible** to **minor**.

Accidental Events

Accidental events, such as oil spills and the subsequent response activity, could affect various recreational resources. The impacts of drilling fluid spills and chemical spills on recreational resources are expected to be negligible because of their small sizes and far distances from recreational resources and are thus not discussed in detail. An oil spill that remained offshore could cause closures that may affect recreational fishing, diving, and boating. An offshore oil spill could also impact nearby coastal areas through media coverage or through misperceptions and uncertainty regarding the extent of the spill. An oil spill would have more direct impacts if it were to reach coastal areas. Environmental Sensitivity Indexes (ESIs) provide overall measures of the sensitivity of a particular coastline to a potential oil spill. The ESIs rank coastlines from 1 (least sensitive) to 10 (most sensitive). Marshes and swamps are examples of resources that have ESIs of 10 due to the difficulty of removing oil from these areas. The ESIs for beach areas generally range from 3 to 6, depending on the type of sand and the extent to which gravel is mixed into the beach area. The ESI maps for any coastline along the Gulf of Mexico can be viewed using the National Oceanic and Atmospheric Administration's ERMA mapping system (USDOC, NOAA, 2015m). The ESI maps also provide point indicators for recreational resources.

The effects of an oil spill on a region would depend on the size of the spill, as well as the success of the containment and cleanup operations following an oil spill. Both manual and machine-based techniques can be used to clean oil; the cleaning technique chosen for a particular beach would depend on the nature of the oiling of a particular beach area. The nature of cleanup operations would also depend on whether a particular beach serves as a habitat to particular animal species because removing oil deep below a beach surface can sometimes do more ecological harm than good. As a result, ecological beaches are often only cleaned to a shallow depth, while nonecological ("amenity") beaches are often cleaned more extensively. The cleanup plan for any particular beach is determined by a Shoreline Treatment Recommendation, which is prepared by the relevant State and Federal agencies for a particular spill. An example of a Shoreline Treatment Recommendation following the *Deepwater Horizon* explosion and oil spill for Grande Isle, Louisiana, can be found at RestoreTheGulf.gov (2010).

Recreational resources such as beaches serve as important bases for certain local economies. Therefore, oiled beach regions can cause economic losses to both individuals and firms in the area of an oiled or closed beach. An economic analysis of the costs of hypothetical beach closures along the Texas Gulf Coast was performed by Parsons and Kang (2007). They estimate that the economic costs of beach closures along the Padre Island National Seashore would range from $26,000 to $172,000 per day, depending on the time of year at which the closures would occur. The New Orleans oil spill of 2008 demonstrates that a spill can affect different types of recreational activities. Namely, this spill impacted some of the boating and restaurant businesses in its vicinity; it also caused some aesthetic impacts to the experiences of tourists in the region (Tuler et al., 2010).

Eastern Research Group (2014b) prepared a study of the impacts of the *Deepwater Horizon* oil spill on tourism activities in the Gulf region. Eastern Research Group analyzed *Deepwater Horizon* claims data, reviewed newspaper accounts of the spill, analyzed county-level employment data, and conducted interviews with people involved in the tourism industry. These various methodologies paint a rich picture of the impacts of the *Deepwater Horizon* explosion, oil spill, and response, and revealed some broad conclusions. First, the *Deepwater Horizon* explosion, oil spill, and response had a broad geographic reach, partially due to public perceptions of the nature and scope of the spill. In addition, restaurants and hotels were particularly impacted by the *Deepwater Horizon* explosion, oil spill, and response, which led areas with more diversified tourism economies to hold up better in the spill's aftermath. Also, tourism generally rebounded strongly after the initial decline. Indeed, employment held up well in most counties and parishes following the *Deepwater Horizon* explosion, oil spill, and response, which supported the recovery. Finally, the impacts of the spill on tourism were shaped by the damage payment system, cleanup processes, and lessons learned from prior disasters. However, an oil spill along the lines of the *Deepwater Horizon* oil spill is not reasonably foreseeable and is not considered as part of a proposed action. The impacts of a catastrophic oil spill are analyzed in the *Catastrophic Spill Events Analysis* white paper (USDOI, BOEM, 2016c).

Any oil spills arising from a proposed action are likely to be small and localized, and thus, the corresponding impacts would be less than those experienced after the *Deepwater Horizon* explosion, oil spill, and response. In addition, there would likely be response and mitigation efforts subsequent to an oil spill. Finally, there would likely be numerous alternative recreational sites during the duration of an oil spill of the type and size that may be reasonably foreseeable as a result of a proposed lease sale. Therefore, the impacts of an oil spill on recreational resources are expected to be **negligible** to **minor**.

Cumulative Impacts

The cumulative analysis considers the incremental impacts of a proposed action relative to past, present, and future OCS lease sales. The following cumulative OCS oil-and gas-related activities would potentially affect recreational resources: marine trash and debris, visibility of OCS platforms, space use conflicts, OCS related spills, and infrastructure emplacement and removal. This analysis also considers the incremental impacts of a proposed action relative to non-OCS oil- and gas-related sources such as aesthetic impacts, beach/wetland erosion, beach disruptions, space-use conflicts, and economic factors.

OCS Oil- and Gas-Related Impacts

Aesthetic Impacts

A proposed action would contribute to aesthetic impacts of the existing and future OCS Programs. For example, the OCS Program contributes to the marine debris problems along the Gulf Coast. The BSEE provides information on marine debris and awareness and requires training of all OCS personnel through the "Marine Trash and Debris Awareness and Elimination" NTL (NTL 2015-BSEE-G03); this NTL is discussed above. Compliance with this NTL, particularly if the Protected Species Stipulation is applied, and other regulations as outlined in the "Routine Activities" section above would likely reduce the potential damage to recreational resources from the discharge of marine debris from OCS oil- and gas-related activities to be **negligible** to **minor**.

A proposed lease sale would also add to the visual impacts from the OCS Program. These impacts would depend on the type of recreational area and on the extent to which platforms are visible. For example, OCS platforms could detract from the nature experiences in certain Gulf Coast parks. As discussed above, during scoping for recent EISs, the National Park Service raised questions regarding the potential visual impacts from OCS platforms to Horn and Petit Bois Islands. **Figure 4-25** presents information regarding the current and historical locations of structures in the vicinity of Horn and Petit Bois Islands. The OCS structures have existed close to Petit Bois Island for approximately 30 years. Most of these have been removed; a few structures remain 7-10 mi (11-16 km) away. **Figure 4-26** is a photograph of the remaining OCS structures taken from Petit Bois Island, in which these structures are minimally visible. The impacts of any new structure would likely be limited unless it was closer to Petit Bois Island than the existing structures. However, as discussed previously, it is highly unlikely that such a structure would arise from a proposed action because of economic considerations and the Bureau of Ocean Energy Management's ITL regarding this issue. Any potential impacts to the Gulf Islands National Seashore would be mitigated by the ITL, and therefore, the incremental contribution would be **negligible** to **minor**. The incremental contribution to impacts to other recreational resources would also range from **negligible** to **minor** because of the limited amount of activity and the distances of the activities from recreational areas.

Space-Use Conflicts

A proposed action would also contribute to space-use conflicts between recreational activities and the broader OCS Program. Bernhardt et al. (2006) present an analysis of space-use conflicts for oil and gas activities off the coast of Texas, although the issues they raise are generally applicable to OCS oil- and gas-related activities. They use a GIS-based framework to identify specific locations where conflicts between oil activities and other concerns (including recreational use) are most acute; they find that recreational use conflicts tend to be concentrated around some of the major wildlife viewing and beach areas near the larger population areas in Texas. There would also be the potential for space-use conflicts, e.g., near ports, along coastal Louisiana due to the high concentration of the OCS oil and gas industry in this area. The vessel traffic near these facilities could cause space-use conflicts with boating and recreational fishing activities. However, even if a space-use conflict was to arise in a particular instance, it is likely that a number of substitute recreational sites would be available. In addition, given the entrenched nature of the OCS oil and gas industry along the WPA and CPA, it is unlikely that any particular OCS oil- and gas-related activity would significantly add to space-use conflicts. As any of the alternatives would propose leasing only a very small portion of the EPA, such space-use conflicts are even less likely in the EPA.

Oil Spills

A proposed action would contribute incrementally to the likelihood of an oil spill caused by the broader OCS Program. Accidental spills most likely would be small, of short duration, and not likely to impact Gulf Coast recreational resources. In particular, as shown in **Table 3-17**, most spills would range from 0 to 500 bbl. Should an oil spill occur and contact a beach area or other recreational resource, it would cause some disruption during the impact and cleanup phases of the spill. However, these impacts are expected to be **negligible** to **minor** because any oil spill arising from a proposed action is expected to be small.

Infrastructure Emplacement and Removal

The overall OCS Program can contribute to coastal erosion through activities such as channel dredging and pipeline emplacements. A more detailed discussion of the cumulative impacts of OCS oil- and gas-related activities on coastal beaches and dunes is presented in **Chapter 4.3.2**. Further information on the cumulative impacts of OCS oil- and gas-related activities on estuarine ecosystems can be found in **Chapter 4.3.1**. Platform emplacements can encourage some recreational activities, such as fishing and diving. However, decommissioning of these structures can have negative impacts on recreational diving if a particular platform were a popular diving site. Hiett and Milon (2002) provide survey data that suggest that the majority of recreational diving in the Gulf of Mexico occurs near oil and gas structures. More information regarding the impacts of infrastructure emplacement and removal is presented above and can be found in **Chapter 4.11**.

A single lease sale would be relatively small when compared with all past, present, and future lease sales (refer to **Table 3-23**). Therefore, the incremental cumulative impacts of the proposed action relative to the overall OCS Program would range from **beneficial** to **minor**.

Non-OCS Oil- and Gas-Related Impacts

Aesthetic Impacts

Marine debris can detract from the aesthetic values of coastal areas, particularly beaches. Non-OCS oil- and gas-related marine debris can originate from State oil and gas activities, sewage treatment plants, recreational and commercial fishing, industrial manufacturing, cruise ships, and various forms of vessel traffic. Various government agencies participate in a coordinated effort to combat marine debris; a broad summary of the issues involved and the policy structure with respect to marine debris can be found in the Interagency Marine Debris Coordinating Committee's report (USDOC, NOAA, 2008b). Ocean Conservancy (2007) describes the structure of the National Marine Debris Monitoring Program; Ocean Conservancy (2014) is the most recent marine debris monitoring report. The incremental impacts of a proposed action are expected to be **negligible** to **minor** because the amount of marine debris that would arise from OCS oil- and gas-related activities would be small relative to the amount of marine debris arising from the sources mentioned above.

Aesthetic impacts can also arise from State oil and gas activities. For example, State oil and gas activities occur closer to shore and, thus, would cause more noise and visual impacts than OCS oil- and gas-related activities. In 2014, Mississippi's plans to hold an offshore oil and gas lease sale in State waters were suspended when a judge ruled against Mississippi's determination that such leases were purely administrative actions (NOLA.com, 2014). It is unclear how this issue would evolve. The visual impacts to Horn and Petit Bois Islands would also be influenced by the major shipping fairway between the islands. This shipping artery (which is shown in **Figure 4-25**) leads to the Port of Pascagoula, which is the 21st most active port in the United States (U.S. Dept. of the Army, COE, 2015c). A proposed action should also be viewed in light of the overall levels of noise on Horn and Petit Bois Islands. White (2014) provides data on baseline noise levels at Horn and Petit Bois Islands relative to Fort Pickens (which is a nonwilderness, higher human use area) in the Florida District of the Gulf Islands National Seashore. This study found that Horn and Petit Bois Islands have lower overall levels of extrinsic noise than Fort Pickens. Horn and Petit Bois Islands have higher measures of watercraft noise and lower levels of aircraft noise than Fort Pickens.

Beach/Wetland Erosion

The OCS Program occurs in an environment in which beach and wetland resources are undergoing depletion due to human development, hurricanes, and natural processes. The ongoing risk of hurricanes is a particular coastal erosion threat in the Gulf of Mexico; coastal erosion also lessens protection against future hurricanes. Non-OCS-related oil spills also have the potential to contribute to beach erosion, both due to contaminated sediment and the potential sediment losses during the cleanup process. More information regarding these issues can be found in **Chapter 3.2.12**. Coastal erosion trends would have impacts on recreational resources to the extent that parts of these areas are used for recreational activities, such as beach visitation, recreational fishing, and boating.

Beach Disruptions

The recreational value of beaches can be affected by beach disruptions. For example, red tides, which are caused by growth of microscopic algae, can negatively impact the aesthetic value of beaches. Red tides can also cause respiratory problems and skin irritation for beachgoers (State of Texas, Dept. of State Health Services, 2015). As discussed in **Chapter 4.3.2** Coastal Barrier Beaches and Associated Dunes, beaches can also be affected by changes in water and sediment flow. The recreational value of beaches can also be negatively impacted by degradations of air quality and water quality (**Chapters 4.1 and 4.2**).

Space-Use Conflicts

Space-use conflicts with recreational activities may arise from commercial and military traffic. **Chapter 3.3.2.7.1** describes the military activities in the vicinity of a proposed action. For example, **Chapter 3.3.2.7.1** discusses the military warning areas and Eglin water test areas, as well as the Military Areas Stipulation that applies to GOM leases. **Chapter 4.14.1.4** describes the cumulative impacts of vessel traffic, including the ports that support the highest vessel traffic. These activities could disrupt recreational fishing, diving, and boating.

Economic Factors

The recreational resources along the Gulf Coast would be subject to various impacts arising from economic development. For example, there may be pressures to develop other industries into existing parks and natural resources. However, development may also encourage the expansion of other recreational resources, such as hotels and restaurants, to accommodate increased tourism and/or local recreation. The projected path of the economies along the Gulf Coast would be influenced by national economic trends. Recreational and tourism activity is positively correlated to the state of the overall national economy because higher levels of disposable income encourage consumers to dedicate more money to travel and leisure activities. More information regarding economic factors can be found in **Chapter 4.14.2**.

A proposed action would be relatively small when compared with the non-OCS oil- and gas-related factors discussed above (refer to **Chapter 3**). Therefore, the incremental cumulative impacts of a proposed action relative to these non-OCS oil- and gas-related factors would range from **beneficial** to **minor**.

Incomplete or Unavailable Information

There is some incomplete or unavailable information regarding the visual impacts from a proposed action. In particular, the attitudes of people towards the visibility of structures that could arise in certain areas are not fully known. BOEM has determined that such information is not essential to a reasoned choice among alternatives because much of this uncertainty relates to the inherent uncertainty regarding where (and what types) of structures would arise from a proposed action. In addition, existing information allows for sufficient estimates of the overall dependence of visual impacts to factors such as distance, height, brightness, and general location. BOEM used generally accepted scientific principles to estimate the visual impacts of a proposed action, including literature sources, data sources, and photographic evidence. This evidence suggests that the incremental visual impacts of a proposed action would be **negligible** to **minor**. In addition, BOEM has issued an ITL to ensure that visual impacts near the Gulf Islands National Seashore are considered at BOEM's site-specific review stage.

4.12.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

The impacts of a proposed action would correspond to the impacts described in **Chapter 4.12.2**. In particular, a proposed action would contribute to the negative aesthetic impacts and the space-use conflicts that arise due to the broader OCS Program. Structure emplacements can have positive impacts on recreational fishing and diving because platforms often act as artificial reefs, although decommissioning would offset these impacts. Oil spills can negatively impact beaches and other coastal recreational resources. The impacts resulting from the routine activities and accidental events would range from beneficial to minor. A proposed action should also be viewed in light of economic trends, as well as various non-OCS oil- and gas-related factors than can cause space-use conflicts and aesthetic impacts, such as commercial and military activities. The incremental cumulative impacts of Alternative A relative to the impacts of all other OCS oil- and gas-related and non-OCS oil- and gas-related factors would be **beneficial** to **minor**.

4.12.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Alternative B entails leasing a subset of the area considered in Alternative A. Therefore, the analysis of Alternative A covers the potential impacts of Alternative B. There would be some differences in impacts between Alternatives A and B due to the scales of OCS oil- and gas-related activities (described in **Chapter 4.12.1**) and to the geographic distributions of activities. Namely, Alternative B would prevent most impacts to recreational resources near drilling and production activities in Federal waters off Texas. However, since CPA/EPA activities may still be serviced by vessels departing from Texas ports, there could still be some space-use conflicts or impacts from oil spills near Texas. However, the differences between Alternatives A and B are not large enough to change the broad impact measures. In particular, Alternative B would contribute to the negative aesthetic impacts and the space-use conflicts that arise due to the broader OCS Program. Structure emplacements can have positive impacts on recreational fishing and diving because platforms often act as artificial reefs, although decommissioning would offset these impacts. Oil spills can negatively impact beaches and other coastal recreational resources. Alternative B should also be viewed in light of economic trends, as well as various non-OCS oil- and gas-related factors than can cause space-use conflicts and aesthetic impacts such as commercial and military activities. The incremental cumulative impacts of Alternative B relative to the impacts of all other OCS oil- and gas-related and non-OCS oil- and gas-related factors would be **beneficial** to **minor**.

4.12.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Alternative C entails leasing a subset of the area considered in Alternative A. Therefore, the analysis of Alternative A covers the potential impacts of Alternative C. There would be some differences in impacts between Alternatives A and C due to the scales of OCS oil- and gas-related activities (described in **Chapter 4.12.1**) and to the geographic distributions of activities. Namely, Alternative C would prevent most impacts to recreational resources near drilling and production activities in CPA/EPA Federal waters. However, since activities in the WPA may still be serviced by vessels departing from ports adjacent to the CPA/EPA, there could still be some space-use conflicts or impacts from oil spills near all Gulf Coast States. However, the differences between Alternatives A and C are not large enough to change most of the broad impact measures. The only difference is that the visual impacts due to structure emplacements should be **negligible** because all structures would be at least 9 nmi (10.36 mi; 16.67 km) from shore and because there would be fewer structure installations in the WPA than in the CPA. Alternative C would contribute to the negative aesthetic impacts and the space-use conflicts that arise due to the broader OCS Program. Structure emplacements can have positive impacts on recreational fishing and diving because platforms often act as artificial reefs, although decommissioning would offset these impacts. Oil spills can negatively impact beaches and other coastal recreational resources. Alternative C should also be viewed in light of economic trends, as well as various non-OCS oil- and gas-related factors than can cause space-use conflicts and aesthetic impacts such as commercial and military activities. The incremental cumulative impacts of Alternative C relative to the impacts of all other OCS oil- and gas-related and non-OCS oil- and gas-related factors would be **beneficial** to **minor**.

4.12.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D entails leasing a subset of the area considered in Alternative A, B, or C. Therefore, the analysis of Alternative A, B, or C covers the potential impacts of Alternative D. The areas that would be restricted from leasing under Alternative D would generally be far from shore and comprise a small portion of recreational activities along the Gulf Coast. In addition, there would be some offsetting adverse impacts (due to aesthetics, space-use conflicts, and oil spills) and some beneficial impacts (due to structure emplacements). The exclusion of blocks south of Baldwin County would prevent some potential negative impacts to tourism arising from the visibility of OCS oil- and gas-related infrastructure; it would also prevent the space-use conflicts, aesthetic impacts, and impacts from accidental events described above. However, the exclusion of these blocks would not prevent similar impacts in other GOM areas. Therefore, the overall impact conclusions for Alternative D are the same as those concluded under Alternative A, B, or C, as appropriate. The significance of impact-producing factors on recreational resources could be somewhat less for Alternative D than for Alternative A, B or C, as a few additional blocks and associated activities would be removed from the proposed lease sale area. However, this is a very small incremental change compared with the other action alternatives.

4.12.2.5 Alternative E—No Action

Under Alternative E, the **beneficial** to **minor** impacts discussed above would not occur as a result of a proposed lease sale. However, recreational resources would still be subject to the impacts from the OCS Program, as well as the impacts from the non-OCS oil- and gas-related sources discussed above. In the short term, there would be a reduction of exploration and drilling activities, and there would be fewer impacts from the space-use conflicts, oil spills, and aesthetics of such activities. If lease sales were not held for a lengthy period of time, there may be a long-term reduction in impacts arising from production activities (such as the role of platforms as artificial reefs) as mature leases reach the end of their production period and are decommissioned.

4.13 ARCHAEOLOGICAL RESOURCES

> *The magnitude of impact to an archaeological site is predicated on the assumption that an impact may occur from an offshore activity regardless of assigned mitigation. BOEM does not differentiate between archaeological site types when conducting an impact analysis at the programmatic level.*

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are capable of providing scientific or humanistic understanding of past human behavior, cultural adaptation, and related topics through the application of scientific or scholarly techniques, such as controlled observation, contextual measurement, controlled collection, analysis, interpretation, and explanation (30 CFR § 250.105). The full analyses of the potential impacts of routine activities and accidental events associated with a proposed action and a proposed action's incremental contribution to the cumulative impacts are presented in the following sections. The approach of the analysis is to focus on the potential impact-producing factors from routine OCS oil- and gas-related activities (i.e., exploration, development, and production), as well as accidental events and cumulative impacts (**Table 4-26**). A brief summary of potential impacts follows. Archaeological resources are primarily impacted by any activity that directly disturbs or has the potential to disturb the seafloor. For the OCS Program, this includes the placement of drilling rigs and production systems on the seafloor; pile driving associated with platform emplacement; pipeline placement and installation; the use of seismic receiver nodes and cables; the dredging of new channels, as well as maintenance dredging of existing channels; anchoring activities; post-decommissioning activities including trawling clearance; and the masking of archaeological resources from industry-related infrastructure and debris. Visual impacts to coastal archaeological and historic sites are not considered, as offshore oil and gas infrastructure has existed on the OCS in the CPA and WPA since the 1940s and constitutes a seaward historic viewshed in its own right. Additionally, its presence predates the NHPA, and therefore, any coastal archaeological site currently on the National Register of Historic Places would not derive its eligibility from an unobstructed view of the GOM.

Impact-Level Definitions

The definition of impact thresholds used in this analysis are listed below.

- **Negligible** – The lowest level of detection that would have neither adverse nor beneficial impacts.
- **Minor** – Disturbance of archaeological resources would result in little, if any, loss of site integrity.
- **Moderate** – Site disturbance would result in a loss of integrity and a partial loss of the character-defining features and information potential that form the basis of the site's National Register of Historic Places' eligibility. Mitigation is accomplished by a combination of archeological data recovery and in-place preservation.

- **Major** – The disturbances result in a loss of site integrity to the extent that the resource is no longer eligible for listing in the National Register of Historic Places. The site's character-defining features and information potential are lost to the extent that archeological data recovery is the primary form of mitigation.
- **Beneficial** – An archeological site is stabilized in its current condition to maintain its existing level of integrity or an archeological site is preserved in accordance with the Secretary of the Interior's Standards for the Treatment of Historic Properties.

Duration: Short-term impacts last for the duration of construction-related activities while long-term impacts last beyond the proposed construction activities and are permanent. Generally, impacts to archeological sites are considered long-term impacts.

The impact of coastal and marine environmental degradation from OCS oil- and gas-related activities is expected to minimally affect cultural resources in comparison to other sources of coastal erosion and subsidence. Impacts of routine discharges are localized in time and space, are regulated by USEPA permits, and would have minimal impact. Accidental events that could impact archaeological resources include blowouts and oil or chemical spills and the associated cleanup response activities, and also the loss of debris from an MODU, platform, lay barge, etc. during offshore operations. A noncatastrophic oil spill (even one reasonably foreseeable as a result of a proposed lease sale) occurring and contacting a submerged archaeological resource is unlikely, given that oil released tends to rise quickly to the surface and that the average size of a spill is <1 bbl (refer to **Chapter 3.2.1.5.3**).

Archaeological surveys, where required prior to an operator beginning OCS oil- and gas-related activities, are expected to be effective at identifying possible archaeological sites. Offshore oil and gas activities resulting from a proposed action could adversely impact an archaeological resource because of incomplete knowledge on the location of these sites in the GOM. The risk of contact to archaeological resources is greater in instances where archaeological survey data are unavailable. Such an event could result in the disturbance or destruction of important archaeological information. Archaeological surveys provide the necessary information to develop avoidance strategies that would reduce the potential for adverse impacts on archaeological resources. As part of the environmental reviews conducted for postlease activities, available information would be evaluated regarding the potential presence of archaeological resources within the proposed action area to determine if additional archaeological resource surveys and mitigation is warranted.

4.13.1 Description of the Affected Environment

4.13.1.1 Prehistoric

Available evidence suggests that sea level in the northern GOM was at least 90 m (295 ft), and possibly as much as 130 m (427 ft), lower than present sea level 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.

Until the late 20th century, it was generally accepted by archaeologists that the earliest humans in North America were the so-called Clovis peoples, named for a lanceolate-shaped, fluted projectile point first found near Clovis, New Mexico. The Clovis culture was thought to have entered the continent by way of Beringia, a landmass connecting Asia to North America exposed during the Last Glacial Maximum, and along an ice-free corridor opened between the Cordilleran and Laurentide ice sheets around 13.5 thousand years B.P. Today, however, a growing body of evidence has dispelled the “Clovis First” model with discovery of several sites with indisputable pre-Clovis dates in the eastern United States (Goodyear, 2005), Chile (Dillehay, 1989; Meltzer et al., 1997) and central Texas (Waters et al., 2011). The Buttermilk Creek Complex identified by Waters et al. (2011) at the Debra L. Friedkin Site (41BL1239) is the nearest to the Gulf of Mexico region and is dated from ~13.2 to 15.5 thousand years B.P.

Establishing a reliable date for the entrance of Native Americans into the coastal regions of the GOM is complicated by the fact that archaeological deposits pre-dating 5500 B.P. lie buried under as much as 40 m (131 ft) of sediment or are underwater on the OCS (Rees, 2010). Conclusive evidence for prehistoric sites on the OCS is sparse. The McFaddin Beach Site (41JF50) in Jefferson County, Texas, has produced hundreds of artifacts 8,000 years old or older that have been redeposited from sites eroding from the now-submerged Pleistocene shoreline. Forty-three percent of the total sample includes artifacts diagnostic of the Middle and Late Paleoindian periods and include Clovis, Dalton, Scottsbluff, and San Patrice projectile points (Stright et al., 1999).

Based on the best evidence currently available, the first Americans arrived on the Gulf Coast around 13,500 B.P. (Rees, 2010). The sea-level curve for the northern GOM proposed by Coastal Environments, Inc. (CEI) suggests that sea level at 12,000 years B.P. would have been approximately 45-60 m (148-197 ft) below the present-day sea level (CEI, 1977 and 1982). On this basis, the continental shelf shoreward of the 45- to 60-m (148- to 197-ft) bathymetric contours has potential for prehistoric sites dating after 12,000 years B.P. Because of inherent uncertainties in both the depth of sea level and the entry date of prehistoric man into North America, BOEM adopted the 60-m (197-ft) water depth as the seaward extent for prehistoric archaeological site potential in GOM region.

Based on their 1977 baseline study, CEI (1977) proposed that sites analogous to the types of sites frequented by Paleoindians can be identified on the now-submerged shelf. Geomorphic features that have a high potential for associated prehistoric sites include barrier islands and back-barrier embayments, river channels and associated floodplains and terraces, and salt-dome features. Investigations in Louisiana and Florida indicate the mound-building activity by prehistoric inhabitants may have occurred as early as 6,200 years 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 BOEM allow interpretations of specific geomorphic features and assessments of archaeological potential in terms of age, type of system the geomorphic features belong to, and geologic processes that formed and modified them. In general, sites protected by sediment overburden have a high potential 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, which were inundated during periods of rapid rise in sea level. Although many specific areas in the GOM having potential for prehistoric site preservation have been identified through 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. Farther to the south and west, a blanket of Holocene sediments overlies the Pleistocene horizon. Along the coast, prehistoric sites representing the Paleoindian 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 megafauna remains and lithics from all archaeological periods, including a large percentage of Paleoindian artifacts (Stright et al., 1999). A study funded by the Minerals Management Service (MMS) (BOEM's predecessor) 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.

High-resolution geophysical surveys 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 potential 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 potential for preservation of associated prehistoric sites. The Salt Mine Valley site on Avery Island is a Paleoindian 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.

4.13.1.2 Historic

Historic archaeological resources on the OCS consist of historic shipwrecks and a single historic lighthouse, the Ship Shoal Light. A historic shipwreck is defined as a submerged or buried vessel or its associated components, at least 50 years old, that has foundered, stranded, or wrecked, and that is currently lying on or embedded in the seafloor. Europeans are known to have traversed the waters of the western Gulf of Mexico as early as Captain Alonso Alvarez de Piñeda's expedition in 1519. Alvar Nuñez Cabeza de Vaca is likely to have the dubious distinction of being the first European to be shipwrecked along the Texas coast as early as 1528 (Francaviglia, 1998).

The NPS and MMS (BOEM's predecessor) contracted three studies (CEI, 1977; Garrison et al., 1989; Pearson et al., 2003) aimed at modeling areas in the GOM where historic shipwrecks are most likely to exist, though numerous shipwreck discoveries since the publication of those studies have empirically shown their models to be flawed due to reporting biases in the historic record. The 1977 study concluded that two-thirds of the total number of shipwrecks in the northern GOM lie within 1 mi (1.6 km) of shore and most of the remainder lies between 1 and 6 mi (1.6 and 10 km) of shore (CEI, 1977). Changes in the late 19th- and early 20th-century sailing routes increased the frequency of shipwrecks in the open sea in the eastern GOM to nearly double that of the central and western GOM (Garrison et al., 1989). The Garrison et al. study also found 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. Based on the results of this study, MMS identified which OCS lease blocks would require the operator to submit an archaeological report with their EP, DOCD, DPP, or other permit application.

Pearson et al. (2003) benefited from the experience of almost 15 years of high-resolution, shallow hazard surveys in lease blocks (a typical lease block is 9 mi^2 [5,760 ac]) and along pipeline routes. Some of these surveys (almost exclusively for pipeline routes) were conducted in deep water. Taking the new data into account, the 2003 study recommended including some deepwater areas, primarily on the approach to the Mississippi River, among those lease areas requiring archaeological investigation. With this in mind, MMS (BOEM's predecessor) revised its guidelines for conducting archaeological surveys and added about 1,200 lease blocks in the CPA to the list of blocks requiring an archaeological survey and assessment. These requirements are posted on BOEM's website under NTL 2005-G07 and NTL 2011-JOINT-G01. Based on additional shallow hazard survey data and shipwreck discoveries since 2008, an archaeological survey may be required as a result of site-specific NEPA analysis conducted for new bottom-disturbing activity associated with plans (USDOI, BOEM, 2011), pipelines, and structure-removal activities. **Table 4-25** illustrates the results of the surveys and archaeological reviews in the last 6 years.

Table 4-25. Archaeological Surveys and Resources Identified, 2009-2014.

Year	Blocks Surveyed	Identified Shipwreck Sites	Potential Archaeological Sites Mitigated by Avoidance (identified through requisite industry surveys)
2009	118	11	479 magnetic anomalies and 103 sonar targets
2010	74	8	274 magnetic anomalies and 100 sonar targets
2011	120	15	577 magnetic anomalies and 171 sonar targets
2012	115	15	341 magnetic anomalies and 112 sonar targets
2013	166	6	374 magnetic anomalies and 163 sonar targets
2014	144	13	417 magnetic anomalies and 146 sonar targets

Many of the above-listed shipwrecks were not previously known to exist in these areas from the historic record. Recent research on historic shipping routes, moreover, suggests that the ultra-deepwater area of the Gulf of Mexico, between 25º and 27.5º N. latitude, was located along the historic Spanish trade route, which therefore increases the probability that a historic shipwreck could be located in this area (Lugo-Fernandez et al., 2007). This route runs through the proposed action area. A study to conduct archival research on these historic shipping routes was completed in 2010 (Krivor et al., 2011) and concluded that both Spanish and French vessels were lost in the 16th, 17th, and 18th centuries while transiting the route between Vera Cruz, New Orleans, and Havana.

A proprietary database of shipwrecks maintained by BOEM currently lists over 1,300 named shipwrecks in the GOM. 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. This list should not be considered exhaustive; 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 of Texas, Louisiana, Mississippi, 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 within or close to the mouth of bays likely would have been quickly buried by transported sediment and therefore somewhat protected from the destructive effects of wood-eating shipworms (*Teredo navalis*) or storms, as has been observed at the site of *La Belle* in Matagorda Bay, Texas (Bruseth and Turner, 2005). Wrecks occurring in deeper water also have a moderate to high preservation potential. In the deep water, temperature at the seafloor is extremely cold (~4 ºC; 39 ºF), which slows the oxidation of ferrous metals. While the cold water at depth would eliminate the wood-eating shipworm *Teredo navalis*, it is clear from recent studies that other marine organisms, including chemosynthetic species, consume wooden shipwrecks, and that microbial organism are at work breaking down steel and iron hulls (Atauz et al., 2006; Church et al., 2007; Church and Warren, 2008; Ford et al., 2008). Due to the high levels of preservation and the decrease in impacts from anthropogenic (e.g., diving, looting, and fishing trawling) and meteorological (e.g., tropical storms and hurricanes) events, the potential is higher in deep water to discover undisturbed sites.

Hurricane activity in the Gulf of Mexico has the ability to directly impact archaeological resources in water depths exceeding 200 ft (61 m) (Gearhart et al., 2011; Lukens and Selberg, 2004). Wrecks occurring as a result of an extremely 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 65 ft (20 m) of water and has been documented by MMS/BOEM (Irion and Anuskiewicz, 1999; Gearhart et al., 2011) as scattered over the ocean floor in a swath over 1,500 ft (457 m) 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.

It is almost certain that any shipwrecks in shallow water within the path of Hurricanes Katrina or Rita were impacted to some extent by these storms. In September 2005, the NPS conducted a study of sites along the Gulf Coast that were impacted by Hurricane Katrina (USDOI, NPS, 2005). This assessment identified three types of damage that can occur to archaeological sites: tree throws; storm surge, scouring, and erosion; and seabed shifting. On the OCS, the two primary types of damage would be associated with storm surge and seabed shifting. In early 2007, MMS awarded a study to investigate the impacts that recent storm activity may have had on historic shipwrecks in the Gulf of Mexico. Analysis of the remote-sensing surveys and diver investigations indicates that at least 3 of the 10 shipwrecks examined were affected by recent storm activity and that older wooden wrecks that had achieved some level of equilibrium in their environment were less affected than more recent steel-hulled wrecks (Gearhart et al., 2011).

4.13.2 Environmental Consequences

Impacts to archeological sites occur when proposed activities result in complete or partial destruction of the resource and are equivalent to a loss of integrity as defined in the National Historic Preservation Act (NHPA) (54 U.S.C. §§ 300101 *et seq.*). In determining the appropriate impact threshold, both the extent to which the proposed activity results in a loss of integrity and the degree to which losses can be compensated by mitigating activities, including preservation or data recovery, are considered. For the purposes of this analysis, all alternatives may be assumed to have effectively similar potential impacts to archaeological resources. Only those resources determined eligible or potentially eligible for listing in the National Register of Historic Places are considered under the NHPA. Resources are eligible for listing in the National Register of Historic Places if they meet one or more eligibility criteria (for archeological sites, generally Criterion D, having the potential to provide information important to history or prehistory) and if they possess integrity. For purposes of archaeological mitigation, BOEM/BSEE considers all uninspected shipwrecks, sonar targets, and magnetic anomalies potentially eligible for the National Register of Historic Places.

For the analysis of impacts to archeological resources, the determination of the intensity of an impact is based on the foreseeable loss of integrity to known or potential resources. The analysis considers only the direct impacts of seafloor disturbance associated with the below-listed impact-producing factors as there should be no additional impacts upon archeological resources under any of the alternatives under consideration upon completion of said activities. As each archaeological resource is unique and exists at a specific location on the seafloor, there is a high level of variability in how a site may be impacted by any potential impact-producing factor. Therefore, it is impossible to evaluate the potential impact to an archaeological site from a proposed action at the programmatic level. During postlease activities, each permitted action would be assessed for site-specific potential impacts during the permit application process.

Routine Activities

Routine impact-producing factors associated with a proposed action that could affect archaeological resources include (1) geotechnical testing/geophysical surveys; (2) well development (drilling), structure installation, and maintenance; (3) pipeline installation and maintenance; (4) vessel or structure anchoring; and (5) idle structure removal.

Geotechnical Testing/Geophysical Surveys

Geotechnical testing includes, but is not limited to, soil boring, seafloor coring, and sediment grabs. The area of effect for a typical geotechnical test is approximately 1 m^2 (11 ft^2); however, several tests are usually conducted as part of a project. The likelihood that an individual test would negatively impact an archaeological site in an unsurveyed area is minimal; however, the effect to an impacted site would be significant were it to occur. Large area geophysical surveys to resolve deep geological structures use either ocean bottom cables or ocean bottom nodes as acoustic receivers. The ocean bottom cables are deployed from a surface vessel onto the seafloor. While the cable itself is light and flexible, the acoustic node assembly and sound dampeners can weigh up to approximately 400 lb (181 kg). The "blind" method of laying down and peeling up the cable from the seafloor could cause the cable to snag on an unknown shipwreck, causing major adverse impacts. The ocean bottom nodes are either dropped from a surface vessel, with a large area of potential bottom contact, or they are placed by ROVs. An archaeological survey is not required in advance of a geophysical survey; however, identified and potential archaeological resources are noted for avoidance. The deployment of ocean bottom cables and ocean bottom nodes dropped from the surface have the potential to significantly negatively impact unidentified archaeological resources. The ocean bottom nodes placed by ROV have minimal potential to impact archaeological resources as the seafloor is visually inspected before placement and recovery. Impacts to archaeological resources from the geotechnical testing/geophysical survey range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

Well Development (Drilling), Structure Installation, and Maintenance

In total, approximately 6,700 platforms have been installed in the GOM. For fixed-legged structures, depending on water depth, seafloor characteristics, and vessel availability, an anchored barge, moored barge, or liftboat may be used in platform installation. Wells are typically drilled in a new location prior to structure installation. Depending primarily on water depth and vessel availability, a jack-up rig or anchored or dynamically positioned MODU may be used. Several directional wells may be drilled from a single top-hole location. Estimates of wells to be drilled and platforms to be installed, by water depth, are presented in **Table 3-2**. Impacts to archaeological resources from well development, structure installation, and maintenance activities range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

Pipeline Installation and Maintenance

Pipelines in the Gulf of Mexico OCS are installed as either a part of lease-block infrastructure or as a right-of-way across others' leases or unleased areas. Pipeline permits allow an operator to install a pipeline within a planned 200-ft (61-m) corridor. Pipelines are laid with either an anchored or a dynamically positioned lay barge. Pipelines installed in water depths <200 ft (61 m) and those deemed a hazard to navigation must be buried at least 3-16 ft (1-5 m) depending on local uses (e.g., fairways, anchorages, etc.), typically using a water jet. Long segments have been observed to flex and move across the seafloor, usually due to storm activity. A survey for all proposed pipeline installation, regardless of location, has only been required since 2005. An example of an adverse impact to an archaeological site from a pipeline installation is the 2001 installation of an oil and gas pipeline that bisected and damaged what is known as the Mica Shipwreck (Atauz et al., 2006). Impacts to archaeological resources from pipeline installation and maintenance activities range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

Vessel or Structure Anchoring

Anchoring associated with exploration drilling, platform and pipeline emplacement, and decommissioning may also physically impact archaeological resources. It is assumed that, during anchor emplacement, an array of 20,000-lb (9,072-kg) anchors is repositioned within the area of potential effect. The anchor's chain has the potential to lie along and sweep across the seafloor. Impacts to archaeological resources from anchoring activities range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

Idle Structure Removal

As per NTL 2010-G05 ("Decommissioning Guidance for Wells and Platforms") (idle iron initiative), idle and toppled oil and gas industry-related structures embedded in the seafloor, including single-leg caissons, multi-legged jacketed fixed platforms, floating platforms secured by suction pilings, and subsea well-head and manifold systems, must be decommissioned and removed. Depending on water depth, seafloor characteristics, and vessel availability, an anchored barge, moored barge, or liftboat may be used. Additionally, the site must be cleared of debris to a radius of 600 or 1,320 ft (183 or 402 m) depending on the structure type and use. Clearance may be carried out by trawling or by sonar and diving operations. As of 2013, BOEM may require, as a condition of approval for a decommissioning permit, an archaeological survey in advance of structure-removal activities when no preexisting survey of the area of potential effect exists. Impacts to archaeological resources from structure-removal activities range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

To mitigate potential adverse impacts to archaeological resources, BOEM requires archaeological reconnaissance survey of all areas impacted by bottom-disturbing activities and avoidance or other actions, up to and including full Phase III excavation, of all potential archaeological resources within the identified area of potential effect of the undertaking. Archaeological surveys are expected to be effective at identifying possible archaeological sites. The technical requirements of the archaeological resource reports are detailed in NTL 2005-G07, "Archaeological Resource Surveys and Reports." Under 30 CFR § 550.194(c) lessees are required to immediately notify BOEM's Regional Director of the discovery of any potential archaeological resources. Under 30 CFR § 250.194(c) and 30 CFR § 250.1010(c), lessees are also required to immediately notify BOEM's and BSEE's Regional Directors of the discovery of any potential archaeological resources.

Accidental Events

Accidental impact-producing factors associated with a proposed action that could affect archaeological resources include accidental oil spills and loss of debris from a vessel or structure.

Accidental Oil Spills

Impacts on archaeological resources could occur as a result of an accidental oil spill. A major impact from an oil spill would be visual and chemical contamination of a historic coastal site, such as a prehistoric shell midden, historic fort, or lighthouse. Although such impacts may be temporary and reversible, cleaning oil from historic structures is by no means a simple or inexpensive process (e.g., Chin and Church, 2010). The major impacts to coastal archaeological sites from the *Exxon Valdez* spill in Alaska in 1989 were related to cleanup activities, such as the construction of helipads, roads, and parking lots, and to looting by cleanup crews rather than from the oil itself (Bittner, 1996). As a result, cultural resources were recognized as significant early in the response to the *Deepwater Horizon* oil spill, and archaeologists were embedded in Shoreline Cleanup and Assessment Technique (SCAT) teams and consulted with cleanup crews.

An oil spill occurring and contacting an archaeological resource is unlikely, given that oil released tends to rise quickly to the surface and that the average size of any spill would be small. Refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c) for an analysis of the potential impacts of a catastrophic oil spill on coastal and submerged archaeological resources.

The impacts to archaeological sites from oil spills and associated activities **have not been quantified**.

Loss of Debris from a Vessel or Structure

Another impact that could result from an accidental event is from the loss of debris from an MODU, platform, lay barge, etc. during offshore operations. Debris such as structural components (i.e., grating, wire, tubing, etc.), boxes, pallets, and other loose items can become dislodged during heavy seas or storm events and fall to the seabed. Similarly, thousands of joints of drill pipe are used during drilling operations, requiring regular transport out to the MODU via workboats. There is the potential to lose pieces of drill pipe during transfer operations or when “tripping pipe” in and out of the wellbore. Similar to the impacts noted under “Routine Activities” (e.g., pipeline movement and anchor damage), if lost drill pipe or debris were to fall onto an unknown archaeological resource, the resulting disturbance could destroy fragile materials, such as the hull remains and artifacts, and could disturb the site’s context and associated artifact assemblage. Additionally, lost material could result in the masking of actual archaeological resources or the introduction of false targets that could be mistaken in the remote-sensing geophysical record as historic resources. Impacts to archaeological resources from the loss of debris from a vessel or structure range from **negligible** to **major**.

Cumulative Impacts

In addition to the cumulative impacts of the OCS Program whose impacts are the same as described above, the cumulative scenario activities that could potentially impact archaeological resources include (1) oil spill and response, (2) State oil and gas programs, (3) sand extraction, (4) artificial reef development, (5) fairway and anchorage use and maintenance, (6) commercial bottom trawling (fishing), (7) treasure hunting/looting, (8) sport diving, (9) research and monitoring, and (10) hurricanes. The chance that a localized cumulative scenario activity could impact any particular archaeological resource on the OCS is negligible (archaeological resources cannot be considered as a population); therefore, if a cumulative scenario activity were to impact an archaeological resource, it would constitute the primary impact to that resource. Consequently, this analysis identifies the range of potential impact levels to a particular archaeological site from specific cumulative scenario activities if the impact were to occur.

OCS Oil- and Gas-Related Impacts

Oil Spill and Response

Oil spills in the GOM range from sub-seafloor contained production casing leaks to environmentally damaging well blowouts to shipping accidents. There have been seven significant oil spills in the GOM, including accidents in State and Mexican waters: *Ixtoc* (1979); Burmah Agate (1979); *Alvenus* (1984); *Megaborg* (1990); *Ocean 255* (1993); the aggregation of the effects of Hurricane Katrina (2005) (USDOC, NOAA, n.d.); and *Deepwater Horizon*/*Macondo* (2010). Activities associated with oil spills that may affect archaeological resources include anchoring of response vessels, drilling relief wells, the application of chemical dispersant, and the distribution of oil. Due to the emergency nature of oil spills, an archaeological survey is not always feasible before related activities take place. The impacts to archaeological sites from oil spills and associated activities **have not been quantified**.

Non-OCS Oil- and Gas-Related Impacts

State Oil and Gas Programs

State oil and gas program wells, structures, and pipelines in State waters are not under the jurisdiction of BOEM with respect to the archaeological resource protection requirements of the NHPA. Under the NHPA, other Federal agencies (such as the COE) that issue permits associated with pipelines in State waters are responsible for taking into consideration the effects of agency-permitted actions on archaeological resources. Therefore, the impacts that might occur to archaeological resources by pipeline construction originating from OCS oil- and gas-related activity within State waters should be mitigated under the requirements of the NHPA, and the same archaeological surveys for planned pipelines that lead into a landfall or a tie-in to a pipeline in State waters are required. Impacts to archaeological resources from State oil and gas program activities range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

Sand Extraction

Impacts to archaeological resources as a result of sand extraction activities include direct contact of a resource by the dredge head or anchors, redepositing of artifacts into the dredge disposal area, sediment transport and/or seabed destabilization around wrecks adjacent to the dredge pit, and direct contact of terrestrial or submerged resources in the dredge disposal area. The OCS sand resources have been identified off the coasts of Mississippi, Louisiana, and Texas in the following OCS areas: High Island; West Cameron; Vermilion; South Marsh Island; Eugene Island; Ship Shoal; South Pelto; West Delta; Chandeleur; and Main Pass. An archaeological review is required in advance of sand extraction activities. A current/ongoing BOEM study is quantifying the impacts to archaeological resources from sand extraction to incorporate into future sand extraction permit application review. Impacts to archaeological resources from sand extraction activities range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

Artificial Reef Development

Artificial reef areas are designated by the COE for the disposal of decommissioned vessels, platform jackets, and other materials in order to promote and enhance biological systems. Potential impacts to archaeological resources include direct contact of the resource by the reefed material. Reefing areas are typically developed in <600 ft (183 m) of water; however, two fixed platform jackets have been reefed in place offshore Louisiana in water depths 620 and 650 ft (189 and 198 m). Nine additional fixed platforms that range in water depths of 650-1,350 ft (198-411 m) are currently being considered for reefing in place by State-managed artificial reef programs (Texas, Louisiana, and Alabama). In addition to the State-managed programs, there are old artificial reefs and disposal areas that are not included in a State-managed program; these areas have not been quantified. The COE does not consistently require archaeological survey in advance of reef permitting. Most sonar and multibeam surveys by the State artificial reef programs are conducted after artificial reef deployments to verify placement. The area of potential effect of reefing activities also includes the anchor radius of tow and placement barges, which often extends outside of the reefing area. Impacts to archaeological resources from artificial reef development activities range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

Fairway and Anchorage Area Use and Maintenance

Fairways and anchorage areas are established to provide safe approaches to major ports in the GOM. Fairways and anchorage areas regulate allowable oil and gas industry and other activities within them, such as installation spacing, anchor and cable depth, pipeline burial, etc. Proper aids to navigation must be affixed to the seafloor. Fairways may be dredged to maintain safe water depths for navigation. An archaeological survey may not have been required in advance of fairway and anchorage area designation. Impacts to archaeological resources from fairway and anchorage area use and maintenance range from **negligible** to **major** if no mitigation is imposed, is not followed, or a site is unidentified prior to the activity.

Commercial Bottom Trawling (Fishing)

Commercial bottom trawling may make use of nets, rakes, or dredges to harvest commercially important benthic organisms (e.g., shrimp, oysters, etc.). An archaeological survey and review has never been required in advance of the development of a commercial bottom trawling fishery in the GOM. Geophysical and diver inspection surveys have shown that trawling apparatuses have negligible to fully destructive impacts to submerged archaeological resources depending on the resources composition and integrity (Steinmetz, 2010). For example, a shrimp net may snag and remain attached to the hull of a 20th-century steel vessel, while a shellfish rake or dredge may obliterate a 19th-century wooden sailing vessel leaving little to no trace of it on the seafloor. Impacts to archaeological resources from commercial bottom trawling range from **negligible** to **major**. There is no archaeological mitigation applied to commercial fishing.

Treasure Hunting/Looting

Treasure hunting involves the intentional, nonscientific, usually commercial exploitation of archaeological resources for profit. Often, specific shipwrecks are targeted for salvage. It is unknown how many archaeological sites have been salvaged by treasure hunters in the GOM. Two recent examples of commercial treasure hunting in the Gulf of Mexico OCS are the salvage of the *New York* (Gearhart et al., 2011; Irion and Ball, 2001; Bowers, 2008) and *El Cazador* (www.elcazador.com). Looting involves the planned or opportunistic removal of artifacts or features from an archaeological site. It may range from the collection of mobile surface artifacts to the complete destruction and/or removal of the vessel. An example of the looting of an archaeological site was the attempted collection and destruction of artifacts on the shipwreck known as the Mardi Gras wreck during an remotely operated vehicle pipeline inspection (Ford et al., 2008). Impacts to archaeological resources from commercial treasure hunting/looting range from **moderate** to **major**. There is no archaeological mitigation applied to treasure hunting/looting.

Sport Diving

Sport diving includes private or commercial recreational diving on archaeological sites for pleasure and education. Negative impacts to archaeological sites from sport diving may result from boat anchor and mooring damage, disturbance to and removal (looting/souvenir hunting) of artifacts, intentional and unintentional physical contact (body or equipment), and the interaction of exhaled air bubbles with the site (Edney, 2006). Sport divers may, however, have a beneficial impact to archaeological sites by monitoring sites, encouraging fellow divers to protect sites, and by reporting any observed adverse impacts to the appropriate State or Federal agency. Impacts to archaeological resources from sport diving range from **beneficial** to **major**. There is no archaeological mitigation applied to sport diving.

Research and Monitoring

Research and monitoring activities in the GOM are not quantified; however, it is possible to discuss a potential range of impacts to archaeological sites from them. Negative impacts to archaeological sites may result from seafloor disturbance such as specimen collection by bottom trawling or geotechnical core sampling. Beneficial impacts may result from the visual identification and/or inspection of sites during ancillary scientific activities or the collection of environmental data that may be used to evaluate the condition of archaeological sites. Impacts to archaeological resources from research and monitoring range from **beneficial** to **major**. Archaeological mitigation may be recommended for research and monitoring if BOEM is (1) aware of the project and (2) is provided the opportunity to comment on the research design.

Hurricanes

Hurricanes and tropical storms are normal occurrences in the GOM and along the Gulf Coast. Shipwrecks in shallow waters are exposed to storm-induced wave action and a greatly intensified, longshore current during tropical storms (Clausen and Arnold, 1975). Under such conditions, there is a potential for hull components and artifacts (e.g., ceramics and glass) to be dispersed. Overall, a significant loss of data from sites has probably occurred, and would continue to occur, in the northern Gulf from the impacts of tropical storms. Impacts to archaeological resources from hurricanes range from **negligible** to **major**. BOEM does not apply any archaeological mitigation in advance of potential hurricane activity.

Incomplete or Unavailable Information

There is incomplete or unavailable information regarding the long-term impacts of oil and/or dispersant contamination on, and the location of, archaeological resources in the GOM. As discussed above, there are currently no published studies on the long-term impacts to archaeological resources exposed to oil or dispersant contamination. However, considering the low probability of an accidental oil spill contacting an archaeological site as a result of a proposed action, BOEM has determined that the information is not essential to a reasoned choice among alternatives.

Additionally, the locations of all archaeological resources in the GOM cannot be determined because the overall costs of obtaining that information through survey of the entire GOM are exorbitant. This incomplete information may be relevant to adverse impacts because the locations and integrity of many archaeological resources remain unknown. Nevertheless, this incomplete information is not likely to be available within the timeline contemplated in the NEPA analysis of this Multisale EIS. It would take several years before data confirming the presence (or lack thereof) of archaeological resources, and the status of each, could be investigated, analyzed, and compiled. Archaeological sites within the GOM have the potential to be buried, embedded in, or laying on the seafloor. The seafloor is comprised of highly variable bathymetric and geophysical regimes, which differentially affect the ease and ability to identify, ground truth, and evaluate archaeological sites. This fact, combined with the scope of the acreage within the GOM, results in the aforementioned exorbitant costs and time factors.

BOEM used existing information and reasonably accepted scientific theories on archaeological site potential in the Gulf of Mexico to extrapolate from available information in completing the relevant analysis. In addition, future site-specific, remote-sensing surveys of the seafloor, where required, help establish the presence of potential resources (NTL 2005-G07, "Archaeological Resource Surveys and Reports"). The results of these surveys are reviewed in tandem with credible scientific evidence from previously identified sites, regional sedimentology, and physical oceanography that is relevant to evaluating the adverse impacts on resources that are a part of the human environment. The survey data are analyzed by industry and BOEM's archaeologists prior to the authorization of any new or significant bottom-disturbing impacts and, if necessary, avoidance of potential archaeological resources is prescribed. Archaeological surveys are expected to be effective in identifying resources to allow for mitigation application and protection of the resource during OCS oil- and gas-related activities. A proposed action is not expected to have a reasonably foreseeable significant impact because BOEM's evaluation of such impacts is based upon pre-disturbance and site-specific surveys, the results of which BOEM uses to require substantial avoidance of any potential resource that could be affected by the proposed activity. Therefore, BOEM has determined that the gaps in information on the presence of or status of archaeological resources is not essential to a reasoned choice among alternatives at the lease sale stage.

4.13.2.1 Alternatives A, B, C, and D

Regardless of which planning area a proposed lease sale is held, the greatest potential impact to an archaeological resource as a result of a proposed action under any of the action alternatives is site specific and would result from direct contact between an offshore activity (i.e., platform installation, drilling rig emplacement, decommissioning, or dredging or pipeline project) and a site. During postlease activities, each permitted action would be assessed for site-specific potential impacts during the permit application process. Archaeological surveys, where required prior to an operator beginning OCS oil- and gas-related activities on a lease, are expected to be effective at identifying possible archaeological sites. The technical requirements of the archaeological resource reports are detailed in NTL 2005-G07, "Archaeological Resource Surveys and Reports." Under 30 CFR § 250.194(c) and 30 CFR § 250.1010(c), lessees are required to immediately notify BOEM's and BSEE's Regional Directors of the discovery of any potential archaeological resources.

Offshore oil- and gas-related activities resulting from a proposed action could impact an archaeological resource because of incomplete knowledge on the location of these sites in the Gulf of Mexico. The risk of contact to archaeological resources is greater in instances where archaeological survey data are unavailable. Such an event could result in the disturbance or destruction of important archaeological information. Archaeological surveys would provide the necessary information to develop mitigation strategies that would reduce the potential for impacts on archaeological resources.

Accidental events producing oil spills may threaten archaeological resources along the Gulf Coast. Should a spill contact an archaeological site, damage might include direct impact from oil-spill cleanup equipment, contamination of materials, and/or looting. A major effect from an oil-spill impact would be contamination of a historic coastal site, such as a historic fort or lighthouse. It is expected that any spill cleanup operations would be considered a Federal action for the purposes of

Section 106 of the NHPA and would be conducted in such a way as to minimize to the extent possible impacts to archaeological resources. Recent research suggests the impact of direct contact of oil on historic properties may be long term and not easily reversible without risking damage to fragile historic materials (Chin and Church, 2010).

The potential for spills is low, the impacts of most noncatastrophic spills would generally be localized, and the cleanup efforts would be regulated. A proposed action, therefore, is not expected to result in impacts to archaeological sites; however, should such impacts occur, unique or substantial archaeological information could be lost and this impact could be irreversible.

There is also the potential for debris from vessels and offshore structures to be lost on the OCS. Debris resulting from accidental events could lead to impacts similar to those expected from routine impacts such as damage through contact with historic archaeological sites and/or the masking of archaeological resources during geophysical surveys.

There is no acceptable threshold of negative cumulative impacts to archaeological sites. A proposed action, including the drilling of wells and installation of platforms, installation of pipelines, anchoring, removal of platforms and other structures installed on the seafloor, and site clearance activities without archaeological review and mitigation may result in **major** impacts to archaeological sites. Identification, evaluation, and avoidance or mitigation of archaeological resources is expected to result in **negligible** long-term cumulative impacts to archeological resources as described in the previous section; however, if an archaeological site were to be impacted, impacts may range from **negligible** to **major**.

4.13.2.2 Alternative E—No Action

If selected, Alternative E, the No Action Alternative, would result in BOEM not undertaking a proposed lease sale. Therefore, the impact-producing factors mentioned above would not take place, and any impact that these actions could cause would not occur. As a result, whatever archaeological resources may be present would not be affected in any way if the No Action Alternative is selected.

4.14 Human Resources and Land Use

4.14.1 Land Use and Coastal Infrastructure

For land use and coastal infrastructure, a proposed action would involve all of the Gulf Coast States: Texas; Louisiana; Mississippi; Alabama; and Florida. Particular emphasis is placed on the 133 counties and parishes that constitute the 23 BOEM-identified EIAs and are located in the coastal areas of all five states. This geographic area is broadly diverse in types of land use and distribution of coastal infrastructure related to OCS oil- and gas-related activities. Some counties and parishes are more closely connected to the offshore oil and gas industry than others, such as Harris County, Texas, and Lafourche Parish, Louisiana. **Figures 3-10, 3-11, and 3-12** illustrate the analysis area's key infrastructure.

Impacts to land use and coastal infrastructure may be positive as well as negative. For example, increased economic demand for services provided by infrastructure facilities would lead to more hiring, and this additional employment would further the positive economic trend as new workers spend their wages in the community. The impacts of each impact-producing factor are summarized in **Table 4-26** using the impact-level definitions below. Negative and positive impacts are measured on that scale.

Impact-Level Definitions

- **Negligible** – Little or no measureable impact.
- **Minor** – Small-scale measurable impact, temporary in duration and geographically small area (less than county/parish level).
- **Moderate** – Medium-scale measurable impact and may last from a few weeks to 1 year and geographically may affect multiple counties/parishes.
- **Major** – Large-scale measurable or potentially unmeasurable impact, long-lasting (1 year to many years), and may occur over a geographically large regional area.

A current snapshot of land use and coastal infrastructure in the GOM reveals a diverse social and economic landscape, with the oil and gas industry playing a substantially larger role in some states (i.e., Texas and Louisiana) than in the rest of the GOM. The oil and gas industry has developed across the region over decades and is intimately intertwined with its socioeconomic structure. This complex structure involves both onshore and offshore (State and Federal OCS) exploration, development, and production activities, complicating the environmental impact analysis because it is very difficult, if not impossible, to separate the impacts of Federal OCS oil- and gas-related activities from those of oil and gas activities in State waters and onshore.

Oil and gas exploration, production, and development activities on the OCS are supported by an expansive onshore network of coastal infrastructure that includes large and small companies providing a wealth of services from construction facilities, service bases, and waste disposal facilities to crew, supply, and product transportation, as well as processing facilities. A description of the affected environment covers land use in the area and different infrastructure categories that support thousands of jobs. These jobs represent direct, indirect, and induced economic impacts that ripple through the Gulf Coast economy. As a long-standing part of the regional economy that developed over the past several decades, the coastal infrastructure network is quite mature in the Gulf of Mexico region. The affected environment is described in the following chapter and a discussion of the impacts of routine activities, accidental events, and cumulative impacts as they relate to land use and coastal infrastructure follows.

Table 4-26. Land Use and Coastal Infrastructure Impact-Producing Factors.

Land Use and Coastal Infrastructure Impact-Producing Factors	Magnitude of Potential Impact*				
	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Routine Activities					
Changes in the Level of OCS Exploration, Development, and Production Activities	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible
Expansions of Existing Infrastructure	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
New Infrastructure Facility Construction	Minor to Moderate	Minor to Moderate	Minor to Moderate	Minor to Moderate	Negligible
Onshore Waste Disposal	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Navigation Channel Maintenance Dredging	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
Accidental Events					
Oil Spills (coastal and offshore)	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible
Chemical/Drilling-Fluid Spills	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible
Spill Response	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible
Vessel Collisions	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible to Moderate	Negligible
Cumulative Impacts					
OCS Oil- and Gas-Related Factors	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major	Negligible
Non-OCS Oil- and Gas-Related Factors	Negligible to Major	Negligible to Major	Negligible to Major	Negligible to Major	Negligible

* The magnitude of the impact depends on the scale and details of the event; therefore, the range for magnitude is generally broad (negligible to moderate or negligible to major).

4.14.1.1 Description of the Affected Environment

Socioeconomic Analysis Area

Along the Gulf Coast, from the southern tip of Cameron County, Texas, to the Florida Keys, 23 BOEM-defined EIAs are identified for the Gulf of Mexico region. The counties and parishes that form the EIAs are listed and the EIAs are visually illustrated on **Figure 4-27**. The EIAs geographically link together not only counties and parishes immediately adjacent to the GOM but also those tied to coastal counties and parishes as parts of functional economic areas. An analysis that encompasses where people live as well as where they work permits a more meaningful assessment of the impact of offshore oil and gas activities. The OCS oil- and gas-related activities draw on existing infrastructural, economic, and labor capacity from across the GOM region. BOEM's analysis considers the potential impacts in all 23 EIAs regardless of where a proposed action may take place.

Land Use

The coastal zone of the GOM is not a physically, culturally, or economically homogenous unit (Gramling, 1984). The counties and parishes along the Gulf Coast represent some of the most valuable coastline in the U.S. and cover approximately 1,631 mi (2,625 km). Not only does it include miles of recreational beaches and 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.

The Gulf coastal plain of Texas makes up most of eastern and southern Texas and constitutes more than one-third of the State. Near the coast, this region is mostly flat and low-lying. It rises gradually to 1,000 ft (300 m) farther inland, where the land becomes more rolling. Belts of low hills occur across 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 GOM is 367 mi (591 km). 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 3,359 mi (5,406 km) long. The region is made up of farmland (i.e., cotton, rice, and citrus fruit), forests, cattle ranches, major cities of commerce (e.g., Houston) and education, tourist locales (e.g., 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 (i.e., 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 (Petterson et al., 2008).

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 (Petterson et al., 2008). Historically, Terrebonne, Plaquemines, 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 GOM, is a major onshore staging area for OCS oil- and gas-related activities in the GOM, and it is the headquarters of the Louisiana Offshore Oil Port (LOOP), which offloads 10 percent of U.S. foreign oil imports and transports that oil to half of the Nation's refining capacity and services over 90 percent of deepwater GOM production (The Greater Lafourche Port Commission, 2015). The LOOP has received and transferred over 11 billion barrels of crude oil since its inception (LOOP LLC, 2015).

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 one-third (Jackson County) is industrial—oil refining and shipbuilding. Upland portions of the three coastal counties—Hancock, Harrison, and Jackson—are timberlands (Petterson et al., 2008). Jackson County has a strong industrial base and designated industrial parks. Pascagoula, in Jackson County, is home to Ingalls Shipbuilding, an 800-ac (324-ha) shipyard that employs 11,000 people, and the Chevron Pascagoula Refinery located in the Bayou Casotte Industrial Park (Ingalls Shipbuilding, 2015; Chevron, 2015). The Port of Pascagoula is one of the top 20 ports in the U.S. by foreign cargo volume, handling forest products, chemicals, crude oil, phosphate rock, and aggregate. The port includes the Pascagoula River Harbor and the Bayou Casotte Harbor (Port of Pascagoula, 2015). Now in a state of expansion after recovering from Hurricane Katrina damages, the Port of Gulfport houses some major OCS oil- and gas-related companies (i.e., shipbuilding, shipyards, pipelaying, and offshore support services) in addition to food importers, casino operations, university research activities, and renewable energy interests (Port of Gulfport, 2016).

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 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. The area's second port, Mobile Middle Bay Port, is a former Naval Station. Major manufacturers in Mobile include three paper mills, a German-owned chemical plant, and two large shipbuilding and repair yards (Petterson et al., 2008). Mobile County has a strong industrial base and designated industrial parks, especially at Theodore Industrial Park and Canal and the Alabama State Docks. In addition, Bayou La Batre in south Mobile County has many shipbuilding firms. Theodore, in Mobile County, has boat and helicopter facilities, and onshore supply bases to support drilling and production (Dismukes, 2011).

The GOM coastal area of Florida includes bays, estuaries, wetlands, an extensive barrier island system, and increasing concentrations of human settlement. This area ranges from heavily urbanized areas, such as Pensacola in Escambia County and Panama City in Bay County with shipping ports and Naval air bases, to scarcely populated areas along the coastal rim, such as the towns of Port St. Joe, Apalachicola, and Carrabelle in Gulf and Franklin Counties. The Florida Panhandle area has military, tourism, fishing, and ports as major components of the economy. The military has had a substantial presence in the Florida Panhandle since World War II. The four main military installations are Pensacola Naval Air Station, Eglin Air Force Base (Okaloosa County), Tyndall Air Force Base, and the Coastal Systems Station (Bay County). The three air bases use the northern GOM as a weapon-testing and training range. These bases were largely untouched by the downsizing of the military in the 1990's and remain an important part of the Florida Panhandle economy. Tourism and recreation are extremely important to the area, along with both commercial and recreational fishing activities. The development of the Florida Panhandle as a major tourist area began in the mid-1930's and grew rapidly after World War II, becoming what is now a key industry in the Florida Panhandle. "Sugar-white" beaches, fishing, other water-based activities, and natural habitats are key parts of the tourist attraction. In the Florida Panhandle, the commercial fishing industry employs several hundred people, who land millions of pounds of fish and shellfish annually (Petterson et al., 2008). Three major deepwater ports are Port of Pensacola, Port Panama City, and Port Tampa Bay. The Port of Pensacola is turning away from bulk container cargo and focusing on expanding operations to cater to the oil and gas industry, and new projects such as deep-sea pipe manufacturing have begun development (Offshore Inland, 2014; DeepFlex, 2014; *Pensacola News Journal*, 2014). Port Panama City served as an onshore support base for exploratory drilling in the GOM during the 1980's before drilling was banned in most of the EPA. Since that time the Port has continued diversifying and has initiated the development of the Port Panama City Intermodal Distribution Center to attract more businesses to the area. Most of the Port handles bulk container cargo, seafood products, and some petroleum products (Dehart, 2013; World Port Source, 2015).

The U.S. Dept. of Agriculture's Economic Research Service classifies counties (includes parishes) into economic types that indicate primary land-use patterns. According to the most recent statistics, most notably only 7 of the 133 counties in the analysis area are classified as farming dependent. Ten counties are defined as mining dependent, suggesting the importance of oil and gas development to these local economies. Manufacturing dependence is noted for another 26 counties. Local school districts and public facilities, such as hospitals and prisons, are often the largest employers in sparsely populated rural areas. Thus, it is not surprising that 19 non-metro counties and 13 metropolitan counties are classified as government employment centers. Another 21 counties have economies tied to service employment while 37 counties are considered nonspecialized. The Economic Research Service also classifies counties in terms of their status as a retirement destination, and of the 133 counties/parishes, 44 are considered major retirement destinations (U.S. Dept. of Agriculture, Economic Research Service, 2008). The varied land-use patterns are displayed in **Figure 4-27**.

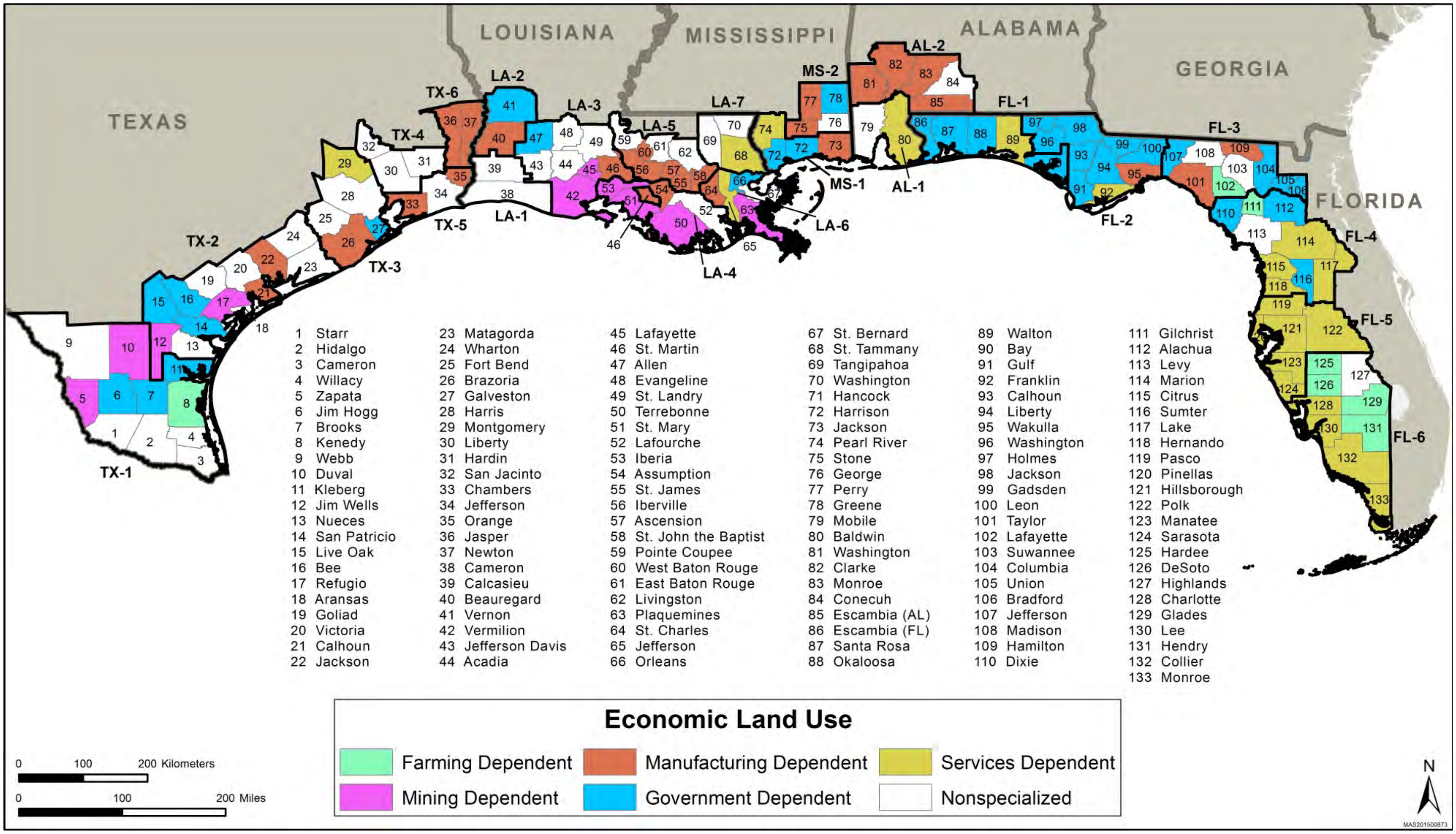

Figure 4-27. Economic Land Use Patterns.

Coastal Infrastructure

The onshore coastal infrastructure is extensive, covers a wide-ranging area, supports development, and consists of thousands of large and small companies. These companies cover every facet of coastal and offshore industry activity, but for analysis purposes, these infrastructure types are organized into the following categories: construction facilities; support facilities; transportation; and processing facilities. More extensive information on OCS oil- and gas-related coastal infrastructure can be found in **Chapter 3.1.7**.

Construction Facilities

The major players among construction facilities in the coastal GOM include platform fabrication yards (**Chapter 3.1.7.1.1**), shipbuilding and shipyards (**Chapter 3.1.7.1.2**), and pipe-coating plants and yards (**Chapter 3.1.7.1.3**). These facilities' service involves both onshore and offshore (State and Federal OCS) oil and gas exploration, development, and production activities. Shipbuilding and shipyards may also be servicing the commercial and recreational fishing industry or the military. This can complicate impact analysis because of the difficulty inherent in trying to separate the impacts of OCS oil- and gas-related activities from non-OCS oil- and gas-related activities, given that they utilize the same critical coastal infrastructure.

Support Facilities

The major support facilities in the coastal GOM include service bases and ports, waste disposal facilities, and natural gas storage facilities. State and Federal (both onshore and offshore) oil and gas exploration, development, and production activities utilize the same critical coastal support infrastructure. Other types of support sectors to the oil and gas industry that may have coastal facilities can include drilling contractors, geological and geophysical contractors, underwater contractors (divers and remotely operated vehicle equipment). Ports and service bases are also used for international and domestic import and export activities, and service other industries including commercial and recreational fishing, cruise ship terminals, and research vessels. Maritime military operations generally have their own ports and bases along the coast, but they may use community waste disposal facilities.

Transportation

The major forms of crew, supply, and product transportation include the following: heliports; coastal pipelines/pipeline landfalls/pipeline shore facilities; and coastal barging/barge terminals. These transportation services can involve both onshore and offshore (State and Federal OCS) exploration, development, and production activities. This complicates impact analysis because of the difficulty inherent in trying to separate the impacts of OCS oil- and gas-related activities from non-OCS oil- and gas-related activities, given that they utilize the same coastal infrastructure. Critical to the success of service bases and port facilities are the railways and major interstates that traverse the areas along the inner margin of the coastal zone. There are nine interstate highways that access the regional area; however, there are numerous other highways into and across the analysis area. The most critical is Louisiana Highway 1 (LA Hwy 1) that provides the only link between Port Fourchon, Louisiana, and the rest of the Nation.

Processing Facilities

The major forms of processing facilities in the coastal GOM include gas processing plants, LNG terminals, refineries, and petrochemical plants. Basic chemical production from petrochemical plants is concentrated along the Gulf Coast, where petroleum and natural gas feedstock are available from refineries. Of the top 10 production complexes in the world, 5 are located in Texas and 1 is located in Louisiana. These facilities can process onshore and offshore (State and Federal OCS) production and foreign imported production. This complicates impact analysis because of the difficulty inherent in trying to separate the impacts of OCS oil- and gas-related activities from non-OCS oil- and gas-related activities, given that they utilize the same critical coastal infrastructure for downstream processing of their products.

4.14.1.2 Environmental Consequences

Analysis and discussion of impact-producing factors from routine activities, accidental events (non-catastrophic), and cumulative activities follow below. For a detailed analysis of a high-impact, low-probability catastrophic oil spill, which is not reasonably foreseeable as a result of a proposed action, refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

Routine Activities

Routine activities of the oil and gas industry result in various impact-producing factors that could affect land use and coastal infrastructure, including the following: fluctuations in the level of OCS exploration, development, and production activities; expansions of existing facilities; construction of new facilities; onshore disposal of OCS waste; and maintenance dredging of existing navigation channels. These routine activities impact, to some extent, each of the infrastructure types discussed in the “Affected Environment” section above, including construction facilities, support services, transportation modes for people and products, and processing facilities. However, the impacts of these factors on land use and coastal infrastructure are mainly **negligible** to **minor** because oil- and gas-related coastal infrastructure is a mature and extensive system, resulting from long-term industry trends, and it is not subject to rapid fluctuations. Routine activities related to a proposed action are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks with existing infrastructure and facilities that have sufficient capacity to accommodate future growth. For this reason, land use conflicts are not likely to occur.

Fluctuations in OCS exploration, development, and production activity levels can impact land use and coastal infrastructure because higher activity levels increase demand for services, which can affect land use if a facility needs to acquire additional land for expansion to meet the demand, and it would affect infrastructure facilities by potentially increasing profits and the need to hire additional employees. This would be a positive impact and could cause localized expansion of economies (i.e., increased demand for services, consumer spending, and indirectly, new employment), resulting in localized land-use changes including commercial and residential development and growth. If activity levels decrease, then the opposite impact occurs. Decreases in demand for services could cause a negative ripple impact through the local (and possibly regional) economies. The OCS activity levels fluctuate based on changes in demand, commodity prices, and offshore service vessel day rates (for shipyards, shipbuilding, and transportation services). When activity levels increase, commuter and truck traffic increase, producing additional wear and tear on the transportation infrastructure. For example, LA Hwy 1 is the only road providing critical access to Port Fourchon, the largest OCS oil- and gas-related service base, which supports 90 percent of all OCS deepwater activities. Whether positive or negative, the impacts described above range from **negligible** to **moderate** depending on the specific situation, type of infrastructure facility being considered, and its location. For example, a small-scale expansion of a waste disposal facility that is already located in a remote area would be a **negligible** impact. If the facility was located in a more populated area, it may cause temporary disruption to traffic from construction activities and thus be a **minor** impact. If it was a larger-scale expansion and the facility was located in a more populated area, then the impact would be **moderate** because the scale of the project would make the disruption last anywhere from a few weeks to a year.

Land use and coastal infrastructure may also be affected by expansions of current facilities that result from oil and gas industry-generated service demand increases. Because of the environmental and regulatory difficulties inherent in permitting and building new facilities, most companies would opt to expand their existing facilities (i.e., fabrication yards, shipyards, pipe-coating facilities, service bases, refineries, gas processing plants, and waste disposal facilities). Expansions of existing facilities generate a positive momentum with increased capabilities leading to increased profitability. Whether positive or negative, the impacts described above range from facility expansions ranges from **minor** to **moderate** depending on the specific situation. For example, a small-scale expansion of a refinery would be a **minor** impact because of the small size of the project, the temporary disruptions caused by increased constructions traffic and the geographically small area affected. If the refinery was located in a more populated area and the project was larger in scale, causing disruptions because of construction activities that last up to one year, then the impact would be **moderate.** BOEM’s scenario projections forecast most increases in demand to be met by expansions at currently existing facilities (Dismukes, official communication, 2015).

Much less common in the GOM, the construction of new facilities requires substantial capital investment and assurances of future service demand to make this option attractive to investors. BOEM’s scenario projections call for possibly 0-1 new gas processing plant and 0-1 new pipeline landfall during the 50-year analysis period for a proposed lease sale (Dismukes, official communication, 2015). If either were to occur, it may negatively impact land use because of potential space-use conflicts, and some gas processing facilities also could be negatively impacted because it may become necessary to increase efforts to maintain competitiveness. In the rare instance of new facility construction, the impacts would range from **minor** to **moderate** depending on the nature and location of the project(s).

The OCS oil- and gas-related waste disposal to onshore facilities is an impact-producing factor that could affect onshore waste disposal facilities and land use if a new facility needs to be constructed to meet the level of offshore wastes coming to shore. **Chapter 3.1.5.3** discusses OCS oil- and gas-related waste disposal and outlines BOEM's scenario analysis, which concluded that no new solid-waste facilities would be built as a result of a single lease sale. Existing solid-waste disposal infrastructure is adequate to support both existing and projected offshore oil and gas drilling and production needs. The industry trend is toward innovative methods to handle wastes to reduce the potential for environmental impacts, e.g., hydrocarbon recovery/recycling programs, slurry fracture injection, treating wastes for reuse as road base or levee fill, and segregating waste streams to reduce treatment time and improve oil recovery. The volume of OCS waste generated is closely correlated with the level of offshore drilling and production activity (Dismukes et al., 2007, Dismukes, 2011, Dismukes, official communication, 2015). The impact of fluctuations in offshore waste disposal would range from **negligible** to **minor** and would not be expected to result in more extensive impacts because existing spare capacity of current facilities is sufficient to meet demand.

Maintenance dredging of existing navigation channels is essential for proper water depths to allow all shipping to move safely through the waterways to ports, services bases, and terminal facilities. Several million cubic yards of sand, gravel, and silt are dredged from waterways and harbors every year. **Chapter 3.1.4.6** discusses scenario projections for navigation channels along the Gulf Coast. Much of the traffic navigating these channels is unrelated to OCS oil- and gas-related activity, and the current system of navigation channels in the northern GOM is projected to be adequate for accommodating traffic generated by a proposed lease sale. Therefore, no new navigation channels are expected to be created as a result of a proposed lease sale (Dismukes, 2011; Dismukes, official communication, 2015). **Chapter 4.3.2** provides a discussion of wetlands and the impacts of navigation channel dredging. Impacts to land use and coastal infrastructure as a result of maintenance dredging are expected to range from **negligible** to **minor** depending on the location of dredging projects.

Routine activities are not expected to produce any major impacts to land use and coastal infrastructure because current supporting oil and gas infrastructure is mature and not subject to rapid changes. As OCS oil- and gas-related activity levels fluctuate, the demand for services provided by coastal infrastructure facilities would fluctuate. If necessary, increases in demand would be met with facility expansions. Regarding new construction, BOEM's scenario projections call for up to one new gas processing facility, up to one new pipeline landfall over the 50-year life of a proposed lease sale, and no new waste disposal facilities. The impacts on land use and coastal infrastructure would be limited, would occur on lands designated for such purposes, and would be **negligible** to **moderate** because the projected addition to infrastructure is so small. Maintenance dredging of navigation channels as a result of a proposed lease sale is expected to produce **negligible** to **minor** impacts to land use and coastal infrastructure (Dismukes, official communication, 2015).

Accidental Events

Impact-producing factors associated with accidental events that may affect land use and coastal infrastructure include coastal and offshore oil spills, chemical/drilling fluid spills, spill-response activities, and vessel collisions. Accidental events associated with a proposed action would occur at differing levels of severity, based in part on the location and size of event. Coastal and offshore oil-spill events discussed in this section are noncatastrophic in nature, smaller in size, occur more frequently, and must be distinguished from low-probability catastrophic oil spills such as the *Deepwater Horizon* blowout, oil spill, and response. **Chapter 3.2.1** provides a detailed discussion of oil spills that have occurred and their frequency. A complete analysis of a high-impact, low-probability catastrophic oil spill is provided in the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

Coastal and offshore oil spills may be associated with OCS exploration, production, or transportation activities that result from a proposed lease sale. Detailed risk analysis of offshore oil spills ≥1,000 bbl, <1,000 bbl, and coastal spills associated with a proposed lease sale is provided in **Chapters 3.2.1.3, 3.2.1.4, and 3.2.1.5**. Because oil spilled in the offshore areas normally volatilizes and is dispersed by currents, it has a low probability of contacting coastal areas. Oil spills in coastal and inland waters, such as spills resulting from the operations of offshore supply vessels, pipelines, barges, tanker ships, and ports, are more likely to affect BOEM-recognized coastal infrastructure categories. For example, if waterways are closed to traffic, this may result in impacts to upstream and downstream business interests as it impedes the flow of commerce. Other potential impacts could include damages to private and public lands, personal injury, damages to collateral property (moveable property such as vehicles and boats), and economic damages from the disruption of business. The impacts to land use and coastal infrastructure from coastal and offshore oil spills could range from **minor** to **major** depending on the size and location of the spill and whether it is catastrophic or not. More specifically, the intensity of the impact would be experienced inconsistently among businesses and residents, meaning it would be worse for some businesses/residents than others. For example, those who have alternative means of transporting their goods would not feel the impact as harshly as those who are most dependent on the waterway for transport. The mean number and sizes of spills estimated to occur in OCS offshore waters from an accident related to rig/platform and pipeline activities supporting a proposed action over a 50-year period are presented in **Table 3-17**.

Chemical/drilling-fluid spills may affect land use and coastal infrastructure and could be associated with exploration, production, or transportation activities that result from a proposed lease sale. **Chapter 3.2.6** provides a detailed discussion of chemical and drilling-fluid spills. Each year, between 5 and 15 chemical spills are expected to occur; most of these are ≤50 bbl in size. Large spills are much less frequent. Even though additional production chemicals are needed in deepwater operations where hydrate formation is a possibility, spill volumes are expected to remain stable because of advances in subsea processing. Overall, the impact of chemical and drilling-fluid spills is expected to be **negligible** to **moderate** depending on the location, size, and duration of the event. For example, potential impacts could include damages to private and public lands, personal injury, damages to collateral property (moveable property such as vehicles and boats), and economic damages from the disruption of business. If a spill is very small (not measurable) in size, located in a remote area, and dissipates quickly, its impact would be **negligible**. If a spill is measurable, occurs in a less remote area, and lasts a few days to a month, then its impact would be **minor**. If a spill occurs in a highly populated area, is larger in quantity, and the response and cleanup last over a month and up to a year with either waterborne commerce affected and/or land transportation affected, then the impact would be **moderate**.

While not an accidental event specifically, spill response results from an accidental spill and is included here accordingly. Spill-response activities may affect land use and coastal infrastructure because of the requisite needs for staging operations, equipment handling, and waste disposal. Depending on where an accidental event occurs, it is expected that the oil-spill response equipment needed to respond to an offshore spill as a result of a proposed lease could be called out from one or more of the following oil-spill equipment base locations: Aransas Pass, Baytown, Corpus Christi, Galveston, Houston, Ingleside, Pasadena, and Port Arthur, Texas; Baton Rouge, Belle Chasse, Fort Jackson, Franklin, Grand Isle, Harvey, Houma, Lake Charles, New Iberia, Port Fourchon, and Sulphur, Louisiana; Kiln and Pascagoula, Mississippi; Bayou La Batre and Mobile, Alabama; Key West, Miami, Panama City, Pensacola, and Tampa, Florida (Marine Spill Response Corporation, 2015b; National Response Corporation, 2015). The impact of spill-response activities on land use and coastal infrastructure would range from **negligible** to **moderate** depending on the spill's location, duration, and whether the event is a small-scale spill or a larger spill. For example, potential impacts could include space-use conflicts related to staging operations, potential mishandling of cleanup equipment (boom), and improper disposal of oily wastes. In addition, the additional use of waterways or roadways used for the vehicles servicing spill response may result in localized increased wear and tear.

Vessel collisions may be associated with exploration, production, or transportation activities that result from a proposed lease sale. **Chapter 3.2.5** provides a detailed discussion of vessel collisions. The majority of offshore vessel collisions involve service vessels colliding with platforms or pipeline risers, although sometimes vessels collide with each other. In coastal waters, vessel collisions are more likely to include other vessels or stationary structures like bridges and docks. Human error accounted for about half of all reported vessel collisions from 1996 through 2009. These collisions often result in spills of various substances and, while most occur on the OCS far from shore, spills in coastal waters can have impacts to land use and coastal infrastructure that can range from **negligible** to **moderate**, depending on the severity and location of a vessel collision, the size of the vessels involved, and whether the collision involves a bridge, pier, or other structure. Land use may be affected if a bridge, pier, or other structure is involved because it could affect the transportation of goods, services, and people to and from work and schools.

The impact of reasonably foreseeable oil spills, chemical and drilling-fluid spills, and vessel collisions are not likely to last long enough to adversely impact overall land use or coastal infrastructure in the analysis area. Spill-response impacts would depend on the location and duration of a spill and whether or not it is a catastrophic event.

Cumulative Impacts

Land use and coastal infrastructure experience cumulative impacts that include all human activities and natural processes and events. This cumulative analysis considers impacts that comprise the incremental contribution of a proposed lease sale combined with all past, present, and reasonably foreseeable future Federal OCS oil- and gas-related lease sales and activities, as well as all past, present, and reasonably foreseeable future actions unrelated to the Federal OCS oil- and gas-related activities (**Chapter 3.3**). Within this divided analytical framework of OCS oil-and gas-related and non-OCS oil- and gas-related impacts, the largest quantity of impact-producing factors for land use and coastal infrastructure occur as non-OCS impacts because these resources are located onshore and exist for the benefit of both offshore and onshore oil- and gas-related activities, as well as other societal and business needs. Land use and coastal infrastructure occur within a complex socioeconomic structure, and OCS oil- and gas-related activities comprise a very small portion of this structure. Overall, cumulative impacts of all past, present, and reasonably foreseeable future OCS and non-OCS oil- and-gas related activities would range from **negligible** to **major** depending on the specifics of each situation, whether the impacts are measurable, how long the impacts would last, and the size of the affected geographic area.

OCS Oil- and Gas-Related Impacts

Potential impacts related to OCS oil- and gas-related activities include the cumulative impact of all past, present, and future lease sales, and the resultant exploration, development, and production in Federal waters that contribute to the following possible impacts: fluctuations in OCS oil- and gas-related activity levels; increases in commuter and truck traffic; onshore infrastructure expansions; construction of new infrastructure facilities; increases in waste disposal volumes; coastal and offshore oil spills, chemical/drilling-fluid spills, spill-response activities, and vessel collisions, which are all discussed above under “Routine Activities.” A proposed lease sale would make a **minor** incremental contribution to the cumulative impact of all past, present, and future lease sales.

The OCS oil- and gas-related onshore coastal infrastructure is extensive, covers a wide-ranging area, supports OCS development, and consists of thousands of large and small companies. **Chapter 3.3.1.10** describes the cumulative scenario projections for the OCS Program. BOEM estimates no additional service bases, heliports, platform fabrication yards, shipyards, or pipe-coating yards. Lease sales would serve mostly to maintain ongoing activity levels associated with the current OCS Program. Industry would more or less maintain its current usage of infrastructure. Expectations for new gas processing facilities being built during the 70-year analysis period as a direct result of the OCS Program are dependent on long-term market trends that are not easily predicable over the next 70 years. Existing facilities would experience equipment switch-outs or upgrades during this time. BOEM projects that expansions at existing LNG facilities and the construction of new facilities would not occur as a direct result of the OCS Program. Cumulative impacts of OCS oil- and gas-related activities are dependent on fluctuations in OCS activity levels; increases in commuter and truck traffic; expansions at existing facilities; new construction of infrastructure; increases in waste disposal volumes; and accidental events such as coastal and offshore oil spills, chemical/drilling-fluid spills, spill-response activities, and vessel collisions. BOEM's scenario projections call for the new construction of 0-1 new gas processing facility and 0-1 new pipeline landfall to result from a proposed lease sale over the analysis period. Increases in demand for services at other facilities would be met by current excess capacity or expansions at current facilities. These activities, along with noncatastrophic accidental events, are reasonably foreseeable.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS oil and gas-related cumulative impacts encompass all human activities and natural processes that may affect land use and coastal infrastructure, the list of which is beyond the scope of this NEPA analysis. Therefore, BOEM limits this cumulative analysis to the following most relevant (past, present, and reasonably foreseeable future) impact-producing factors:

- State oil and gas activity;
- onshore oil and gas activities;
- demands on transportation systems and ports;
- maintenance and improvements to transportation systems;
- construction and maintenance of industrial facilities;
- agricultural uses;
- urbanization;
- demographic shifts (i.e., in-migration and out-migration);
- evolution of State and Federal regulations;
- city planning and zoning;
- development of residential areas and recreational facilities;
- modifications to public facilities such as water, sewer, educational, and health facilities;
- military activities;
- coastal land loss;
- coastal storms; and
- global, national, and regional economic trends.

All of the cumulative non-OCS oil- and gas-related impacts discussed in this section can range across the scale of intensity, i.e., from **negligible** to **major** depending on the unique specifics of each situation, whether the impacts are measurable, how impacts are measured, how long they would last, the size of the affected area, and often, the viewpoints of the various people that may be involved. For example, in the case of urbanization, land developers would say any negative impacts are minor or negligible because they would be out-weighed by the positive economic benefits to the area (i.e., jobs, increased tax revenues, etc.), but a conservationist would say the impacts are major, negative, and highly detrimental because of habitat loss and damages to air and water quality. Given that within each listed category above there can be a myriad of potential situations that arise across the very large (133 counties and parishes) Gulf Coast analysis area, the discussion below would not assign individual labels (i.e., negligible, minor, moderate, or major) to each category of cumulative impact described.

Non-OCS oil- and gas-related activities onshore and in State waters utilize many of the same coastal infrastructure facilities as offshore OCS oil- and gas-related activities (**Figure 3-10**) and would continue to contribute to the cumulative impacts on land use and coastal infrastructure throughout the 70-year analysis period. Over the past several years, there has been a substantial decrease in offshore natural gas production, partially as a result of increasing emphasis on onshore shale gas development, which is less expensive to produce and which provides larger per-well production opportunities and reserve growth. Onshore unconventional natural gas production has increased to the point that existing Gulf Coast LNG facilities are seeking to export natural gas to foreign consumers. For all coastal infrastructure types, especially processing facilities, it has proven impossible to parse out what percentage of demand is generated by OCS oil- and gas-related activities as opposed to non-OCS oil- and gas-related activities. This difficulty is an inherent problem in analyzing most cumulative impacts to coastal land use and infrastructure.

For example, demands on transportation systems and ports are not isolated to OCS oil- and gas-related activities. Transportation systems (e.g., rail, trucks, highways, barges, supply vessels, and tankers) and ports also serve oil and gas activities onshore and in State waters, as well as other industrial uses unrelated to oil and gas activities (e.g., agricultural and manufacturing transport, and commercial and recreational fishing). The maintenance and improvements necessary for transportation systems and ports also are likely to cause cumulative impacts to land use and coastal infrastructure, in varying degrees, depending on the magnitude of each project. Similarly, construction or expansion and maintenance of non-OCS-related industrial facilities, such as paper mills and aluminum plants, could contribute to cumulative impacts on land use and coastal infrastructure depending on proximity and scale of the work being done.

Agricultural uses may also contribute to cumulative impacts on land use and coastal infrastructure. Of the over 400,000 mi^2 (1,035,995 km^2) comprising these coastal states, 18 percent of the total land area is covered in cropland, which includes cropland harvested, crop failure, cultivated summer fallow, cropland used only for pasture, and idle cropland. Texas and Mississippi have the highest percentages of cropland, with 20 percent and 19 percent of each respective state's total land being used for cropland. Texas leads the Nation in cattle, cotton, hay, sheep, and wool. Texas also leads the Nation in the number of farms and ranches, with 247,500 farms and ranches covering 130.4 million ac (52.8 million ha). For all four coastal states, 42 percent of the total land area is used for grassland pasture and range, with Texas devoting 61 percent or close to 262,000 mi^2 (679,095 km^2) for grassland pasture and range. Agriculture places many demands on the environment and produces impacts that include, but are not limited to, habitat fragmentation, pesticide and nutrient runoff, competing urban and agricultural water needs, changes to watershed hydrology, and changes in soil quality. Both State and Federal entities regulate various farming and ranching practices through laws such as the Clean Water Act, which establishes pollutant standards for many of the inputs used in conventional farming methods (Lubowski et al., 2006).

Cumulative impacts of urbanization on land use and coastal infrastructure affect the Gulf of Mexico EIAs with the highest numbers of people. Demographic shifts as people move in and out of areas contribute to the cumulative impacts on land use and coastal infrastructure. Census urban areas include densely populated areas with at least 50,000 people ("urbanized areas") and densely populated areas with 2,500-50,000 people ("urban clusters"). Included in the Census urban area definition are residential areas and concentrations of nonresidential urban areas such as commercial, industrial, and institutional land; office areas; urban streets and roads; major airports; urban parks and recreational areas; and other land within urban defined areas. Development takes the place of natural ecosystems and fragments habitat. It also influences decisions people make about how to get around and determines how much people must travel to meet daily needs. These mobility and travel decisions have indirect impacts on human health and the natural environment by affecting air and water pollution levels. Impacts of urbanization include habitat fragmentation, reduced water and air qualities, and the urban heat island impact. On the other hand, residents of cities live in smaller homes and drive less because of the close proximity of amenities. Future trends in urban land use would be largely determined by economics, demographic shifts, local ordinances, and zoning (USEPA, 2013c).

Within the geo-political realm, non-OCS related cumulative impacts on land use and coastal infrastructure could also include evolving State and Federal regulations (especially environmental), city planning and zoning, residential development, recreational facilities, public facilities (i.e., water, sewer, health, and education), and military activities. Land-use patterns vary greatly by region, reflecting differences in soils, climate, topography, and patterns of population settlement. Land-use changes would largely depend upon local zoning and economic trends. Mississippi and Louisiana are located in what the U.S. Department of Agriculture's Economic Research Service calls the Delta farm production region, while Alabama is located in the Southeast farm production region, and Texas is located in the Southern Plain region (Lubowski et al., 2006). The Economic Research Service conducts land-use inventories based on available land-use data obtained from surveys conducted both by the Economic Research Service and predecessor agencies. **Figure 4-27** illustrates the dominant land-use patterns in the counties and parishes that comprise the BOEM-identified EIAs.

Coastal land loss resulting from erosion, subsidence, and coastal storms is one of the more significant cumulative impacts for land use and coastal infrastructure. The Gulf Coast region has been experiencing land loss in varying degrees from state to state, especially in coastal Louisiana. **Figure 4-28** shows the amount of land that coastal Louisiana has lost from 1932 to 2010. **Figures 4-29 and 4-30** illustrate scientists' projections for future land loss in Louisiana. The moderate scenario assumes more mitigating measures, and the less optimistic scenario shows the projected impact if extensive mitigating measures are not instituted. Overlaid on all three of these figures are the locations of existing OCS oil- and gas-related infrastructure. As evident from these visual depictions, coastal land loss is one of the greatest threats to the stability and future of OCS oil- and gas-related infrastructure, producing a **major** negative impact to those facilities located close to areas vulnerable to land loss.

Second only to coastal land loss as a **major** cumulative impact on land use and coastal infrastructure are the regular changes in economic trends on the regional, national, and global levels. Micro-economic and macro-economic shifts in demand, investment opportunities, and commodity prices all affect the course of business in the oil and gas industry and the regional economies and communities in ways that are not always in tandem. For example, the drop in the price of oil from the end of 2014 through 2015 kept the price of gas down, which is good for people and businesses that drive cars and trucks to travel. However, the downturn has also led to many layoffs in the oil and gas industry (Larino, 2015; Stickney, 2015; and Strauss, 2015). An economic Gordian knot best explains the complex relationship between the industry, society at large, and the resources of land use and coastal infrastructure, which reside at the core of this intricate system of effects and counter-effects.

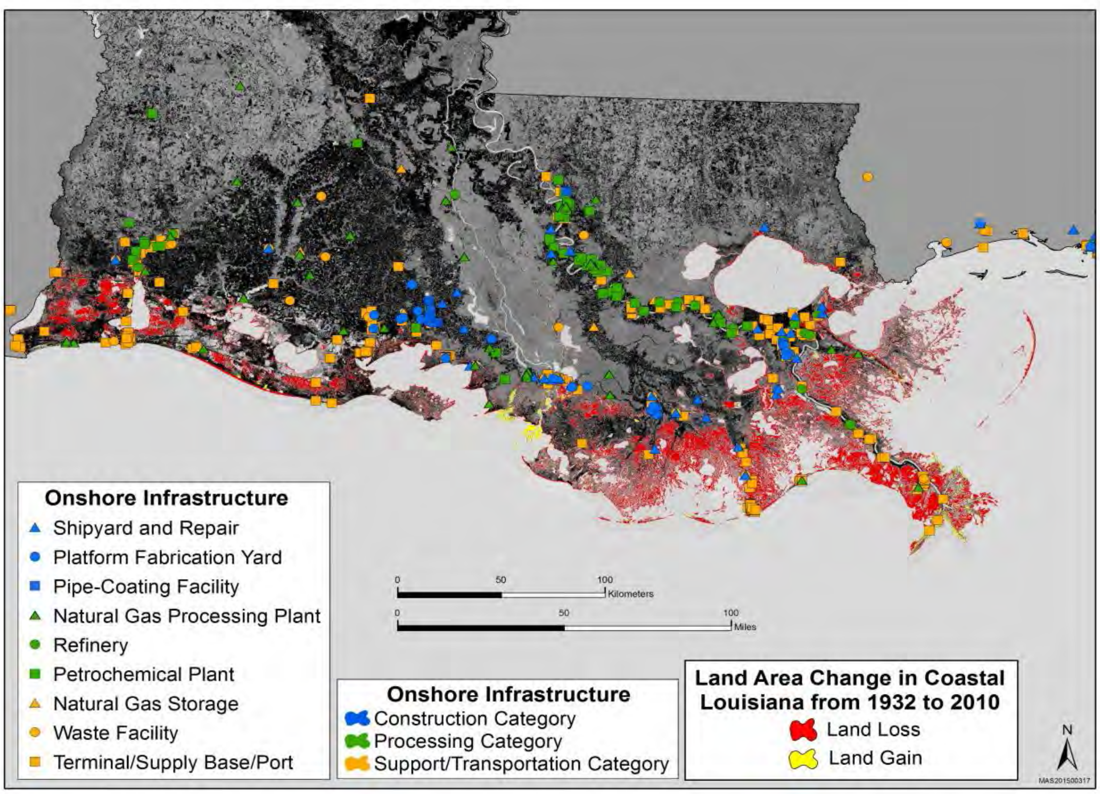

Figure 4-28. Historical Land Loss in Louisiana, 1932-2010.

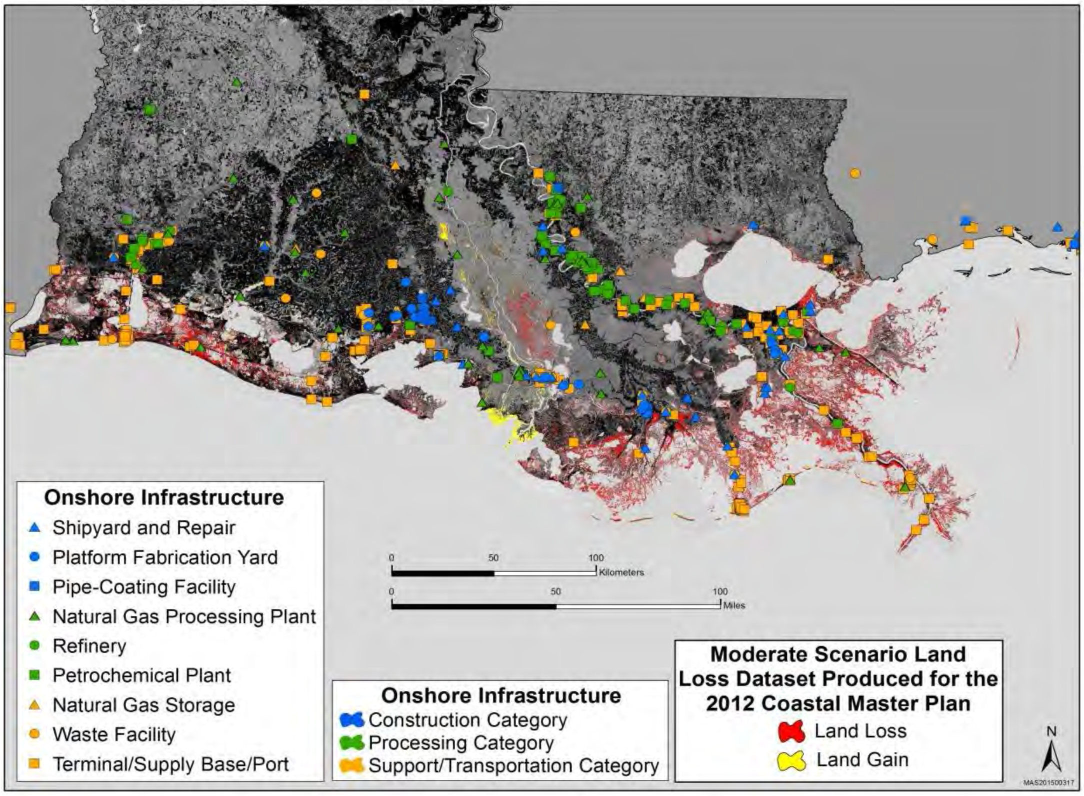

Figure 4-29. Moderate Scenario: Projected Land Loss in Louisiana.

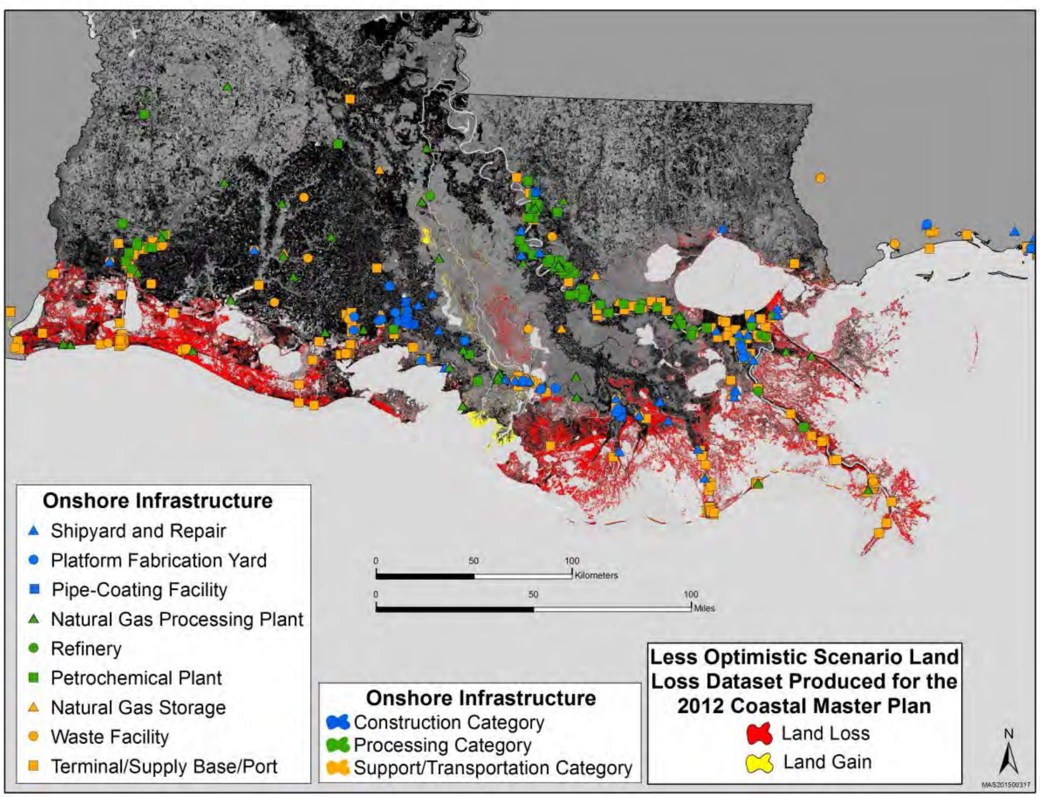

Figure 4-30. Less Optimistic Scenario: Projected Land Loss in Louisiana.

Incomplete or Unavailable Information

BOEM has identified incomplete information regarding the potential impacts of coastal land loss on land use and coastal infrastructure. This incomplete information may be relevant to adverse impacts because it is not completely known how current subsidence and erosion is affecting industry or what plans industry is making to mitigate current or future impacts. Because there are hundreds of large and small property-owning businesses spread across the coastal zone, which directly and indirectly support the offshore petroleum industry, there is no practical way to identify these properties and estimate possibilities of losses due to subsidence and erosion. BOEM has proposed a study that would attempt to evaluate these potential impacts by surveying industry on current impacts and potential adaptation strategies; however, as of the publication of this Multisale EIS, it is unfunded and would take several years before data could be available. Therefore, this incomplete information is not likely to be available within the timeline contemplated by the NEPA analysis of this Multisale EIS.

BOEM used reasonably accepted scientific methodologies to extrapolate from existing information on dredged material used to mitigate for land loss in completing its analysis and formulating the conclusions presented here. For example, in the case of coastal ports, dredged material from navigation slips are used to fill in property and mitigation habitat areas for wildlife and to act as a barrier to protect ports from storm surges (Volz, 2013). This example shows that, although BOEM does not possess a complete understanding of what industrial infrastructure improvements may occur, such as mitigation for land loss, industry would most likely mitigate as necessary to protect existing and growing infrastructure. Like any industrial infrastructure improvements, future adaptations would occur on an as-needed basis or as new technologies become available. While coastal infrastructure is subject to the impacts of coastal land loss and routine tropical storm activity, there is still considerable investment to expand, improve, and protect existing infrastructure. Therefore, BOEM has determined that the information is not essential to a reasoned choice among alternatives. BOEM continues to monitor industry and its infrastructure footprint over time to document short- and long-term impacts of continued land loss. For a more detailed discussion on deltaic land loss, refer to **Chapter 4.3.2** (Coastal Barrier Beaches and Associated Dunes.)

4.14.1.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Oil and gas exploration, production, and development activities on the OCS are supported by an expansive onshore network of coastal infrastructure that includes hundreds of large and small companies. Land use in the Gulf Coast analysis region covers a broad spectrum from rural to metropolitan land uses, ranging across 133 counties and parishes from the southern tip of Texas north along the Texas coastal plain and looping around the Gulf Coast through Louisiana, Mississippi, Alabama, and Florida, all the way southward to Key West in Monroe County, Florida. The impact-producing factors for land use and coastal infrastructure would range from **negligible** to **minor** because oil- and gas-related coastal infrastructure is a mature and extensive system, resulting from long-term industry trends, and it is not subject to rapid fluctuations. For example, a small-scale expansion of a gas-processing plant would be a **negligible** impact because of the small size of the project, the temporary disruptions caused by increased construction traffic, and the geographically small area affected. If the expansion project was larger, lasting a few weeks and affecting a larger geographic area, then the impact would be **minor**. If the gas-processing plant project was larger in scale, causing disruptions because of construction activities that last up to 1 year, then the impact would be **moderate**. Activities related to a proposed action are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks with existing infrastructure and facilities that have sufficient capacity to accommodate future growth. BOEM's scenario projections call for the new construction of 0-1 new gas processing facility and 0-1 new pipeline landfall to result from a proposed lease sale over the analysis period. Increases in demand for services at other facilities would be met by current excess capacity or expansions at current facilities. These activities, along with noncatastrophic accidental events, are reasonably foreseeable.

The impacts of reasonably foreseeable accidental events, such as oil spills, chemical and drilling fluid spills, vessel collisions, and spill-response activities are expected to be **negligible** to **moderate** depending on the location, size, and duration of the event. Potential impacts could include damages to private and public lands, personal injury, damages to collateral property (moveable property such as vehicles and boats), and economic damages from the disruption of business. For example, if an oil spill is very small (not measurable) in size, located in a small geographic and remote area, and dissipates quickly, its impact would be **negligible**. If a spill is measurable, covers a larger geographic area, and lasts a few days to a month, then its impact would be **minor**. If a spill occurs in a highly populated area, is larger in quantity, and the response and cleanup last over a month and up to a year with either waterborne commerce affected and/or land transportation affected, then the impact would be **moderate**.

In regard to cumulative impacts, activities relating to the OCS Oil and Gas Program and State oil and gas production are expected to minimally affect the current land use of the analysis area because most subareas have strong industrial bases and designated industrial parks to accommodate future growth. The incremental contribution of a proposed lease sale to the cumulative impacts on land use and coastal infrastructure are expected to be **minor** because the impacts of one lease sale are minimal when compared with the combination of all past, present, and future lease sales. Non-OCS oil- and gas-related impact-producing factors provide a very large contribution to the cumulative impacts on land use and coastal infrastructure, but there is only a **minor** incremental contribution of a proposed lease sale and OCS Oil and Gas Program to all cumulative impacts. The cumulative impacts of non-OCS oil- and gas-related factors on land use and coastal infrastructure could range from **negligible** to **major** depending on the specific situation, whether the impacts are measurable, how impacts are measured, how long they would last, the size of the affected area, and the viewpoints of the various people that may be involved.

4.14.1.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Impacts for land use and coastal infrastructure are directly related to the level of OCS oil- and gas-related activities in the Gulf of Mexico. Alternative B would result in less OCS oil- and gas-related activities than Alternative A because the WPA (approximately 23 million ac) would not be available for leasing. Alternative A includes all three planning areas of the GOM (i.e., the WPA, CPA, and EPA). Alternative B includes the CPA and EPA, and excludes the WPA. Therefore, Alternative B would produce proportionately smaller OCS oil- and gas-related activities than Alternative A, and the impacts of Alternative B would be proportionately less than Alternative A but greater than Alternative C, as described below.

4.14.1.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Impacts for land use and coastal infrastructure are directly related to the level of OCS oil- and gas-related activities in the Gulf of Mexico. Alternative C would result in less OCS oil- and gas-related activities than Alternative A or B because the CPA and EPA (approximately 48 million ac) would not be available leasing. Alternative A includes the WPA, CPA, and EPA, and Alternative B include the CPA and EPA. In contrast, Alternative C includes only the WPA. Therefore, Alternative C would produce proportionately smaller OCS oil- and gas-related activities than Alternative A and B, and the impacts of Alternative C would be proportionately less than either Alternative A or B.

4.14.1.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Impacts for land use and coastal infrastructure are directly related to the level of OCS oil- and gas-related activities in the Gulf of Mexico. Alternative D would have minimal impact on social factors because there are so few available unleased blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and Blocks South of Baldwin County, Alabama, Stipulations. The difference between Alternatives A, B, and C, with and without the exclusionary stipulations, is negligible for land use and coastal infrastructure. The impacts under Alternative D would not be much different and likely not even be measurable when compared with the other alternatives. To the extent that Alternative D would generate less OCS oil- and gas-related activities due to the reduced number of blocks available for lease, the impacts of Alternative D would be slightly less than Alternative A, B or C, but this difference would likely be indiscernible.

4.14.1.2.5 Alternative E—No Action

Alternative E would result in no lease sale and, thus, no direct impacts as a result of a proposed lease sale and no incremental contribution of impacts to land use and coastal infrastructure beyond a temporary negative economic impact for the oil and gas industry. However, activities and impacts from activities related to past OCS oil and gas lease sales would continue.

Since a single lease sale produces minimal impact, it would take the cancellation of several lease sales before a substantial impact would be experienced.

4.14.2 Economic Factors

This chapter discusses the affected environment, routine activities, accidental events, and cumulative impacts to economic factors that would arise from the alternatives. Many of the economic impacts of the alternatives would be beneficial, and these impacts are stated in terms of standard measures of economic activity. The negative impacts are measured in terms of the severity, duration, and geographical extent of impacts. In particular, the impact-level measures are listed below.

Impact-Level Definitions

In this chapter (and in the analyses of the alternatives) the impact measures are defined in terms of the intensity, duration, and geographical extent of the impacts to the human uses of recreational resources along the Gulf Coast.

- **Beneficial** – Impacts would be stated in levels and percentages of employment (number of jobs), labor income (wages, benefits, and sole-proprietor income), and/or value-added (contribution to gross regional product).
- **Negligible** – Little or no detectable impact.
- **Minor** – Impacts are detectable but less than severe.
- **Moderate** – Impacts are severe but are short-term and/or not extensive.
- **Major** – Impacts are long-term, extensive, and severe.

4.14.2.1 Description of the Affected Environment

Economic factors are factors that explain and quantify the human behaviors that determine the positive and negative impacts from the alternatives. The following sections discuss the overall economies that could be impacted by the alternatives, as well as provide specific information regarding the offshore oil and gas industry.

Economic Impact Areas

Offshore oil and gas activities affect various onshore areas because of the various industries involved and because of the complex supply chains for these industries. Many of these impacts occur in counties and parishes along the Gulf of Mexico region. BOEM aggregates 133 GOM counties and parishes into 23 EIAs based on economic and demographic similarities among counties/parishes (Fannin and Varnado, 2015); **Figure 4-27** is a map of these EIAs. Much of the analysis below focuses on these EIAs since many of the positive and negative impacts of the alternatives would be concentrated in these EIAs. These EIAs also serve as consistent units for which to present various economic and demographic data.

Economic and Demographic Data

Woods & Poole Economics, Inc. (2015) provides county-level economic and demographic data for prior years, as well as forecasts of these data through 2050. **Table 4-27** aggregates the Woods & Poole data by EIA and presents each EIA's population, employment, gross regional product, labor income, median age, male percentage, and race composition. The largest EIAs (presented in descending order of gross regional product) are TX-3 (which includes Houston and Galveston), FL-5 (which includes Tampa), LA-6 (which includes New Orleans), LA-5 (which includes Baton Rouge), FL-6, and TX-1. The smallest EIAs (presented in ascending order of gross regional product) are MS-2, TX-6, AL-2, LA-2, and TX-4. The forecasts from Woods & Poole Economics, Inc. (2015) for future years are presented in the cumulative analysis (**Chapter 4.14.2.2**). Kaplan et al. (2011) presents additional economic and demographic data for certain GOM regions that are important to the offshore oil and gas industry.

Table 4-27. Economic and Demographic Information for BOEM's Economic Impact Areas in 2015.

	Economic Variables				Demographic Variables						
EIA	Population	Employment	Gross Regional Product[1]	Labor Income	Median Age	Male %	White	Black	Hispanic	Native American	Asian
Texas											
TX-1	1,713,140	752,177	45,961,422	26,189,354	32.2	49.0%	7.4%	0.5%	91.1%	0.1%	0.9%
TX-2	757,829	440,230	40,665,099	21,121,438	39.3	50.0%	37.8%	4.9%	55.4%	0.3%	1.6%
TX-3	6,340,375	3,897,727	433,804,883	268,244,910	35.9	49.8%	37.1%	17.1%	37.5%	0.3%	7.9%
TX-4	163,193	59,934	4,119,292	2,059,513	40.2	49.5%	75.9%	9.0%	13.9%	0.4%	0.7%
TX-5	374,402	205,831	18,218,742	10,695,487	37.1	50.9%	53.7%	25.9%	17.0%	0.4%	3.0%
TX-6	50,558	22,415	1,388,043	684,253	41.6	50.0%	74.6%	18.4%	5.8%	0.5%	0.7%
Louisiana											
LA-1	204,559	119,065	10,819,182	5,701,097	38.5	48.8%	70.2%	24.9%	3.0%	0.5%	1.4%
LA-2	89,805	41,414	4,077,567	2,040,359	34.1	52.0%	75.1%	14.5%	7.2%	1.3%	1.8%
LA-3	588,935	337,248	34,334,083	16,300,997	36.7	49.2%	68.5%	26.7%	3.1%	0.5%	1.2%
LA-4	364,662	219,030	23,652,206	11,941,630	37.6	49.3%	67.4%	23.4%	4.6%	3.0%	1.6%
LA-5	858,991	533,746	49,605,913	26,421,022	37.3	48.7%	56.6%	37.0%	4.0%	0.3%	2.2%
LA-6	934,399	612,228	59,338,051	32,291,523	36.3	48.5%	46.3%	39.8%	9.9%	0.4%	3.7%
LA-7	425,178	207,007	16,064,830	8,610,839	38.4	48.7%	73.8%	19.9%	4.6%	0.4%	1.2%
Mississippi											
MS-1	442,571	230,577	16,142,025	10,142,320	39.2	49.5%	71.4%	20.6%	5.1%	0.5%	2.5%
MS-2	68,605	21,814	1,132,099	675,920	38.2	52.1%	79.7%	18.0%	1.6%	0.4%	0.3%
Alabama											
AL-1	620,990	338,439	22,529,209	13,682,033	40.0	48.2%	66.7%	27.3%	3.4%	0.9%	1.8%
AL-2	115,636	51,498	3,406,314	2,053,406	42.2	49.2%	57.7%	37.5%	1.6%	2.8%	0.4%

	Economic Variables				Demographic Variables						
EIA	Population	Employment	Gross Regional Product[1]	Labor Income	Median Age	Male %	White	Black	Hispanic	Native American	Asian
Florida											
FL-1	913,655	499,506	34,545,257	21,061,882	39.2	50.4%	75.8%	14.1%	6.2%	0.8%	3.1%
FL-2	513,271	273,299	18,167,329	11,079,024	40.4	50.8%	61.9%	29.5%	5.9%	0.5%	2.2%
FL-3	237,107	89,044	5,422,707	3,259,404	41.3	54.5%	70.5%	22.0%	6.3%	0.5%	0.8%
FL-4	1,436,702	604,746	36,362,418	22,058,081	48.6	48.7%	75.7%	11.2%	10.2%	0.3%	2.5%
FL-5	4,151,943	2,229,968	164,060,192	100,460,406	45.4	48.6%	67.0%	11.9%	17.6%	0.3%	3.2%
FL-6	1,495,975	752,134	47,563,571	29,203,481	45.5	49.8%	68.4%	7.9%	21.8%	0.3%	1.5%

EIA = Economic Impact Area.
[1] Gross Regional Product and labor income are presented in thousands of dollars.

Source: Woods & Poole Economics, Inc., 2015.

Offshore Oil and Gas Industry

The offshore energy industry in the Gulf of Mexico extracts oil, natural gas, and natural gas liquids (NGLs), which are then processed and transported for use in various activities, including transportation, electricity generation, space heating, and chemical manufacturing. Extraction of oil, natural gas, and natural gas liquids entails spending on various processes, including G&G surveying, drilling, platform fabrication, shipbuilding, and various support services. Spending on these processes supports businesses further along supply chains and supports spending by workers. Quest Offshore Resources, Inc. (2011) provides an overview of the spending impacts of the offshore oil and gas industry in the Gulf of Mexico. This report estimates that $26.9 billion in capital and operating expenditures supported $29.1 billion in U.S. gross domestic product in 2009. Kaiser et al. (2013) provide background information on the drilling and rig construction markets; Eastern Research Group, Inc. (2011) provides background information on the oil services contract industry; and Priest and Lajaunie (2014) and Austin et al. (2014a) present background information on the shipbuilding and fabrication industries.

The offshore energy industry has been adapting to recent declines in energy prices. Lower energy prices have caused slowdowns in offshore drilling activities (Beaubouef, 2015) and rig construction (Odell, 2015). However, offshore oil and gas production is generally slower to respond to changes in energy prices since offshore developments take years to be designed, approved, and developed. Once a project is producing, it is often most profitable to maintain production as long as the revenues received are above the marginal costs of production. Indeed, GOM offshore oil production is forecast to increase from an average of 1.54 MMbbl/day in 2015 to 1.63 MMbbl/day in 2016 and to 1.79 MMbbl/day in 2017 (USDOE, Energy Information Administration, 2016a). This production increase reflects the contributions of 14 Gulf of Mexico projects that are expected to come online in 2016 and 2017 (USDOE, Energy Information Administration, 2016b).

Office of Natural Resources Revenue Data

The U.S. Department of the Interior's Office of Natural Resources Revenue collects various data regarding offshore oil and gas activities. **Table 4-28** presents data regarding sales volumes, sales values, and government revenues received from Federal offshore energy activities in the Gulf of Mexico (USDOI, Office of Natural Resources Revenue, 2015). Government revenues are generated from offshore oil and gas activities through bonus bids, rental payments, and royalty payments. Bonus bids are received shortly after a lease sale, rental payments occur during the nonproducing phase of a lease, and royalties are paid as a percentage of oil and gas output from a lease. BOEM's "Fair Market Value" webpage describes the rental rates, royalty rates, and other terms associated with Gulf of Mexico leases (USDOI, BOEM, 2015d). Some offshore oil and gas activities are subject to partial or full royalty exemptions. BOEM's "Royalty Relief Information" webpage provides more information regarding BOEM's royalty relief programs (USDOI, BOEM, 2015e).

Panel A of **Table 4-28** presents annual data regarding the quantities of royalty-bearing and nonroyalty-bearing sales volumes of natural gas, NGLs, and oil. In FY 2014, royalty-bearing natural gas sales continued on a long-term downward trend, falling from 953 million Mcf (thousand cubic feet) in FY 2013 to 900 million Mcf in FY 2014. Sales volumes of royalty-bearing NGLs increased from almost 36 MMbbl in FY 2013 to 40 MMbbl in FY 2014, while sales volumes on nonroyalty-bearing NGLs decreased from 9.1 MMbbl in FY 2013 to 7.4 MMbbl in FY 2014. Sales volumes of royalty-bearing oil increased from 358 MMbbl in FY 2013 to 396 MMbbl in FY 2014, while sales volumes on nonroyalty-bearing oil decreased from 100 MMbbl in FY 2013 to 87 MMbbl in FY 2014. Panel B of **Table 4-31** presents the sales values of gas, NGLs, and oil produced in Federal areas in the Gulf of Mexico. Sales values of oil, natural gas, and NGLs all increased in FY 2014 compared with FY 2013. Panel C of **Table 4-31** presents data on Federal Government revenues received from rental payments, royalty payments, lease sale bonus bids, and other revenue sources due to offshore energy activities in the Gulf of Mexico. The Federal Government received $7.3 billion in revenues from all sources combined during FY 2014, which was a decline from the $8.8 billion received in FY 2013. This decline arose primarily due to the decline in bonus bid revenues.

Table 4-28. Sales Volumes, Sales Values, and Revenues.

Panel A: Sales Volumes							
FY	2008	2009	2010	2011	2012	2013	2014
Gas (royalty) (mcf)	2,143,219,978	1,730,441,404	1,687,273,215	1,377,976,860	1,118,510,486	952,559,046	900,114,993
Gas (non-royalty) (mcf)	316,986,987	461,373,909	371,665,155	297,608,514	241,687,280	232,010,830	157,147,262
NGL (royalty) (bbl)	48,691,691	41,495,664	48,461,861	42,672,187	37,429,317	35,984,532	40,008,495
NGL (non-royalty) (bbl)	3,857,382	3,701,216	9,158,031	9,229,184	7,247,838	9,113,729	7,433,072
Oil (royalty) (bbl)	274,782,936	393,146,795	414,283,323	358,715,537	336,361,314	357,651,947	395,806,007
Oil (non-royalty) (bbl)	162,506,924	127,353,025	179,566,357	152,390,468	121,890,202	99,945,768	86,737,322
Panel B: Sales Values							
FY	2008	2009	2010	2011	2012	2013	2014
Gas ($)	19,784,563,673	7,906,066,513	7,901,285,172	5,901,378,985	3,254,881,856	3,527,244,352	3,984,226,004
NGL ($)	3,067,671,727	1,267,858,373	2,075,764,329	2,747,520,920	1,748,239,028	1,309,742,071	1,538,883,909
Oil ($)	29,410,660,793	21,108,193,437	31,085,489,576	35,371,471,285	36,870,071,043	38,027,551,056	39,477,254,223
Other ($)	423,743	173,955	86,350	60,125	48,228	66,780	41,563
Total ($)	52,263,319,935	30,282,292,277	41,062,625,426	44,020,431,314	41,873,240,156	42,864,604,259	45,000,405,699
Panel C: Revenues							
FY	2008	2009	2010	2011	2012	2013	2014
Gas royalties ($)	2,873,174,184	1,109,453,399	1,111,565,590	833,964,068	455,003,075	498,454,983	553,674,802
NGL royalties ($)	286,514,305	119,772,432	244,216,684	280,309,056	217,352,432	157,910,822	184,978,637
Oil royalties ($)	4,056,267,707	2,767,151,995	4,091,755,677	4,800,678,071	5,026,388,805	5,185,254,716	5,316,466,639
Other royalties ($)	43,812	14,947	4,095	3,307	3,927	4,384	2,273
Rents ($)	231,475,837	228,538,775	238,240,338	217,625,357	218,147,551	236,321,909	232,376,449
Bonus ($)	6,817,546,915	1,174,069,762	986,997,466	37,054,282	606,446,360	2,732,922,142	967,365,328
Other ($)	3,325,433	-29,904,061	46,809,265	3,951,382	5,045,519	34,753,295	43,014,645
Total ($)	14,268,348,192	5,369,097,248	6,719,589,116	6,173,585,523	6,528,387,669	8,845,622,251	7,297,878,773
Gas ($)	19,784,563,673	7,906,066,513	7,901,285,172	5,901,378,985	3,254,881,856	3,527,244,352	3,984,226,004
NGL ($)	3,067,671,727	1,267,858,373	2,075,764,329	2,747,520,920	1,748,239,028	1,309,742,071	1,538,883,909
Oil ($)	29,410,660,793	21,108,193,437	31,085,489,576	35,371,471,285	36,870,071,043	38,027,551,056	39,477,254,223
Other ($)	423,743	173,955	86,350	60,125	48,228	66,780	41,563
Total ($)	52,263,319,935	30,282,292,277	41,062,625,426	44,020,431,314	41,873,240,156	42,864,604,259	45,000,405,699

(1) This table presents the sales volumes, sales values, and revenues received based on offshore oil and gas activities in the Gulf of Mexico.

(2) Data in this table refer to the years in which sales occurred (not to the years in which government revenues were received).

Source: USDOI, Office of Natural Resources Revenue, 2015.

4.14.2.2 Environmental Consequences

The impacts from routine activities and accidental events, and the cumulative impacts to economic factors that would arise from projected activities from a single lease sale are analyzed in this chapter. While there are some differences in the amount of activities associated with the alternatives, many of the impacts associated with the alternatives are similar. Therefore, this chapter describes the impacts that are expected to apply to all alternatives, while any deviations from these impact conclusions are discussed in **Chapters 4.14.2.2.1-4.14.2.2.6**.

For each alternative, the numerical estimates are presented for two scenarios for oil and gas development:

(1) *Low*: A scenario that corresponds to low amounts of offshore oil and gas activities, which could arise due to low oil and gas prices or other unfavorable economic conditions. This scenario also assumes that oil and gas leasing activities would be spread over two lease sales in a given year.

(2) *High*: A scenario that corresponds to high amounts of offshore oil and gas activities, which could arise due to high oil and gas prices or other favorable economic conditions. This scenario also assumes that oil and gas leasing activities would be spread over two lease sales in a given year.

It is also possible that industry could focus their leasing activities in a particular lease sale for unique circumstances rather than activity being spread over two lease sales in a given year. If this would occur, the economic impacts would be approximately double the impacts presented here. However, this is unlikely to occur, particularly as industry adjusts to the pattern of two lease sales per year.

Routine Activities

Routine activities arising from a proposed action would have various economic impacts. First, extraction of oil, NGLs, and natural gas generate expenditures on various goods and services. Routine activities could also generate corporate profits and government revenues, as well as have impacts on the overall energy market. Finally, a proposed action would have negative impacts (discussed below) that would partially offset the positive impacts. It is important to note that a proposed action occurs in the context of an expansive existing offshore oil and gas industry. Therefore, the various impacts (discussed below) should be interpreted as the extent to which the alternatives contribute to the impacts of the existing offshore oil and gas existing industry.

Expenditure Impacts

A proposed action would have economic impacts on a variety of businesses along the OCS industry's supply chain. For example, a proposed action would directly affect firms that drill wells, manufacture equipment, construct pipelines, and service OCS oil- and gas-related activities. The OCS oil- and gas-related activities would also impact the suppliers to those firms, as well as firms that depend on consumer spending of oil and gas industry workers. In order to estimate these impacts, BOEM has developed MAG-PLAN, which is a two-stage economic model. The first stage estimates the levels of spending in various industries that arise from a particular scenario for oil and gas exploration and development. The second stage estimates the employment, income, and value added impacts that result from oil and gas industry spending along the Gulf Coast. The OCS industry's spending would support activities further down the supply chain; these are referred to as "indirect" impacts. In addition, the incomes of employees along the OCS industry's supply chain would support consumer spending throughout the economy; these are referred to as "induced" impacts. These indirect and induced impacts are estimated using the economic modeling software and data system IMPLAN. In particular, MAG-PLAN uses IMPLAN "multipliers" to compute how direct OCS spending translates into various direct, indirect, and induced economic impacts. MAG-PLAN results for the various scenarios are presented in **Chapters 4.14.2.2.1-4.14.2.2.5**.

Government Revenue Impacts

A proposed action would generate government revenues through bonus bids, rental payments, and royalty payments. Revenue forecasts for the alternatives are discussed in **Chapters 4.14.2.2.1-4.14.2.2.5**. The impacts generated by these revenues depend on where and how the revenues are used. Historically, most revenues have accrued directly to the Federal Treasury. Although it is not possible to trace Federal spending to specific revenue streams, it is reasonable to assume that Federal OCS revenues would be spent in approximately the same proportions as overall Federal spending. This implies that the Federal revenue impacts of OCS oil- and gas-related activities would be fairly widespread, and thus not overly concentrated in BOEM's economic impact areas. Historically, modest portions of OCS revenues beyond those implicit in normal Federal spending have been allocated to the Gulf Coast States, including 8(g) revenues (which arise due to leasing with 3 mi [5 km] of State waters), the Coastal Impact Assistance Program, and Phase 1 revenue sharing arising from the Gulf of Mexico Energy Security Act of 2006 (GOMESA). Phase 2 of GOMESA revenue sharing, which will begin in Fiscal Year 2017, will expand revenue sharing with Texas, Louisiana, Mississippi, and Alabama. In particular, Phase 2 of GOMESA calls for 37.5 percent of qualified revenues to be disbursed to the Gulf Coast States and their political subdivisions, and 12.5 percent of revenues to be disbursed to the Land and Water Conservation Fund. Phase 2 revenue sharing will be subject to a $500 million cap through 2055 (USDOI, BOEM, 2015d). Phase 2 of GOMESA may increase the beneficial impacts to BOEM's economic impact areas arising from a proposed action, although only if the revenues occur in a year in which the cap was not reached by revenues arising from other lease sales. The economic impacts of the various revenue disbursements would depend on how and where the money is spent. The OCS oil- and gas-related activities can also induce government revenues arising from taxes on economic activities (such as taxes on profits and dividends). The USDOI (2015b) provides methodologies for estimating the scales and distributions of revenue impacts of OCS oil- and gas-related activities. This report estimates that revenue impacts accounted for 26 percent of total value-added impacts in the United States in 2014. This percentage is forecast to remain roughly similar in future years, although it could vary based on oil prices and the geographic distributions of impacts would change because of GOMESA revenues.

Profit Impacts

A proposed action could also generate profits to firms along the OCS supply chain. Corporate profits can be distributed to stockholders as dividends or retained by firms for future spending on goods and services. Higher profits can also increase stock prices, which would increase the wealth of stockholders. Since stocks of most energy firms can be held by people from anywhere in the world, the wealth and dividend impacts would be fairly widespread and, thus, not overly concentrated in BOEM's economic impact areas. Similarly, it is difficult to trace specific spending by firms to increases in corporate profits, although these impacts are also likely to be widespread. The USDOI (2015b) estimates that approximately 25 percent of total value-added benefit to the United States from the OCS Program arises due to corporate profits, and this percentage could vary slightly during the timeframe of a proposed action, given changes in oil prices and other factors.

Market Impacts

The oil, natural gas, and NGLs produced due to a proposed action would meet the demands of end users of those products. Increased energy supply would put downward pressure on energy prices, although the small scale of a proposed action relative to the overall energy market would make these price effects minimal. The OCS crude oil production typically has different quality measures (such as API gravity and sulfur content) than crude oil from other sources and flows through pipelines already in place, which can enhance the relative value of OCS crude to nearby refiners designed to process OCS-type crude oil. A proposed action can also contribute to U.S. policy goals of energy independence and security. Again, these impacts would be small due to the small scale of a proposed action.

Adverse Impacts

A proposed action could negatively affect various resources, as described in the other chapters of this Multisale EIS. The corresponding negative economic impacts are also discussed in their respective chapters. For example, the OCS Program could cause negative impacts to recreational fishing, commercial fisheries, recreational resources, land use and coastal infrastructure, and social factors. Industrial Economics (2012) provides information regarding the Offshore Environmental Cost Model, which incorporates methodologies for quantifying the adverse impacts to various resources. However, these adverse impacts are likely to be **minor** because of the small scale of a proposed action.

In summary, a proposed action would have various beneficial impacts, such as impacts from expenditures, government revenues, corporate profits, and market adjustments. A proposed action would also lead to minor adverse impacts that would partially offset the beneficial impacts.

Accidental Events

Accidental events, such as oil spills, chemical spills, and vessel collisions, can have various impacts on local economies. The most direct impacts are felt in industries that depend on resources that are damaged or rendered unusable for a period of time. For example, beach recreation, recreational fishing, and commercial fishing would be vulnerable if beach or fish resources were damaged due to an accidental event. However, since accidental events arising from a proposed action would likely be small, the impacts to economic factors would likely be **negligible** or **minor**. More information on the impacts of accidental events on these individual resources can be found in **Chapters 4.10, 4.11, and 4.12**. An oil spill could also impact important transportation routes or impact the operations of port facilities. However, the likelihood of a single oil spill shutting down an entire waterway or port facility is quite low.

The other economic impacts of an accidental event would be determined by indirect actions or events that occur along with an oil spill. For example, an oil spill could lead to decreased levels of oil and gas industry operations. These impacts would be most felt in coastal Louisiana and Texas since these are the primary locations where OCS oil- and gas-related employment is concentrated. The direct impacts of an oil spill on a particular industry would also ripple through that industry's supply chain; consumer spending by employees of these firms would also have impacts to the broader economy. Decreased levels of offshore oil and gas activities could also impact corporate profits and the revenue streams of the various levels of government in the impacted areas. Finally, the response and cleanup operations following an oil spill can have impacts on local economies. For example, compensation for damages could partially mitigate the economic impacts of an accidental event. The influx of response workers to local areas can have positive economic impacts, although it can also cause disruptions to the normal functioning of local economies. In addition, the people and equipment that are dedicated to oil-spill response efforts may be diverted from some existing services (such as hospitals, firefighting capability, and emergency services) available to local residents. These indirect impacts would be negligible for most spills expected to arise from a proposed action, although they could be minor in unique circumstances.

The *Deepwater Horizon* oil spill provides some insights into the impacts of oil spills, although an oil spill of the scale of the *Deepwater Horizon* is not part of a proposed action and not reasonably foreseeable; the impacts of catastrophic spills are discussed in *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c). Austin et al. (2014b and 2014c) are two volumes of a recently completed study of the economic and social impacts of the *Deepwater Horizon* oil spill. This study employed an ethnographic methodology that entailed analyzing data sources, examining various sources of descriptive information, and conducting field interviews with people in Louisiana, Mississippi, and Alabama. This study documents the complex and varied impacts of the *Deepwater Horizon* oil spill during the 20 months subsequent to the spill. This study found that the impacts of the spill on a particular community depended on a number of factors, such as its proximity to the spill, its economic structure, its social and political dynamics, its organizational structure for dealing with disasters, and its ability to adapt to the structures of the oil cleanup and damage claims processes.

Overall, the economic impacts from accidental events likely to arise from a proposed action would likely be **negligible** or **minor** because any oil spills would likely be small.

Cumulative Impacts

OCS Oil- and Gas-Related Impacts

A proposed action would contribute to the economic impacts arising from the overall OCS Program (which includes all past, present, and future lease sales). The OCS Program would have economic impacts on a variety of firms along the OCS industry's supply chain. BOEM uses the model MAG-PLAN (described above) to estimate the impacts of offshore oil and gas industry expenditures. MAG-PLAN's estimates of the total employment, labor income, and value-added impacts for the low and high cumulative scenarios are presented in **Tables 4-29 and 4-30**. These tables present the average values (over 50 years), peak values, and percent of peak values relative to total employment, labor income, and value-added in each EIA. In the low scenario, the OCS Program would support a peak of 110,000 jobs, $8 billion in labor income, and $14 billion in value-added benefits throughout the United States. Most of these impacts would occur in the Gulf of Mexico region, particularly in coastal Texas and Louisiana. The EIAs that would experience the highest economic impacts are TX-3, TX-2, LA-3, LA-4, LA-6, MS-1, and AL-1. In the high scenario, a proposed action would support a peak of 250,000 jobs, $15 billion in labor income, and $24 billion in value-added. The geographic distributions of impacts would be similar to those of the low scenario.

The overall OCS Program (which refers to all past, present, and future lease sales; refer to **Chapter 3.3.1** for more information) generates government revenues through bonus bids, rental payments, and royalty payments (described above). BOEM estimates the revenues associated with the OCS Program under the low- and high-case cumulative scenarios for the following time horizons: bonus bids (26 years); rental payments (35 years); and royalty payments (70 years). In the low-case scenario, the OCS Program would generate approximately $9.4 billion in bonus bids, $2.6 billion in total rental payments (with an annual peak of $151 million), and $132 billion in royalty payments (with an annual peak of $3.5 billion). In the high-case scenario, the OCS Program would generate approximately $17.8 billion in bonus bids, $4.8 billion in total rental payments (with an annual peak of $175 million), and $922.9 billion in total royalty payments (with an annual peak of $18.8 billion). The geographic distributions of impacts from these revenues would correspond to those described above.

A proposed action would also contribute to the corporate profit impacts, market impacts, adverse impacts from routine activities, and adverse impacts from accidental events that would arise from the overall OCS Program. The impacts arising from the overall OCS Program would be directly proportional to the amount of activity (discussed above). The incremental contribution of any of the alternatives relative to the overall OCS Program would be minimal.

Table 4-29. Cumulative Low: MAG-PLAN Industry Expenditure Impacts.

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Texas									
TX-1	1,340	2,470	0.0%	67,000	127,000	0.0%	101,000	190,000	0.0%
TX-2	3,360	6,310	0.1%	204,000	378,000	0.1%	378,000	679,000	0.0%
TX-3	13,890	26,150	0.1%	1,276,000	2,437,000	0.1%	2,433,000	4,343,000	0.0%
TX-4	100	190	0.0%	6,000	12,000	0.0%	13,000	23,000	0.0%
TX-5	370	670	0.0%	27,000	48,000	0.0%	76,000	122,000	0.0%
TX-6	20	30	0.0%	1,000	2,000	0.0%	2,000	3,000	0.0%
All Texas EIAs	19,080	35,830	–	1,582,000	3,002,000	–	3,002,000	5,360,000	–
Rest of Texas	2,920	5,700	–	204,000	409,000	–	401,000	741,000	–
Texas Total	22,000	41,530	–	1,786,000	3,411,000	–	3,404,000	6,098,000	–
Louisiana									
LA-1	1,040	1,970	0.2%	74,000	141,000	0.2%	111,000	210,000	0.2%
LA-2	40	80	0.0%	2,000	3,000	0.0%	3,000	6,000	0.0%
LA-3	2,810	5,150	0.2%	147,000	266,000	0.1%	277,000	485,000	0.1%
LA-4	3,560	6,850	0.3%	247,000	476,000	0.3%	400,000	752,000	0.2%
LA-5	1,100	2,190	0.1%	57,000	115,000	0.0%	94,000	183,000	0.0%
LA-6	3,290	6,380	0.1%	198,000	383,000	0.1%	308,000	579,000	0.1%
LA-7	510	1,000	0.1%	26,000	51,000	0.0%	44,000	83,000	0.0%
All Louisiana EIAs	12,350	23,510	–	751,000	1,428,000	–	1,238,000	2,293,000	–
Rest of Louisiana	1,850	3,570	–	105,000	206,000	–	212,000	393,000	–
Louisiana Total	14,200	27,060	–	856,000	1,634,000	–	1,450,000	2,681,000	–
Mississippi									
MS-1	2,460	5,000	0.3%	129,000	264,000	0.3%	195,000	392,000	0.3%
MS-2	120	240	0.2%	4,000	8,000	0.1%	7,000	14,000	0.1%
All Mississippi EIAs	2,580	5,230	–	133,000	272,000	–	202,000	406,000	–
Rest of Mississippi	2,240	4,350	–	120,000	237,000	–	223,000	413,000	–
Mississippi Total	4,820	9,590	–	252,000	509,000	–	425,000	819,000	–
Alabama									
AL-1	2,810	5,900	0.2%	135,000	294,000	0.2%	227,000	473,000	0.2%
AL-2	220	450	0.1%	9,000	20,000	0.1%	18,000	35,000	0.1%
All Alabama EIAs	3,020	6,350	–	144,000	314,000	–	244,000	508,000	–
Rest of Alabama	1,760	3,540	–	104,000	218,000	–	205,000	386,000	–
Alabama Total	4,780	9,890	–	248,000	532,000	–	450,000	892,000	–
Florida									
FL-1	290	680	0.0%	21,000	53,000	0.0%	40,000	90,000	0.0%
FL-2	10	20	0.0%	0	1,000	0.0%	1,000	2,000	0.0%
FL-3	0	10	0.0%	0	0	0.0%	0	1,000	0.0%
FL-4	50	110	0.0%	3,000	7,000	0.0%	7,000	14,000	0.0%
FL-5	20	50	0.0%	1,000	3,000	0.0%	3,000	5,000	0.0%
FL-6	0	10	0.0%	0	1,000	0.0%	1,000	1,000	0.0%
All Florida EIAs	380	870	–	26,000	64,000	–	52,000	112,000	–
Rest of Florida	1,700	3,310	–	107,000	209,000	–	202,000	370,000	–
Florida Total	2,080	4,180	–	132,000	273,000	–	254,000	477,000	–
All States									
All EIAs in All States	37,410	71,780	–	2,635,000	5,080,000	–	4,738,000	8,675,000	–
All Gulf States	47,880	92,250	–	3,275,000	6,359,000	–	5,981,000	10,966,000	–

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
USA									
Rest of the United States	9,520	20,750	–	726,000	1,650,000	–	1,540,000	3,020,000	–
Totals									
Total Expenditure Impacts	57,400	113,000	–	4,000,000	8,009,000	–	7,521,000	13,986,000	–

Note: Totals may not sum due to rounding.

Source: BOEM internal modeling estimates.

Table 4-30. Cumulative High: MAG-PLAN Industry Expenditure Impacts.

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Texas									
TX-1	90	480	0.0%	4,000	20,000	0.0%	6,000	29,000	0.0%
TX-2	320	1,310	0.1%	17,000	66,000	0.1%	24,000	95,000	0.0%
TX-3	2,170	7,640	0.1%	178,000	617,000	0.1%	246,000	865,000	0.0%
TX-4	10	40	0.0%	1,000	2,000	0.0%	1,000	3,000	0.0%
TX-5	40	140	0.0%	2,000	8,000	0.0%	3,000	12,000	0.0%
TX-6	0	10	0.0%	0	0	0.0%	0	0	0.0%
All Texas EIAs	2,630	9,490	–	201,000	705,000	–	281,000	997,000	–
Rest of Texas	360	1,200	–	22,000	73,000	–	37,000	126,000	–
Texas Total	2,990	10,650	–	223,000	778,000	–	318,000	1,122,000	–
Louisiana									
LA-1	160	430	0.2%	11,000	30,000	0.2%	16,000	43,000	0.2%
LA-2	10	20	0.0%	0	1,000	0.0%	0	1,000	0.0%
LA-3	460	1,240	0.2%	23,000	61,000	0.1%	34,000	92,000	0.1%
LA-4	480	1,460	0.3%	31,000	95,000	0.3%	45,000	137,000	0.2%
LA-5	200	590	0.1%	10,000	28,000	0.0%	15,000	43,000	0.0%
LA-6	530	1,540	0.1%	31,000	90,000	0.1%	44,000	125,000	0.1%
LA-7	100	260	0.1%	4,000	12,000	0.0%	6,000	17,000	0.0%
All Louisiana EIAs	1,930	5,470	–	110,000	313,000	–	161,000	454,000	–
Rest of Louisiana	230	730	–	11,000	34,000	–	20,000	65,000	–
Louisiana Total	2,160	6,180	–	121,000	347,000	–	181,000	517,000	–
Mississippi									
MS-1	450	1,400	0.3%	20,000	64,000	0.3%	30,000	94,000	0.3%
MS-2	30	70	0.2%	1,000	2,000	0.1%	1,000	3,000	0.1%
All Mississippi EIAs	480	1,460	–	21,000	65,000	–	31,000	97,000	–
Rest of Mississippi	250	840	–	11,000	39,000	–	19,000	67,000	–
Mississippi Total	730	2,280	–	32,000	103,000	–	50,000	163,000	–
Alabama									
AL-1	510	1,650	0.2%	21,000	70,000	0.2%	34,000	115,000	0.2%
AL-2	40	130	0.1%	1,000	5,000	0.1%	3,000	9,000	0.1%
All Alabama EIAs	550	1,780	–	23,000	75,000	–	36,000	124,000	–
Rest of Alabama	200	710	–	10,000	35,000	–	18,000	65,000	–
Alabama Total	760	2,470	–	33,000	110,000	–	54,000	189,000	–

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Florida									
FL-1	20	150	0.0%	1,000	11,000	0.0%	2,000	18,000	0.0%
FL-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-3	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-4	10	20	0.0%	0	1,000	0.0%	1,000	2,000	0.0%
FL-5	0	10	0.0%	0	0	0.0%	0	1,000	0.0%
FL-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Florida EIAs	30	180	–	2,000	12,000	–	3,000	21,000	–
Rest of Florida	220	720	–	12,000	38,000	–	20,000	66,000	–
Florida Total	260	870	–	14,000	48,000	–	24,000	83,000	–
All States									
All EIAs in All States	5,630	18,360	–	356,000	1,165,000	–	512,000	1,682,000	–
All Gulf States	6,900	22,420	–	422,000	1,383,000	–	627,000	2,069,000	–
USA									
Rest of the United States	1,080	4,680	–	69,000	299,000	–	128,000	564,000	–
Totals									
Total Expenditure Impacts	7,980	27,030	–	491,000	1,669,000	–	755,000	2,605,000	–

Note: Totals may not sum due to rounding.

Source: BOEM internal modeling estimates.

Non-OCS Oil- and Gas-Related Impacts

Woods & Poole Data

Most approaches to analyzing cumulative impacts begin by assembling a list of other likely projects and actions that would be included with a proposed action for analysis. However, no such list of future projects and actions could be assembled that would be sufficiently current and comprehensive to support a cumulative analysis for all 133 of the coastal counties and parishes in the analysis area. Instead of an arbitrary assemblage of future possible projects and actions, the analysis employs the economic and demographic projections from Woods & Poole Economics, Inc. (2015) to define the contributions of other likely projects, actions, and trends to the cumulative case. These projections are based on local, regional, and national data, as well as likely changes to economic and demographic conditions. Therefore, the projections include employment associated with the continuation of current patterns in OCS leasing activity, as well as the continuation of trends in other industries important to the region.

Woods & Poole Economics, Inc. (2015) provides county-level economic and demographic data for prior years, as well as forecasts of these data through 2050. **Table 4-31** aggregates Woods & Poole data by EIA and presents each EIA's population, employment, gross regional product, labor income, median age, male percentage, and race composition. The largest EIAs (presented in descending order of gross regional product) are TX-3 (which includes Houston and Galveston), FL-5 (which includes Tampa), LA-6 (which includes New Orleans), LA-5 (which includes Baton Rouge), FL-6, and TX-1. The smallest EIAs (presented in ascending order of gross regional product) are MS-2, TX-6, AL-2, LA-2, and TX-4. **Table 4-31** presents Woods & Poole's forecasted levels of economic and demographic variables in 2050. From 2015 through 2050, the fastest population and employment growth is forecast in TX-1, TX-3, FL-6, and FL-4; the slowest growth is forecast in LA-6, TX-5, AL-2, and MS-1.

Table 4-31. Economic and Demographic Information for BOEM's Economic Impact Areas in 2050.

	Economic Variables				Demographic Variables						
EIA	Population	Employment	Gross Regional Product[1]	Labor Income	Median Age	Male %	White	Black	Hispanic	Native American	Asian
Texas											
TX-1	3,211,678	1,510,514	122,978,193	70,686,006	37.1	49.6%	3.9%	0.5%	94.8%	0.0%	0.8%
TX-2	901,108	594,209	74,012,799	37,740,590	39.3	50.9%	26.1%	6.4%	64.8%	0.3%	2.5%
TX-3	11,318,207	7,262,133	1,095,629,086	667,969,020	37.7	50.1%	18.8%	14.1%	53.8%	0.2%	13.0%
TX-4	244,211	93,227	7,722,339	4,108,509	41.2	49.8%	61.6%	10.3%	26.3%	0.5%	1.4%
TX-5	407,234	257,973	29,621,937	17,100,218	40.4	53.4%	32.9%	23.2%	40.0%	0.3%	3.5%
TX-6	63,947	34,006	2,596,031	1,311,359	40.6	49.9%	52.4%	30.0%	15.5%	0.6%	1.4%
Louisiana											
LA-1	248,184	158,977	18,087,099	9,507,742	40.5	48.8%	65.3%	26.8%	4.9%	0.7%	2.3%
LA-2	108,507	56,413	7,166,445	3,673,737	35.8	51.3%	68.3%	15.5%	12.1%	1.5%	2.6%
LA-3	776,541	522,500	71,038,683	33,614,841	40.2	49.5%	62.4%	30.6%	4.9%	0.5%	1.6%
LA-4	428,273	322,607	46,645,705	22,575,517	41.5	49.6%	56.0%	26.2%	11.3%	3.6%	3.0%
LA-5	1,253,207	823,740	94,931,543	50,201,612	42.7	49.2%	49.4%	41.3%	6.1%	0.3%	3.0%
LA-6	924,191	755,835	94,351,565	50,648,128	39.5	49.3%	32.7%	42.0%	19.6%	0.4%	5.3%
LA-7	647,551	335,006	34,109,728	18,482,013	41.5	48.5%	64.4%	23.5%	9.6%	0.4%	2.0%
Mississippi											
MS-1	527,738	298,996	21,694,991	16,628,795	41.0	49.2%	63.0%	24.4%	9.3%	0.4%	2.8%
MS-2	87,917	28,786	1,880,313	1,129,831	41.1	53.1%	72.0%	24.9%	2.4%	0.3%	0.4%
Alabama											
AL-1	840,489	525,223	43,583,841	25,996,755	41.9	47.9%	61.7%	28.6%	6.2%	0.8%	2.7%
AL-2	116,672	66,584	5,802,458	3,319,000	46.3	50.7%	45.4%	46.6%	2.9%	4.2%	0.9%
Florida											
FL-1	1,271,987	756,445	67,816,779	40,841,162	42.5	51.9%	69.3%	16.9%	9.3%	0.6%	3.9%
FL-2	721,561	396,668	33,967,696	20,313,641	45.2	52.1%	53.3%	37.6%	5.9%	0.4%	2.8%
FL-3	335,944	132,391	10,488,863	6,078,422	44.1	56.4%	64.1%	26.4%	7.9%	0.4%	1.2%
FL-4	2,445,932	1,050,736	78,635,995	48,938,904	52.0	50.3%	69.2%	12.7%	14.7%	0.3%	3.1%
FL-5	6,237,613	3,589,267	365,775,112	220,553,234	45.0	49.5%	45.3%	14.1%	34.0%	0.2%	6.4%
FL-6	2,465,544	1,320,017	117,042,429	70,468,182	47.0	51.0%	50.9%	7.4%	40.0%	0.2%	1.5%

[1] Gross Regional Product is presented in thousands of dollars.

Source: Woods & Poole Economics, Inc., 2015.

Overall Energy Market

The oil and gas industry would be impacted by the various forces affecting supply and demand for energy products. For example, the rapid expansion of U.S. onshore energy production in recent years contributed to a noticeable decline in oil prices beginning in late 2014. Energy supply and demand has also been affected by international developments, including policy towards Iran and decisions made by the Organization for Petroleum Exporting Countries. Demand for energy products would also be affected by various factors, including economic activity, technological developments, and government policies. The Energy Information Administration provides forecasts of energy markets that incorporate these various factors. In particular, the Energy Information Administration publishes monthly short-term (2-year) forecasts (USDOE, Energy Information Administration, 2015h) and annual long-term (25-year) forecasts (USDOE, Energy Information Administration, 2015i). The incremental contribution of a proposed action relative to the outlooks described in these reports is expected to be minimal.

Incomplete or Unavailable Information

Even after evaluating the information above, there is still incomplete or unavailable information. This information primarily relates to the onshore geographic distributions of economic impacts arising from the OCS Program, which would allow BOEM to better estimate the impacts from routine activities and cumulative impacts. This information is difficult to obtain since most data sources do not adequately differentiate between onshore and offshore oil and gas activities. In addition, standard data sources do not trace revenue and corporate profit streams to ultimate expenditures. BOEM used reasonably accepted scientific methodologies to extrapolate from existing information in completing the relevant analysis and formulating the conclusions presented here. For example, BOEM used the model MAG-PLAN to estimate the impacts of the alternatives and OCS Program. In addition, the economic impacts arising from the OCS Program are generally positive, not adverse. Therefore, BOEM has determined that the incomplete or unavailable information is not essential to a reasoned choice among alternatives.

4.14.2.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

Alternative A entails holding a regionwide lease sale. The impacts of Alternative A would correspond to the impacts discussed above. This chapter will clarify the numerical impact estimates for Alternative A. The MAG-PLAN's estimates of the total employment, labor income, and value-added expenditure impacts for the low and high scenarios are presented in **Tables 4-32 and 4-33**. These tables present the average values (over 50 years), peak values, and percent of peak values relative to total employment, labor income, and value-added in each EIA. The average values are calculated over 50 years for consistency and because that is the time horizon over which activities arising from the alternatives are expected to occur. In the low scenario, a proposed action would support a peak of 9,500 jobs, $600 million in labor income, and $970 million in value-added benefits throughout the United States. Most of these impacts would occur in the Gulf of Mexico region, particularly in coastal Texas and Louisiana. The EIAs that would experience the highest economic impacts are TX-3, TX-2, LA-3, LA-4, LA-6, MS-1, and AL-1. However, these impacts would represent a small fraction of each EIA's economy. In the high scenario, a proposed action would support a peak of 27,000 jobs, $1,7 billion in labor income, and $2.6 billion in value-added. The geographic distributions of impacts would be similar to those of the low scenario. However, these expenditure impacts would represent less than 1 percent of the economies of all EIAs. The impacts of the very high scenario would be double the impacts of the high scenario. However, as discussed previously, the very high scenario is unlikely to occur.

Table 4-32. Gulf of Mexico Single Low: MAG-PLAN Industry Expenditure Impacts.

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Texas									
TX-1	20	220	0.0%	1,000	9,000	0.0%	1,000	13,000	0.0%
TX-2	60	610	0.1%	3,000	30,000	0.1%	4,000	44,000	0.0%
TX-3	250	1,900	0.1%	20,000	150,000	0.1%	31,000	241,000	0.0%
TX-4	0	20	0.0%	0	1,000	0.0%	0	2,000	0.0%
TX-5	10	50	0.0%	0	3,000	0.0%	1,000	5,000	0.0%
TX-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Texas EIAs	340	2,660	–	25,000	185,000	–	38,000	294,000	–
Rest of Texas	70	460	–	4,000	29,000	–	7,000	51,000	–
Texas Total	410	3,120	–	28,000	213,000	–	45,000	345,000	–
Louisiana									
LA-1	20	170	0.2%	2,000	12,000	0.2%	2,000	17,000	0.2%
LA-2	0	10	0.0%	0	0	0.0%	0	0	0.0%
LA-3	50	340	0.2%	3,000	16,000	0.1%	4,000	26,000	0.1%
LA-4	70	600	0.3%	5,000	40,000	0.3%	7,000	57,000	0.2%
LA-5	20	200	0.1%	1,000	10,000	0.0%	2,000	16,000	0.0%
LA-6	60	500	0.1%	4,000	30,000	0.1%	5,000	42,000	0.1%
LA-7	10	80	0.1%	1,000	4,000	0.0%	1,000	6,000	0.0%
All Louisiana EIAs	250	1,870	–	14,000	113,000	–	21,000	163,000	–
Rest of Louisiana	40	300	–	2,000	14,000	–	4,000	28,000	–
Louisiana Total	290	2,150	–	16,000	126,000	–	25,000	190,000	–
Mississippi									
MS-1	50	470	0.3%	3,000	24,000	0.3%	4,000	35,000	0.3%
MS-2	0	20	0.2%	0	1,000	0.1%	0	1,000	0.1%
All Mississippi EIAs	60	490	–	3,000	25,000	–	4,000	36,000	–
Rest of Mississippi	50	350	–	2,000	16,000	–	4,000	29,000	–
Mississippi Total	100	830	–	5,000	41,000	–	8,000	64,000	–
Alabama									
AL-1	60	600	0.2%	3,000	28,000	0.2%	5,000	47,000	0.2%
AL-2	10	40	0.1%	0	2,000	0.1%	0	3,000	0.1%
All Alabama EIAs	70	640	–	3,000	30,000	–	5,000	51,000	–
Rest of Alabama	40	310	–	2,000	16,000	–	4,000	30,000	–
Alabama Total	110	940	–	5,000	45,000	–	9,000	80,000	–
Florida									
FL-1	10	90	0.0%	0	6,000	0.0%	1,000	11,000	0.0%
FL-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-3	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-4	0	10	0.0%	0	1,000	0.0%	0	1,000	0.0%

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
FL-5	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Florida EIAs	10	100	–	1,000	7,000	–	1,000	12,000	–
Rest of Florida	40	290	–	2,000	14,000	–	4,000	27,000	–
Florida Total	50	380	–	3,000	20,000	–	5,000	37,000	–
All States									
All EIAs in All States	720	5,730	–	45,000	358,000	–	69,000	550,000	–
All Gulf States	960	7,420	–	58,000	445,000	–	91,000	713,000	–
USA									
Rest of the United States	220	2,150	–	14,000	136,000	–	27,000	262,000	–
Totals									
Total Expenditure Impacts	1,180	9,540	–	72,000	579,000	–	118,000	970,000	–

Note: Totals may not sum due to rounding.

Source: BOEM internal modeling estimates.

Table 4-33. Gulf of Mexico Single High: MAG-PLAN Industry Expenditure Impacts.

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Texas									
TX-1	90	480	0.0%	4,000	20,000	0.0%	6,000	29,000	0.0%
TX-2	320	1,310	0.1%	17,000	66,000	0.1%	24,000	95,000	0.0%
TX-3	2,170	7,640	0.1%	178,000	617,000	0.1%	246,000	865,000	0.0%
TX-4	10	40	0.0%	1,000	2,000	0.0%	1,000	3,000	0.0%
TX-5	40	140	0.0%	2,000	8,000	0.0%	3,000	12,000	0.0%
TX-6	0	10	0.0%	0	0	0.0%	0	0	0.0%
All Texas EIAs	2,630	9,490	–	201,000	705,000	–	281,000	997,000	–
Rest of Texas	360	1,200	–	22,000	73,000	–	37,000	126,000	–
Texas Total	2,990	10,650	–	223,000	778,000	–	318,000	1,122,000	–
Louisiana									
LA-1	160	430	0.2%	11,000	30,000	0.2%	16,000	43,000	0.2%
LA-2	10	20	0.0%	0	1,000	0.0%	0	1,000	0.0%
LA-3	460	1,240	0.2%	23,000	61,000	0.1%	34,000	92,000	0.1%
LA-4	480	1,460	0.3%	31,000	95,000	0.3%	45,000	137,000	0.2%
LA-5	200	590	0.1%	10,000	28,000	0.0%	15,000	43,000	0.0%
LA-6	530	1,540	0.1%	31,000	90,000	0.1%	44,000	125,000	0.1%
LA-7	100	260	0.1%	4,000	12,000	0.0%	6,000	17,000	0.0%
All Louisiana EIAs	1,930	5,470	–	110,000	313,000	–	161,000	454,000	–
Rest of Louisiana	230	730	–	11,000	34,000	–	20,000	65,000	–
Louisiana Total	2,160	6,180	–	121,000	347,000	–	181,000	517,000	–
Mississippi									
MS-1	450	1,400	0.3%	20,000	64,000	0.3%	30,000	94,000	0.3%
MS-2	30	70	0.2%	1,000	2,000	0.1%	1,000	3,000	0.1%
All Mississippi EIAs	480	1,460	–	21,000	65,000	–	31,000	97,000	–

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Rest of Mississippi	250	840	–	11,000	39,000	–	19,000	67,000	–
Mississippi Total	730	2,280	–	32,000	103,000	–	50,000	163,000	–
Alabama									
AL-1	510	1,650	0.2%	21,000	70,000	0.2%	34,000	115,000	0.2%
AL-2	40	130	0.1%	1,000	5,000	0.1%	3,000	9,000	0.1%
All Alabama EIAs	550	1,780	–	23,000	75,000	–	36,000	124,000	–
Rest of Alabama	200	710	–	10,000	35,000	–	18,000	65,000	–
Alabama Total	760	2,470	–	33,000	110,000	–	54,000	189,000	–
Florida									
FL-1	20	150	0.0%	1,000	11,000	0.0%	2,000	18,000	0.0%
FL-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-3	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-4	10	20	0.0%	0	1,000	0.0%	1,000	2,000	0.0%
FL-5	0	10	0.0%	0	0	0.0%	0	1,000	0.0%
FL-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Florida EIAs	30	180	–	2,000	12,000	–	3,000	21,000	–
Rest of Florida	220	720	–	12,000	38,000	–	20,000	66,000	–
Florida Total	260	870	–	14,000	48,000	–	24,000	83,000	–
All States									
All EIAs in All States	5,630	18,360	–	356,000	1,165,000	–	512,000	1,682,000	–
All Gulf States	6,900	22,420	–	422,000	1,383,000	–	627,000	2,069,000	–
USA									
Rest of the United States	1,080	4,680	–	69,000	299,000	–	128,000	564,000	–
Totals									
Total Expenditure Impacts	7,980	27,030	–	491,000	1,669,000	–	755,000	2,605,000	–

Note: Totals may not sum due to rounding.

Source: BOEM internal modeling estimates.

Alternative A would generate government revenues through bonus bids, rental payments, and royalty payments. In the low scenario, a regionwide lease sale would generate approximately $260 million in bonus bids, $46 million in total rental payments (with an annual peak of $6.7 million), and $1.7 billion in royalty payments (with an annual peak of $119 million). In the high scenario, a regionwide lease sale would generate approximately $520 million in bonus bids, $98 million in total rental payments (with an annual peak of $14 million), and $19.8 billion in total royalty payments (with an annual peak of $1.2 billion). The revenue impacts of the very high scenario would be double the impacts of the high scenario. The corporate profit and market impacts, the adverse impacts arising from routine activities and accidental events, and the cumulative impacts would be proportional to the amount of activities as described above.

Overall, Alternative A would lead to beneficial impacts arising from industry expenditures, government revenues, corporate profits, and other market impacts. Some of these impacts would be concentrated along the Gulf Coast, while others would be widely distributed. Alternative A would also lead to negative economic impacts arising from accidental events and other sources. A proposed action should be viewed in light of the OCS Program, as well the numerous forces that can affect energy markets and the overall economy. Most of the incremental economic impacts of a proposed action are forecast to be **beneficial**, although there would be some **negligible** to **minor** adverse impacts due to oil spills and to effects on industries that compete with the offshore oil and gas industry for resources. Therefore, the impacts of Alternative A would lead to **beneficial** impacts, as well as some offsetting **negligible** to **minor** adverse impacts.

4.14.2.2.2 Alternative B—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Alternative B would entail leasing only in the CPA and EPA. As discussed above, the low and high scenarios assume that Alternative B is chosen in the context of typically holding two lease sales per year. If Alternative B were chosen in the context of the CPA/EPA area only being offered once in a year, the economic impacts would be approximately double those presented here because leasing activities would not be spread over the two lease sales; the maximum impacts would correspond to the very high scenario discussed above.

The positive economic impacts of Alternative B would be slightly less than for Alternative A. The MAG-PLAN's estimates of the total employment, labor income, and value-added impacts for the low and high scenarios are presented in **Tables 4-34 and 4-35**. These tables present the average values (over 50 years), peak values, and percent of peak values relative to total employment, labor income, and value-added in each EIA. In the low scenario, Alternative B would support a peak of 7,300 jobs, $440 million in labor income, and $740 million in value-added benefits throughout the United States. Most of these impacts would occur in the Gulf of Mexico region, particularly in coastal Texas and Louisiana. The EIAs that would experience the highest economic impacts are TX-3, TX-2, LA-3, LA-4, LA-6, MS-1, and AL-1. The proportion of total economic impacts would be slightly higher in Louisiana, Mississippi, and Alabama and lower in Texas compared with Alternative A. However, these impacts would represent small fractions of each EIA's economy. In the high scenario, Alternative B would support a peak of 20,000 jobs, $1.2 billion in labor income, and $1.9 billion in value-added. The geographic distributions of impacts would be similar to those of the low scenario. However, the expenditure impacts would represent <1 percent of the economies of all EIAs. The impacts of the very high scenario would be double the impacts of the high scenario. However, as discussed previously, the very high scenario is unlikely to occur. The revenue, corporate profit, market, and adverse impacts would also be proportionately lower. The nature of potential accidental events would be the same, although slightly fewer activities would likely lead to slightly fewer accidental events.

Overall, Alternative B would lead to beneficial impacts arising from industry expenditures, government revenues, corporate profits, and other market impacts. Some of these impacts would be concentrated along the Gulf Coast, while others would be widely distributed. Alternative B would also lead to negative economic impacts arising from accidental events and other sources. The proposed action should be viewed in light of the OCS Program, as well the numerous forces that can affect energy markets and the overall economy. Most of the incremental economic impacts of the proposed action are forecast to be positive, although there would be some **negligible** to **minor** adverse impacts due to oil spills and to effects on industries that compete with the offshore oil and gas industry for resources. The differences in the adverse impacts among the alternatives would be roughly proportional to the level of OCS oil- and gas-related activities, but the precise impacts would depend on the types and locations of activities.

Table 4-34. CPA Single Low: MAG-PLAN Industry Expenditure Impacts.

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Texas									
TX-1	10	90	0.0%	0	4,000	0.0%	1,000	7,000	0.0%
TX-2	40	390	0.1%	2,000	19,000	0.1%	3,000	29,000	0.0%
TX-3	160	1,040	0.1%	13,000	85,000	0.1%	20,000	139,000	0.0%
TX-4	0	10	0.0%	0	0	0.0%	0	1,000	0.0%
TX-5	0	20	0.0%	0	1,000	0.0%	0	2,000	0.0%
TX-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Texas EIAs	210	1,480	–	16,000	107,000	–	24,000	173,000	–
Rest of Texas	50	350	–	3,000	22,000	–	5,000	39,000	–
Texas Total	260	1,830	–	19,000	129,000	–	30,000	212,000	–
Louisiana									
LA-1	20	160	0.2%	2,000	12,000	0.2%	2,000	17,000	0.2%
LA-2	0	10	0.0%	0	0	0.0%	0	0	0.0%
LA-3	50	310	0.2%	2,000	14,000	0.1%	4,000	23,000	0.1%
LA-4	60	530	0.3%	4,000	36,000	0.3%	6,000	51,000	0.2%
LA-5	20	190	0.1%	1,000	10,000	0.0%	2,000	15,000	0.0%
LA-6	60	490	0.1%	4,000	29,000	0.1%	5,000	40,000	0.1%
LA-7	10	80	0.1%	0	4,000	0.0%	1,000	6,000	0.0%
All Louisiana EIAs	230	1,760	–	14,000	106,000	–	20,000	152,000	–
Rest of Louisiana	30	220	–	2,000	10,000	–	3,000	21,000	–
Louisiana Total	260	1,970	–	15,000	117,000	–	23,000	173,000	–
Mississippi									
MS-1	50	440	0.3%	3,000	23,000	0.3%	4,000	32,000	0.3%
MS-2	0	20	0.2%	0	1,000	0.1%	0	1,000	0.1%
All Mississippi EIAs	50	460	–	3,000	23,000	–	4,000	33,000	–
Rest of Mississippi	40	270	–	2,000	13,000	–	3,000	22,000	–
Mississippi Total	90	720	--	4,000	36,000	--	7,000	55,000	--
Alabama									
AL-1	60	530	0.2%	3,000	25,000	0.2%	4,000	41,000	0.2%
AL-2	0	40	0.1%	0	2,000	0.1%	0	3,000	0.1%
All Alabama EIAs	60	570	–	3,000	27,000	–	5,000	44,000	–
Rest of Alabama	30	240	–	2,000	12,000	–	3,000	24,000	–
Alabama Total	100	810	–	5,000	39,000	–	8,000	67,000	–

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Florida									
FL-1	0	60	0.0%	0	4,000	0.0%	1,000	7,000	0.0%
FL-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-3	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-4	0	10	0.0%	0	0	0.0%	0	1,000	0.0%
FL-5	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Florida EIAs	10	70	–	0	5,000	–	1,000	8,000	–
Rest of Florida	30	220	–	2,000	11,000	–	3,000	21,000	–
Florida Total	40	290	–	2,000	15,000	–	4,000	29,000	–
All States									
All EIAs in All States	560	4,340	–	35,000	269,000	–	53,000	411,000	–
All Gulf States	750	5,640	–	45,000	336,000	–	71,000	536,000	–
USA									
Rest of the United States	180	1,640	–	11,000	104,000	–	21,000	200,000	–
Totals									
Total Expenditure Impacts	930	7,280	–	56,000	440,000	–	92,000	736,000	–

Note: Totals may not sum due to rounding.

Source: BOEM internal modeling estimates.

Table 4-35. CPA Single High: MAG-PLAN Industry Expenditure Impacts.

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Texas									
TX-1	50	140	0.0%	3,000	7,000	0.0%	4,000	11,000	0.0%
TX-2	220	630	0.1%	11,000	33,000	0.1%	16,000	47,000	0.0%
TX-3	1,740	5,220	0.1%	145,000	435,000	0.1%	199,000	591,000	0.0%
TX-4	10	20	0.0%	0	1,000	0.0%	1,000	2,000	0.0%
TX-5	10	40	0.0%	1,000	2,000	0.0%	1,000	3,000	0.0%
TX-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Texas EIAs	2,030	6,060	–	160,000	478,000	–	221,000	654,000	–
Rest of Texas	310	860	–	19,000	53,000	–	31,000	90,000	–
Texas Total	2,340	6,930	–	179,000	531,000	–	252,000	744,000	–
Louisiana									
LA-1	160	420	0.2%	11,000	29,000	0.2%	16,000	43,000	0.2%
LA-2	10	20	0.0%	0	1,000	0.0%	0	1,000	0.0%
LA-3	420	1,110	0.2%	21,000	55,000	0.1%	31,000	81,000	0.1%
LA-4	430	1,200	0.3%	29,000	80,000	0.3%	42,000	115,000	0.2%
LA-5	200	570	0.1%	9,000	27,000	0.0%	14,000	41,000	0.0%
LA-6	510	1,470	0.1%	30,000	86,000	0.1%	42,000	119,000	0.1%
LA-7	90	250	0.1%	4,000	11,000	0.0%	6,000	16,000	0.0%
All Louisiana EIAs	1,820	5,040	–	104,000	288,000	–	152,000	417,000	–
Rest of Louisiana	190	520	–	9,000	24,000	–	17,000	46,000	–

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Louisiana Total	2,010	5,540	–	113,000	312,000	–	168,000	461,000	–
Mississippi									
MS-1	440	1,290	0.3%	19,000	57,000	0.3%	29,000	85,000	0.3%
MS-2	30	70	0.2%	1,000	2,000	0.1%	1,000	3,000	0.1%
All Mississippi EIAs	470	1,360	–	20,000	59,000	–	30,000	88,000	–
Rest of Mississippi	210	590	–	9,000	27,000	–	16,000	47,000	–
Mississippi Total	680	1,950	–	29,000	86,000	–	46,000	134,000	–
Alabama									
AL-1	500	1,510	0.2%	21,000	63,000	0.2%	33,000	101,000	0.2%
AL-2	40	120	0.1%	1,000	4,000	0.1%	3,000	7,000	0.1%
All Alabama EIAs	540	1,630	–	22,000	67,000	–	35,000	108,000	–
Rest of Alabama	170	490	–	8,000	24,000	–	15,000	44,000	–
Alabama Total	710	2,120	–	30,000	92,000	–	50,000	152,000	–
Florida									
FL-1	20	90	0.0%	1,000	6,000	0.0%	2,000	11,000	0.0%
FL-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-3	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-4	0	10	0.0%	0	1,000	0.0%	0	1,000	0.0%
FL-5	0	10	0.0%	0	0	0.0%	0	1,000	0.0%
FL-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Florida EIAs	30	110	–	1,000	7,000	–	3,000	13,000	–
Rest of Florida	190	510	–	10,000	27,000	–	17,000	46,000	–
Florida Total	220	610	–	12,000	33,000	–	20,000	57,000	–
All States									
All EIAs in All States	4,890	14,190	–	307,000	899,000	–	440,000	1,278,000	–
All Gulf States	5,950	17,140	–	363,000	1,054,000	–	536,000	1,549,000	–
USA									
Rest of the United States	890	2,990	–	57,000	192,000	–	106,000	358,000	–
Totals									
Total Expenditure Impacts	6,840	20,140	–	420,000	1,246,000	–	642,000	1,907,000	–

Note: Totals may not sum due to rounding.

Source: BOEM internal modeling estimates.

4.14.2.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Alternative C would entail leasing only in the WPA. As discussed above, the low and high scenarios assume that Alternative C is chosen in the context of typically holding two lease sales per year. If Alternative C were chosen in the context of the WPA area only being offered once in a year, the economic impacts would be approximately double those presented here because leasing activities would not be spread over the two lease sales; the maximum impacts would correspond to the very high scenario discussed above.

The positive economic impacts of Alternative C would be less than for Alternative A, particularly since less activity generally occurs in the WPA relative to the CPA. MAG-PLAN's estimates of the total employment, labor income, and value-added impacts for the low and high scenarios are presented in **Tables 4-36 and 4-37**. These tables present the average values (over 50 years), peak values, and the percent of peak values relative to total employment, labor income, and value-added in each EIA. In the low scenario, Alternative C would support a peak of 2,300 jobs, $140 million in labor income, and $230 million in value-added benefits throughout the United States. Most of these impacts would occur in the Gulf Region. The EIAs that would experience the highest economic impacts are TX-3, TX-2, TX-1, LA-4, and AL-1. The proportion of total economic impacts would be higher in Texas (and lower in the other Gulf States) compared to Alternative A. However, these impacts would represent small fractions of each EIAs economy. In the high scenario, Alternative C would support a peak of 6,900 jobs, $420 million in labor income, and $700 million in value-added. The geographic distributions of impacts would be similar to those of the low scenario. The impacts of the very high scenario would be double the impacts of the high scenario. However, as discussed previously, the very high scenario is unlikely to occur. The revenue, corporate profit, market, and adverse impacts would also be proportionately lower. The nature of potential accidental events would be the same, although slightly fewer activities would likely lead to slightly fewer accidental events.

Overall, Alternative C would lead to beneficial impacts arising from industry expenditures, government revenues, corporate profits, and other market impacts. Some of these impacts would be concentrated along the Gulf Coast, while others would be widely distributed. Alternative C would also lead to negative economic impacts arising from accidental events and other sources. A proposed action should be viewed in light of the OCS Program, as well the numerous forces that can affect energy markets and the overall economy. Most of the incremental economic impacts of a proposed action are forecast to be positive, although there would be some **negligible** to **minor** adverse impacts due to oil spills and to effects on industries that compete with the offshore oil and gas industry for resources.

Table 4-36. WPA Single Low: MAG-PLAN Industry Expenditure Impacts.

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Texas									
TX-1	10	130	0.0%	0	4,000	0.0%	1,000	6,000	0.0%
TX-2	20	220	0.1%	1,000	10,000	0.1%	2,000	15,000	0.0%
TX-3	100	860	0.1%	7,000	65,000	0.1%	11,000	102,000	0.0%
TX-4	0	10	0.0%	0	0	0.0%	0	0	0.0%
TX-5	0	30	0.0%	0	2,000	0.0%	0	3,000	0.0%
TX-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Texas EIAs	130	1,180	–	9,000	77,000	–	13,000	121,000	–
Rest of Texas	10	110	–	1,000	7,000	–	1,000	12,000	–
Texas Total	150	1,290	–	10,000	84,000	–	15,000	133,000	–

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Louisiana									
LA-1	0	0	0.2%	0	0	0.2%	0	0	0.2%
LA-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
LA-3	0	30	0.2%	0	2,000	0.1%	0	3,000	0.1%
LA-4	10	70	0.3%	0	4,000	0.3%	1,000	6,000	0.2%
LA-5	0	10	0.1%	0	0	0.0%	0	1,000	0.0%
LA-6	0	20	0.1%	0	1,000	0.1%	0	2,000	0.1%
LA-7	0	0	0.1%	0	0	0.0%	0	0	0.0%
All Louisiana EIAs	20	110	–	1,000	7,000	–	1,000	10,000	–
Rest of Louisiana	10	80	–	0	4,000	–	1,000	7,000	–
Louisiana Total	20	180	–	1,000	9,000	–	2,000	16,000	–
Mississippi									
MS-1	0	30	0.3%	0	2,000	0.3%	0	3,000	0.3%
MS-2	0	0	0.2%	0	0	0.1%	0	0	0.1%
All Mississippi EIAs	0	30	–	0	2,000	–	0	3,000	–
Rest of Mississippi	10	90	–	0	4,000	–	1,000	7,000	–
Mississippi Total	10	110	–	1,000	5,000	–	1,000	9,000	–
Alabama									
AL-1	0	70	0.2%	0	3,000	0.2%	0	7,000	0.2%
AL-2	0	0	0.1%	0	0	0.1%	0	0	0.1%
All Alabama EIAs	0	70	–	0	3,000	–	0	7,000	–
Rest of Alabama	10	70	–	0	3,000	–	1,000	7,000	–
Alabama Total	10	120	–	1,000	6,000	–	1,000	13,000	–
Florida									
FL-1	0	30	0.0%	0	2,000	0.0%	0	4,000	0.0%
FL-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-3	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-4	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-5	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Florida EIAs	0	30	–	0	2,000	–	0	4,000	–
Rest of Florida	10	70	–	0	3,000	–	1,000	6,000	–
Florida Total	10	90	–	1,000	5,000	–	1,000	9,000	–
All States									
All EIAs in All States	160	1,400	–	10,000	89,000	–	16,000	139,000	–
All Gulf States	210	1,790	–	13,000	109,000	–	20,000	177,000	–
USA									
Rest of the United States	50	500	–	3,000	32,000	–	6,000	62,000	–
Totals									
Total Expenditure Impacts	250	2,260	–	16,000	139,000	–	26,000	234,000	–

Note: Totals may not sum due to rounding.

Source: BOEM internal modeling estimates.

Table 4-37. WPA Single High: MAG-PLAN Industry Expenditure Impacts.

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
Texas									
TX-1	40	340	0.0%	2,000	12,000	0.0%	2,000	18,000	0.0%
TX-2	110	680	0.1%	5,000	33,000	0.1%	8,000	48,000	0.0%
TX-3	430	2,420	0.1%	32,000	182,000	0.1%	47,000	274,000	0.0%
TX-4	0	20	0.0%	0	1,000	0.0%	0	2,000	0.0%
TX-5	20	110	0.0%	1,000	5,000	0.0%	2,000	9,000	0.0%
TX-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Texas EIAs	600	3,430	–	41,000	227,000	–	60,000	342,000	–
Rest of Texas	60	330	–	3,000	20,000	–	6,000	36,000	–
Texas Total	660	3,720	–	44,000	247,000	–	66,000	378,000	–
Louisiana									
LA-1	0	10	0.2%	0	0	0.2%	0	1,000	0.2%
LA-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
LA-3	40	120	0.2%	2,000	7,000	0.1%	3,000	10,000	0.1%
LA-4	40	260	0.3%	3,000	15,000	0.3%	4,000	22,000	0.2%
LA-5	10	20	0.1%	0	1,000	0.0%	0	2,000	0.0%
LA-6	20	70	0.1%	1,000	5,000	0.1%	2,000	6,000	0.1%
LA-7	0	10	0.1%	0	1,000	0.0%	0	1,000	0.0%
All Louisiana EIAs	110	430	–	6,000	25,000	–	9,000	37,000	–
Rest of Louisiana	40	200	–	2,000	10,000	–	3,000	19,000	–
Louisiana Total	150	640	–	8,000	35,000	–	12,000	56,000	–
Mississippi									
MS-1	10	110	0.3%	1,000	7,000	0.3%	1,000	9,000	0.3%
MS-2	0	0	0.2%	0	0	0.1%	0	0	0.1%
All Mississippi EIAs	10	110	–	1,000	7,000	–	1,000	10,000	–
Rest of Mississippi	40	240	–	2,000	11,000	–	3,000	20,000	–
Mississippi Total	50	330	–	3,000	17,000	–	4,000	28,000	–
Alabama									
AL-1	10	140	0.2%	1,000	7,000	0.2%	1,000	14,000	0.2%
AL-2	0	10	0.1%	0	0	0.1%	0	1,000	0.1%
All Alabama EIAs	10	150	–	1,000	7,000	–	1,000	15,000	–
Rest of Alabama	30	220	–	2,000	11,000	–	3,000	21,000	–
Alabama Total	50	350	–	2,000	18,000	–	4,000	37,000	–
Florida									
FL-1	10	60	0.0%	0	4,000	0.0%	1,000	7,000	0.0%
FL-2	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-3	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-4	0	10	0.0%	0	0	0.0%	0	1,000	0.0%
FL-5	0	0	0.0%	0	0	0.0%	0	0	0.0%
FL-6	0	0	0.0%	0	0	0.0%	0	0	0.0%
All Florida EIAs	10	70	–	0	5,000	–	1,000	9,000	–
Rest of Florida	30	210	–	2,000	11,000	–	3,000	20,000	–
Florida Total	40	270	–	2,000	14,000	–	4,000	26,000	–
All States									
All EIAs in All States	750	4,170	–	49,000	266,000	–	72,000	404,000	–
All Gulf States	950	5,280	–	59,000	329,000	–	91,000	520,000	–

Economic Impact Area	Employment Impacts (number of jobs)			Labor Income Impacts ($ thousands)			Value-Added Impacts ($ thousands)		
	Average	Peak	Peak %	Average	Peak	Peak %	Average	Peak	Peak %
USA									
Rest of the United States	190	1,680	–	12,000	106,000	–	23,000	206,000	–
Totals									
Total Expenditure Impacts	1,130	6,890	–	71,000	423,000	–	113,000	698,000	–

Note: Totals may not sum due to rounding.

Source: BOEM internal modeling estimates.

4.14.2.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Alternative D only slightly reduces the available areas for leasing. Therefore, the economic impacts of Alternative D would the same or only slightly less than the impacts of Alternative A, B, or C.

4.14.2.2.5 Alternative E—No Action

The selection of Alternative E would prevent the positive economic impacts described above from occurring; it would also prevent the associated negative impacts from occurring. The impacts of selecting Alternative E would depend on the extent to which the public were to interpret it as a signal of a policy change that would continue into future lease sales. For example, if the public were to interpret the selection of Alternative E as a one-time event, the economic impacts would be limited. However, the selection of Alternative E could impact longer-term oil and gas industry investment decisions if it introduced uncertainty regarding the OCS Program. This is particularly true given the long life cycles of oil and gas investment projects.

4.14.3 Social Factors (Including Environmental Justice)

While the entire petroleum industry (onshore, State waters, and OCS) has developed over decades and is deeply intertwined in the Gulf of Mexico region's communities and economies, a single lease sale is like a blip on a radar screen, i.e., one tiny piece of a vastly complex social and economic structure.

The petroleum industry as a whole in the Gulf of Mexico region has matured over several decades and is well-developed, expansive, extensive, and deeply intertwined in the regional communities and economies of the five coastal states, i.e., Texas, Louisiana, Mississippi, Alabama, and Florida. An inherent complication in conducting an impact analysis of OCS oil- and gas-related activities lies in the fact that the industry involves onshore, State offshore, and Federal OCS exploration, development, and production. Teasing out the OCS oil- and gas-related impacts from the impacts of activities onshore and in State waters is difficult, if not impossible. Moreover, this long-lived, well-developed, and extensive industry functions within a much larger context, a socioeconomic framework that weaves through the region in a complex, inter-connected grid-like manner. Nothing occurs as an isolated event, but rather results from and simultaneously triggers other events, all of which are experienced at varying degrees of a negative or positive impact. For example, when oil prices drop and then gasoline prices drop, this positively impacts individuals and businesses who buy fuel. When oil prices remain low for many months, negative impacts begin to appear. Companies start trimming costs by reducing the number of employees to cut operational costs. Laid-off employees no longer have income to make purchases and the businesses where workers would normally spend their money began to suffer and, when necessary, people began moving out of the area to find other work, leading to a negative impact on the housing market, depressing real estate prices as the number of units available for rent or sale outgrows the demand. A negative impact for some (i.e., sellers and landlords) becomes a positive impact for others (i.e., buyers and renters). This is just one example of an event unrelated to OCS oil- and gas-related activities leading to dual ripple impacts (negative and positive) through communities and illustrates the complexity of the socioeconomic framework. Within this context, a single lease sale is like a blip on a radar screen, i.e., one tiny piece of a vastly complex social and economic structure. A single lease sale's main impact on communities would be to contribute to the maintenance of current employment levels and not to create new jobs; not to cause people to move into the region; not to cause new roads, schools, or hospitals to be built; and not to cause large public works improvements. A single lease sale would solely help to maintain what decades of economic development have built, the complex Gulf of Mexico region that exists today.

While this chapter is titled "social factors," the resource discussed here is essentially human beings. The list of potential impact-producing factors is, in a sense, nearly limitless because the industry involves people at all levels; it simultaneously affects and is affected by people, their communities, and their daily lives. Most of the impacts to people are positive, e.g., in the form of direct employment in the industry, indirect employment in the extensive support sectors, and employees' spent wages and tax revenues that support the community businesses and services. After describing the affected environment, this impact analysis addresses routine activities related to the oil and gas industry and accidental events that may occur from OCS oil- and gas-related activities as a result of a single lease sale, as well as the cumulative impacts of OCS oil- and gas-related and non-OCS oil- and gas-related impact-producing factors. An environmental justice determination follows in **Chapter 4.14.3.3**.

Impact-Level Definitions

Impacts to people and communities may be positive as well as negative. For example, increased economic demand would lead to more hiring, and this additional employment would further the positive economic trend as new workers spend their wages in the community. Negative and positive impacts are measured on the following scale:

- **Negligible** – Little or no measureable impact.
- **Minor** – Small-scale measurable impact, temporary in duration, and geographically small area (less than county/parish level).

- **Moderate** – Medium-scale measurable impact, may last from a few weeks to 1 year, and geographically may affect multiple counties/parishes.
- **Major** – Large-scale measurable or potentially unmeasurable impact, long lasting (1 year to many years), and may occur over a geographically large regional area.

4.14.3.1 Description of the Affected Environment

The affected environment that comprises the baseline for the social factors' environmental impact analysis is geographically distributed across 23 BOEM-identified EIAs in all five Gulf Coast States. **Figure 4-31** shows the aggregation of 133 counties and parishes that comprise the EIAs. **Chapter 4.14.2** (Economic Factors) discusses the methodology behind the development of the EIAs and employment in the analysis area.

The U.S. Census Bureau's calculations estimate that the total population of the combined BOEM economic impact areas exceeded 22.7 million in 2014. **Figure 4-31** presents the range of population levels by county/parish across the GOM coastal region. County and parish population levels vary greatly across the coastal GOM. For example, Kenedy County, Texas, holds the low end of the range with 400 residents and Harris County, Texas, tops out the range at more than 11,000 times that number (4,441,370). At the low end of the population spectrum, 42 (or nearly one-third) of 133 counties/parishes in BOEM's EIAs have less than 25,000 residents. In the upper range, other counties with the >500,000 residents include Hillsborough County, Florida (1,316,298); Pinellas County, Florida (938,098); Hidalgo County, Texas (831,073); Fort Bend County, Texas (685,345); Lee County, Florida (679,513); Polk County, Florida (634,638); and Montgomery County, Texas (518,947) (USDOC, Census Bureau, 2014).

Population in the coastal regions of Gulf Coast States increased 150 percent from 1960 through 2008 and continues to grow. There are 23 states in the U.S. with coastline populations, and the 5 Gulf Coast States occupy over 25 percent of the total for the coastal population of the U.S. Of the eight U.S. coastal counties with the fastest growth, six Gulf Coast counties posted the highest percentage of increase—from Lee County, Florida, at 1,091.5 percent to Collier County, Florida, at 1,901.3 percent. In the nearly five decades from 1960 to 2008, the Gulf of Mexico coastal counties/parishes increased their populations by 246 percent, which is more than 52 percent greater than Pacific coastal counties (130%) and well over two-times as great as the Atlantic area (98%) (USDOC, Census Bureau, 2010a and 2010b; USDOC, NOAA, 2011).

Population density refers to the number of persons per square mile that live in a geographically defined area. In the GOM, the counties/parishes with the highest population density (persons per square mile) are Pinellas County, Florida (3,348); Harris County, Texas (2,402); Orleans Parish, Louisiana (2,029); Jefferson Parish, Louisiana (1,463); and Hillsborough County, Florida (1,205). Three of these top five counties/parishes have a high concentration of oil and gas industry in addition to hosting large cities: Harris County (Houston, Texas); and Orleans and Jefferson Parishes (Louisiana).

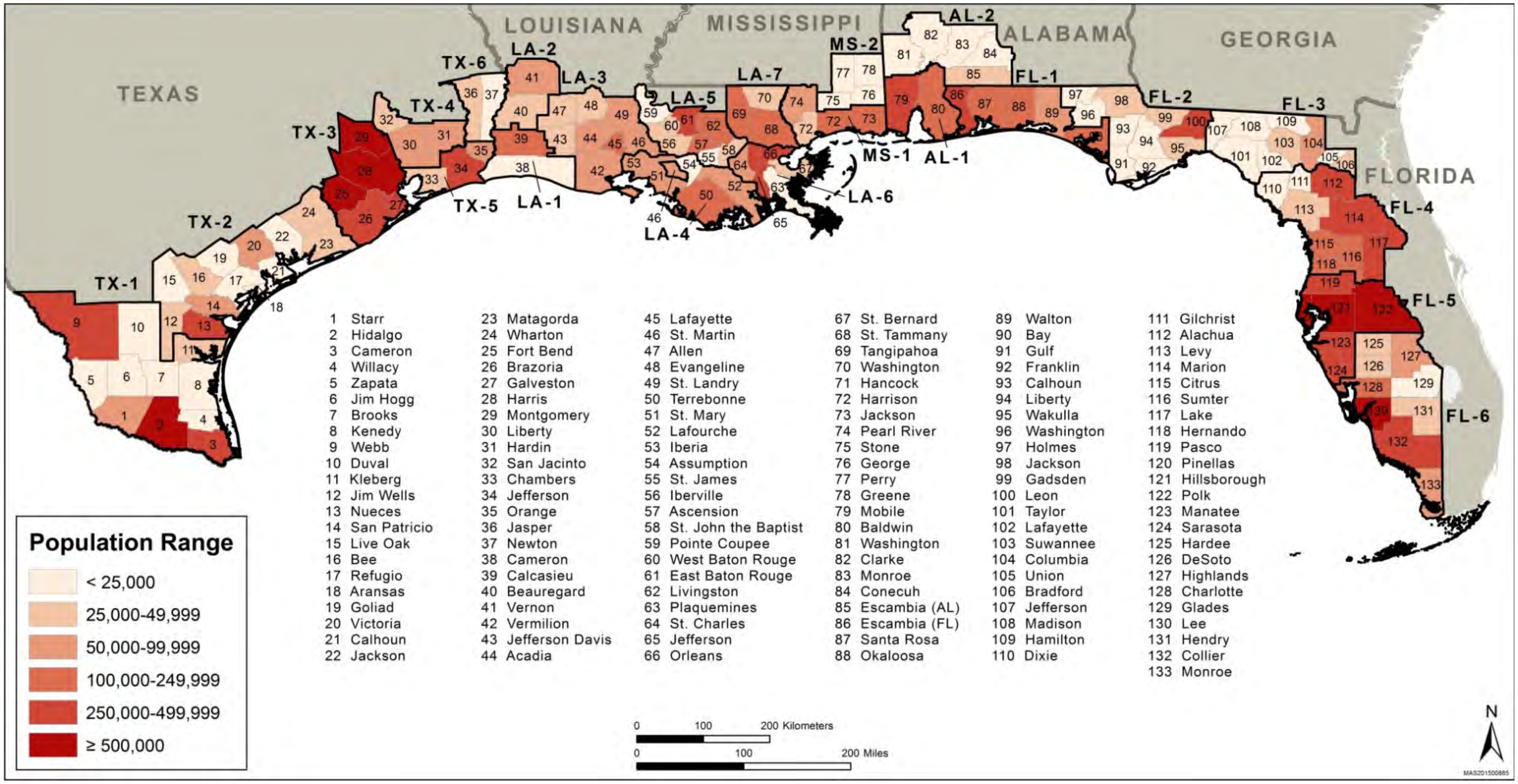

Figure 4-31. Population of BOEM’s Economic Impact Areas in the Gulf of Mexico.

Of all 133 counties/parishes in BOEM's EIAs, Harris County, Texas, holds the largest number of oil- and gas-related companies and associated support infrastructure (Petterson et al., 2008; Dismukes, 2011; Kaplan, et al., 2011). Additional counties and parishes with strong ties to the oil and gas industry include Galveston, Jefferson, Brazoria, and Nueces Counties, Texas; Jefferson, Plaquemines, Orleans, St. Bernard, Lafourche, Terrebonne, St. Mary, Vermilion, Cameron, and Calcasieu Parishes, Louisiana; Jackson County, Mississippi; and Mobile County, Alabama (Kaplan et al., 2011).

In the Gulf Coast region, the annual median household income at $41,203 is about 5 percent below the national average of $43,462 (USDOC, Census Bureau, 2010b). **Figures 4-32 and 4-33** illustrate poverty levels across the GOM. Within the 133 counties/parishes that comprise BOEM's EIAs, 104 counties/parishes have residents living below the national average of 14.5 percent. The highest concentration of poverty is in TX-1 where 8 out of 11 counties have more than 30 percent of their population living below the national poverty level. Willacy County, Texas, has the highest poverty level (40%) and Fort Bend County, Texas, has the lowest poverty level (8.4%) (USDOC, Census Bureau, 2013a and 2013b).

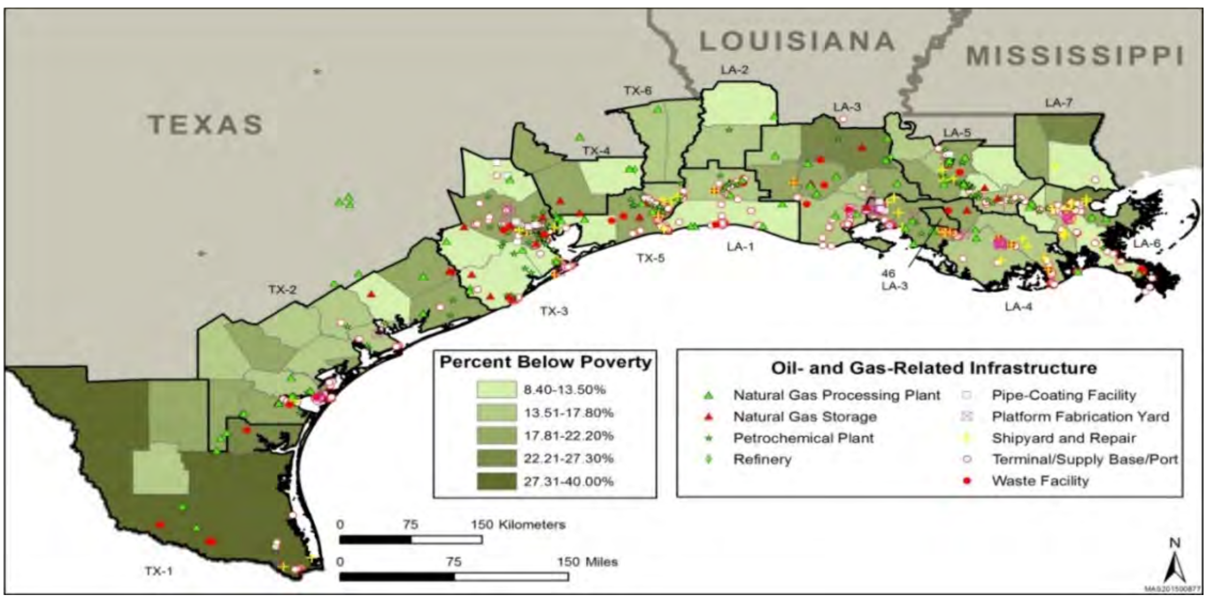

Figure 4-32. Percentage of Poverty in Texas and Louisiana.

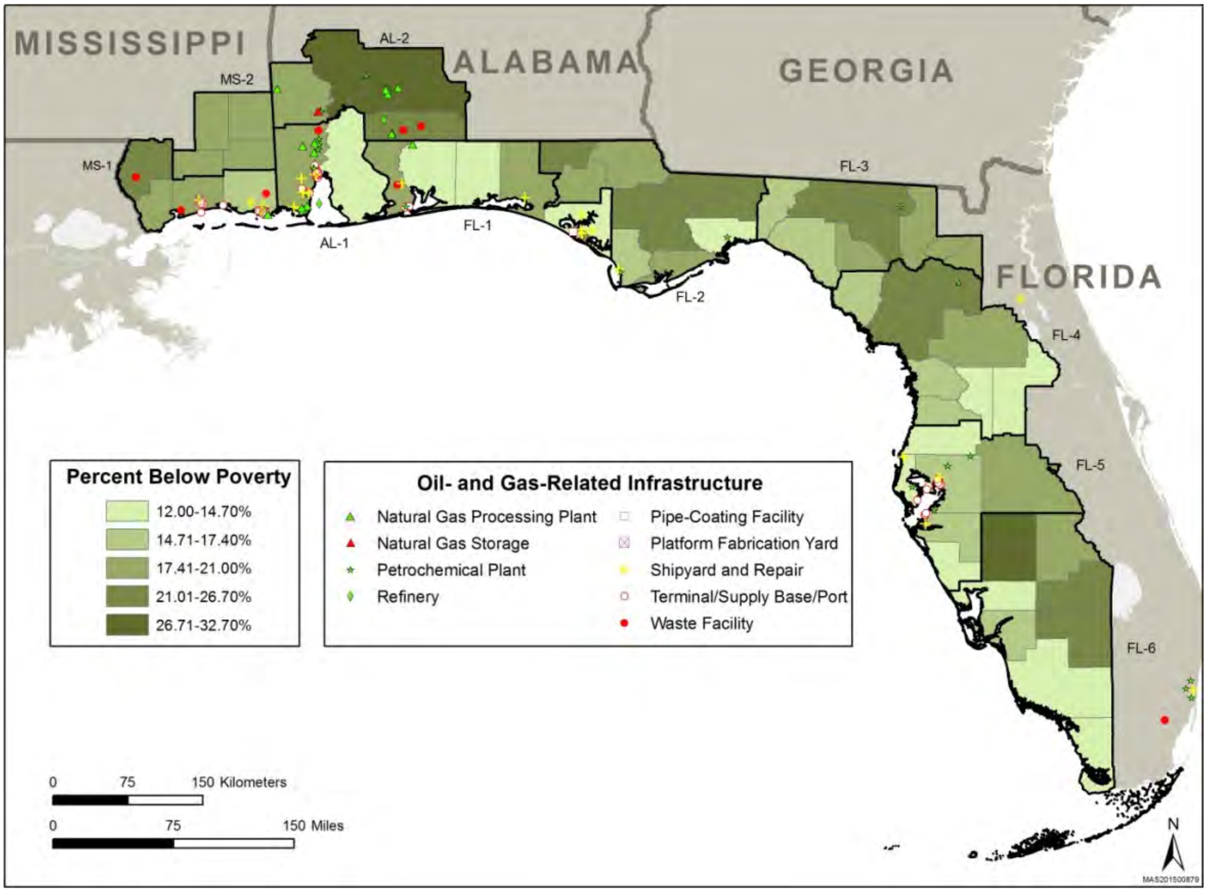

Figure 4-33. Percentage of Poverty in Mississippi, Alabama, and Florida.

The average percentage of minority residents throughout the 23 BOEM-identified EIAs is 22.9 percent, which is slightly below the national average of 26 percent. Forty-four counties/parishes have minority population levels above the national average. **Figures 4-34 and 4-35** illustrate the distribution of minority populations across the five Gulf Coast States. Orleans Parish, Louisiana, has the highest concentration of minority residents at 66.4 percent, while the lowest percentage is shared by two Texas counties, Kenedy and Zapata Counties, at 1.7 percent (USDOC, Census Bureau, 2013c).

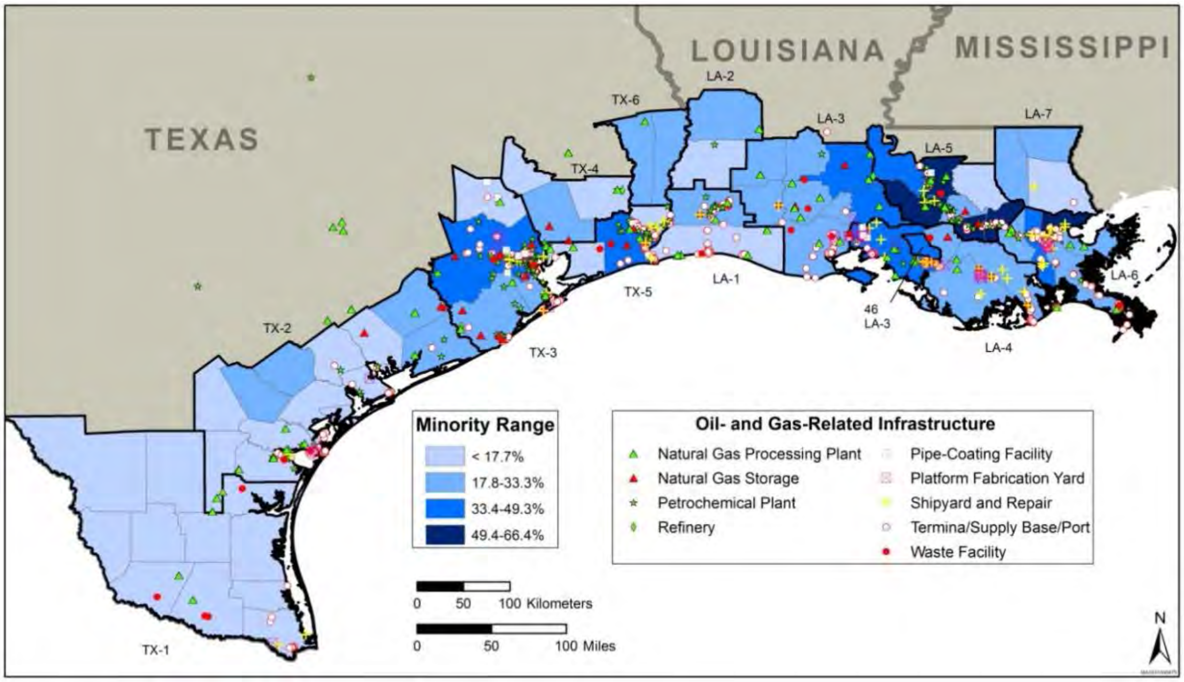

Figure 4-34. Percentage of Minority Populations in Texas and Louisiana.

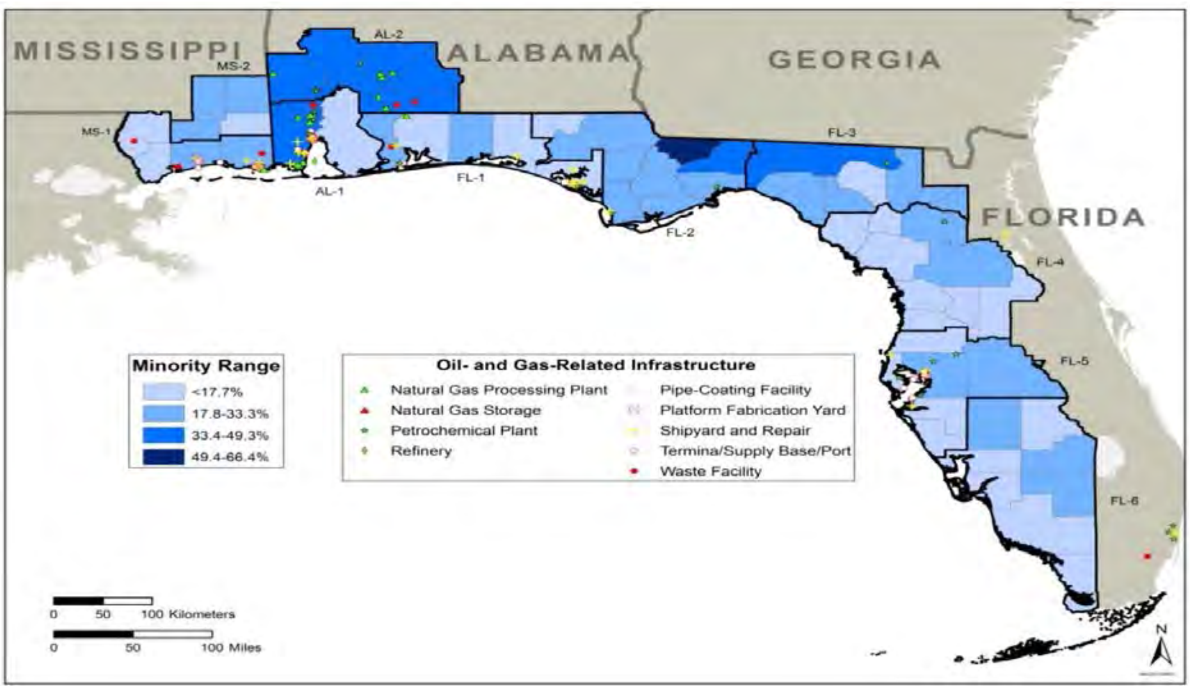

Figure 4-35. Percentage of Minority Populations in Mississippi, Alabama, and Florida.

4.14.3.2 Environmental Consequences

A regionwide proposed lease sale is the preferred alternative and involves all of the Gulf Coast States, i.e., Texas, Louisiana, Mississippi, Alabama, and Florida. Particular emphasis is placed on the 133 counties and parishes that constitute the 23 BOEM-identified EIAs and that are located in the coastal areas of all five states. **Figure 4-27** shows the aggregation of counties and parishes into the EIAs used for BOEM's socioeconomic analysis. This geographic area possesses a culturally and racially diverse population. Some counties and parishes are more closely connected to the offshore oil and gas industry than others. These include counties and parishes are Harris County, Texas, and Lafourche Parish, Louisiana. An analysis and discussion of the impact-producing factors from routine activities, accidental events (noncatastrophic), and cumulative activities can be found below. For a detailed analysis of a high-impact, low-probability catastrophic oil spill, refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c).

Analysis of the various alternatives considers impact-producing factors within a distinct framework that includes frequency, duration, and geographic extent. Frequency (i.e., rare, intermittent, and continuous) refers to how often the impact-producing factor occurs over the entire analysis period of 50 years for routine activities and accidental events and for an analysis period of 70 years for cumulative impacts. Duration (i.e., low, medium, and high) refers to how long the impact-producing factor lasts (i.e., from less than a year to many years). Geographic extent refers to which areas are affected and, depending on the impact-producing factor, the size of an affected area.

Routine Activities

Routine activities related to a single lease sale would be incremental in nature, not expected to change existing conditions, and positive in its contribution to the sustainability of current industry and related support services and employment.

People and communities are a major part of, and provide basic support for, the oil and gas industry. An analysis of the impacts of the industry's routine activities (described in Chapter 3.1) on people and communities is complex because they are experienced at multiple levels that overlap, i.e., industry workers, families of workers, and the communities at large. Impacts occur in varying degrees of intensity. How communities as a whole and how families, workers, and other individuals are secondarily affected would vary depending on the industry sector and economic diversity of the communities in which they live. The interactions of industry and community are complex, resulting in a myriad of impacts, some positive and some negative. This complex relationship between industry and the community evolves over time, and the subsequent impacts evolve accordingly. Impact-producing factors related to routine activities can be experienced as positive or negative, depending on the specifics of any given situation, and cover a broad spectrum, i.e., employment stability, wages and opportunities for advancement, economic rewards in exchange for work (benefits), work scheduling patterns and how these dictate time spent off the job or with families, industry cycles and fluctuations in OCS oil- and gas-related activity levels, demographic shifts (in-migration and out- migration), commuter and truck traffic, commodity (oil/gas) price fluctuations, expansions of existing infrastructure, and new construction of infrastructure.

The oil and gas industry has evolved in the GOM for many decades, simultaneously affecting and being affected by the societal and economic conditions in the region. Because of this long-standing, complex interrelationship, the impacts of the oil and gas industry as a whole are diverse and widespread over many years. Austin et al. (2002) and Austin and McGuire (2002) describe this complexity from the viewpoint of workers and their families, and they found that impacts are experienced at many different levels and intensities depending on what sector of the industry is involved. For example, workers in the production sector enjoy more stable employment, while the drilling sector is volatile and provides less secure employment as it is more easily affected by fluctuations in oil and gas prices.

Employment stability in the oil and gas industry and its support sectors correlates directly with fluctuations in OCS oil- and gas-related activity levels, which are, in turn, closely related the changes in oil and gas commodity prices. Scott (2014) describes how important and influential the extraction, refining, and pipeline sectors of the oil and gas industry are for the State of Louisiana, from supporting over 287,000 jobs to paying nearly $1.5 billion in taxes to the State for 1 year alone. While the residents and communities of Louisiana enjoy unquestionable economic benefits, they also are most impacted by fluctuation in OCS oil- and gas-related activity levels and oil and gas prices. Petterson et al. (2008) describe how the benefits and burdens of the oil and gas industry are distributed unevenly across Texas, Louisiana, Mississippi, Alabama, and Florida, with some states (Texas and especially Louisiana) bearing the most burdens, while others accrue the benefits without suffering the burdens of hosting oil- and gas-related activities (e.g., Florida). This is further illustrated by Donato (2004) and Aratame and Singelmann (2002), who examine demographic shifts in Louisiana and the region related to the changing labor situation in the region, from the generally positive impact of immigrant workers to the commuting and migration trends from noncoastal to coastal communities following fluctuations in labor demand across the region.

The potential impacts resulting from the industry's routine activities occur within the larger socioeconomic context of the GOM region. Given the existing, extensive, and widespread support system for the OCS oil- and gas-related industry and its associated labor force, the impacts of routine activities related to a single lease sale are expected to be **negligible**, widely distributed, and to have little impact. Routine activities related to a single lease sale would be incremental in nature, not expected to change existing conditions, and positive in their contribution to the sustainability of current industry, related support services, and associated employment.

Accidental Events

Accidental events related to OCS oil- and gas-related activities that could affect people and communities include oil spills, chemical/drilling-fluid spills, spill response, and vessel collisions. These events are described in **Chapter 3.2**. This section considers small-scale oil spills that have a greater probability of occurring. Potential oil spills, including surface spills and underwater well blowouts, may be associated with exploration, production, or transportation phases of a proposed lease sale. A detailed risk analysis of offshore oil spills and coastal spills associated with a proposed lease sale can be found in **Chapter 3.2.1**. When oil is spilled in offshore areas, much of the oil volatilizes or is dispersed by currents, so it has a low probability of contacting coastal areas. Oil spills that occur in coastal or nearshore waters have a greater chance of directly affecting local populations. Most small-scale oil spills are short in duration and have impacts ranging from **negligible** to **moderate**. Similarly, the impacts of chemical and drilling-fluid spills depend on the location of the spill, with closer to shore proximity increasing the likelihood of negative impacts, which can range from **negligible** to **moderate**, depending on the specific characteristics of the event. Vessel collisions also may affect local populations as they often result in oil or chemical spills and may interrupt transportation along waterways or roadways if a bridge is involved. Small-scale, noncatastrophic events involve varying degrees of spill response and containment. Spill-response activities are expected to have **negligible** to **moderate** impacts to people and communities, and these impacts also depend on the location and scale of the event being addressed. For example, if an accidental event is very small (not measurable) in size, affects a small geographic area, and is of short duration, its impact would be **negligible**. If an accidental event is measurable, covers a larger geographic area, and lasts a few days to a month, then its impact would be **minor**. If an accidental event affects a more than one county or parish, is measurable with impacts lasting up to 1 year, then the impact would be **moderate**.

For a detailed discussion of a low-probability, catastrophic oil spill, refer to the *Catastrophic Spill Event Analysis* white paper (USDOI, BOEM, 2016c). Also, a BOEM-funded study (Austin et al., 2014b and 2014c) researched and documented the complex and varied social impacts of the *Deepwater Horizon* explosion, oil spill, and response. This study found that the impacts of the spill on a particular community depended on a number of factors, such as social and political dynamics, proximity to the spill, economic structure, organizational structure for dealing with disasters, and ability to adapt to the oil cleanup and damage claims processes. With the exception of a catastrophic accidental event, such as the *Deepwater Horizon* explosion, oil spill, and response, the impacts of oil spills, chemical/drilling-fluid spills, vessel collision, and spill-response activities are not or are not likely to be of sufficient duration to have adverse and disproportionate long-term impacts for people and communities in the analysis area.

Cumulative Impacts

People and communities experience cumulative impacts that include all human activities and natural processes and events. The cumulative analysis considers impacts that could result from a proposed lease sale combined with all past, present, and future OCS oil- and gas-related lease sales and activities, as well as all past, present, and reasonably foreseeable future actions that are external to OCS oil- and gas-related activities (described in **Chapter 3.3**). Within this divided analytical framework of OCS oil-and gas-related and non-OCS oil- and gas-related impacts, the largest quantity of impact-producing factors for people and communities occur as non-OCS oil- and gas-related impacts because OCS oil- and gas-related activities form such a small part of the greater, complex socioeconomic structure in the GOM, as described in the below sections.

OCS Oil- and Gas-Related Impacts

Potential impacts related to OCS oil- and gas-related activities include the OCS Program, consisting of 10 proposed lease sales in the GOM from 2017 to 2022, and the resultant exploration, development, and production in Federal waters that contribute to the following possible impacts

(**Chapter 3.3.1**): employment stability; wages and opportunities for advancement; economic rewards in exchange for work (benefits); work scheduling patterns and how these dictate time spent off the job or with families; industry cycles and fluctuations in OCS oil- and gas-related activity levels; demographic shifts (in-migration and out- migration); commuter and truck traffic; commodity (oil/gas) price fluctuations; expansions of existing infrastructure; new construction of infrastructure; coastal and offshore oil spills, chemical/drilling-fluid spills; spill-response activities; and vessel collisions. A proposed lease sale would make an incremental contribution to the cumulative impact of all past, present, and future lease sales.

For most of the GOM, the OCS Program would result in only minor economic changes. Generally, impacts would be widely yet thinly distributed across the Gulf Coast and would consist of slight increases in employment and few, if any, increases in population. Some places could experience elevated employment, population, infrastructure, and/or traffic impacts because of local concentrations of fabrication and supply operations. Because of its extensive oil-related support system, Louisiana is likely to experience more employment impacts related to a proposed lease sale than are the other coastal states. For example, Lafourche Parish, Louisiana, already services about 90 percent of all deepwater oil production and 45 percent of all shallow-water oil and gas production in the Gulf, and it is likely to continue experiencing benefits from the OCS Program (Scott, 2014). Except in Louisiana, the OCS Program is expected to provide little additional employment, although it would serve to maintain current activity levels, which is expected to be beneficial to the GOM as a whole.

With the exception of a catastrophic accidental event, such as the *Deepwater Horizon* explosion, oil spill, and response, the impacts of oil spills, chemical/drilling-fluid spills, vessel collision, and spill-response activities are not or are not likely to be of sufficient duration to have adverse and disproportionate long-term impacts for people and communities in the analysis area (refer to *Catastrophic Spill Event Analysis* white paper, USDOI, BOEM, 2016c). Research into possible long-term health impacts of the *Deepwater Horizon* explosion, oil spill, and response is ongoing (National Institute of Environmental Health Science, 2014; National Center for Disease Preparedness, 2013 and 2014; Substance Abuse and Mental Health Services Administration and Centers for Disease Control and Prevention, 2013).

Non-OCS oil- and gas-related factors are greater in number and actually contribute much more to the cumulative impacts on people and communities than do factors related to OCS oil- and gas-related activities because of the analysis area's complex socioeconomic framework.

Non-OCS Oil- and Gas-Related Impacts

Non-OCS oil- and gas-related impacts (described in Chapter 3.3.2) cover a wide range of potential impact-producing factors, including all human activities and natural events and processes that are not related to OCS oil- and gas-related activities. Some of the human activities that may include people and communities include, but are not limited to, the following: State-based and onshore oil and gas activities, commercial/residential/agricultural development; urbanization; pollution; zoning ordinances;

expansions to the Federal, State, and local highway systems; expansions to regional port facilities; demographic shifts; shifts on the national, State, and local levels; military activities; government functions; educational systems; family support systems; public health; contraction or expansion of the tourism industry; State renewable energy activities; river channelization; and dredging of waterways.

State offshore oil and gas programs and onshore oil and gas activities pose the same potential issues as does the OCS Program, although since State leases are closer to land, their petroleum-related activities are generally viewed as having greater potential for directly impacting coastal communities. BOEM assumes that sitings of any future facilities associated with State programs would be based on the same economic, logistical, zoning, and permitting considerations that determined past sitings. Revenues from oil programs in State waters have produced several positive impacts, and the steady stream of oil exploration and development have produced positive cumulative impacts that include increased funding for infrastructure, higher incomes, better health care, and improved educational facilities. This is certainly true for Texas, which has historically used oil and gas revenues on State lands to equalize education district disparities across the State. While offshore leasing in shallow waters has been in a general decline, Louisiana is attempting to incentivize increased activity closer to the shore. In 2006, the Louisiana Legislature authorized the Louisiana Dept. of Environmental Quality to implement an Expedited Processing Program, which has so far resulted in a 55 percent reduction in coastal permitting time (State of Louisiana, Dept. of Natural Resources, 2009).

Ongoing for decades, urbanization continues to impact people and communities, involving demographic shifts as people move into or out of the more densely populated areas. Impacts that result include strains on public infrastructure, habitat fragmentation, and reduced air and water quality, as well as the urban heat island effect. Closely related, but not limited to urban areas, are pollution impacts such as garbage dumping, air, light and noise pollution, and contaminated runoff, which also impact people and the communities in which they live. Zoning ordinances and land development, whether residential, commercial, or agricultural, can have negative and positive impacts on people, depending on how they stand to benefit or not from various proposed projects. When highway systems (whether local, State, or Federal) and port facilities are expanded, there is a tradeoff between the benefits of expansion and the potential negative impact to the local environment, people, and communities.

Economic conditions contribute to cumulative impacts on people and communities. When there is an economic downturn, some people lose their jobs and unemployment rises; people have less money to spend, causing a negative ripple effect through the local/regional/national economy as a result of direct, indirect, and induced economic impacts on communities. Military activities also contribute to cumulative impacts, whether through base closures that result in job losses or infrastructure expansion at military bases that may produce both positive (jobs) and negative (habitat loss) impacts.

Other human activities that also have cumulative impacts on Gulf Coast populations are related to local, State, and Federal government functions, which are numerous and expansive. Two of the more crucial government responsibilities for basic community functioning involve municipal waterworks and sewage systems. If these are not maintained in good condition with adequate capacity, negative impacts to the residents and community result. Similarly, the status of a community's educational system may be a positive or negative benefit to these populations, depending on the quality of the educational facilities and infrastructure, the teacher-to-student ratios, the standardized test scores, the amount and extent of busing across cities and towns, and the availability of special education services in the public schools (National Education Association, 2015; FSG Social Impact Consultants, 2011). Another very important non-OCS oil- and gas-related impact-producing factor involves public health and family support services systems, namely their availability, proximity, and quality (CommonHealth ACTION, 2015). Social services such as public health clinics, mental health support, charity hospitals, addictive disorder rehabilitation, foster care, head start programs, and family planning services are often hard to find in rural areas, but these services may be more accessible in larger cities, towns, and urban areas.

Another important factor to consider is the contraction and expansion of the tourism industry, which is very important to the economies of the Gulf of Mexico region. When there is a contraction in the tourism sector, the negative impacts are felt by all, whether directly or indirectly. BOEM funded a study (Eastern Research Group, Inc., 2014a) that developed methodologies for estimating the scales of recreation and tourism in a particular area. This entailed defining which industries comprise recreation and tourism, as well as estimating the percent of each industry that supports tourism. For example, the hotel industry is primarily supported by tourists, while the restaurant industry is supported by both tourists and local residents. **Chapter 4.13** provides a complete discussion of tourism as a part of recreational resources. State renewable energy programs are non-OCS oil- and gas-related and may also contribute to cumulative impacts due to their potential placement in areas that conflict with local uses, such as preferred fishing grounds. River channelization and dredging of other waterways also contribute to cumulative impacts for local populations, especially low- income and minority populations who may have traditionally fished and tended oyster beds negatively impacted by the disruption of the natural balance of the delicate ecosystem.

While human activities are extensive and nearly all-encompassing, there are many natural events and processes that may be classified as non-OCS oil- and gas-related impact-producing factors. Some of the natural events and processes that coastal populations may be affected by include, but are not limited to, the following: oyster reef degradation; saltwater intrusion; sedimentation of rivers; sediment deprivation; barrier island migration and erosion; fish kills; red tide; coastal erosion/subsidence; sea-level rise; coastal storms; and climate change.

When degradation of oyster reefs occurs, it may negatively impact people and communities by decreasing the number of oysters that are able to harvest for both economic and subsistence uses. Saltwater intrusion affects oyster reefs and the overall wetlands ecosystem. In some places too much sediment is deposited in waterways, and in others there is sediment deprivation; both of these negatively impact the delicate ecosystem upon which coastal populations depend. Barrier islands are very important for fishing, but the barrier islands in the region have been migrating and eroding for decades. This natural process is one of the challenges faced in the region and contributes to cumulative impacts. Also, fish kills and red tide interfere with people's use and enjoyment of the natural environment and contribute to negative cumulative impacts on GOM coastal populations.

Coastal erosion and subsidence in some parts of the southeastern coastal plain amplify the vulnerability of communities, infrastructure, and natural resources to storm-surge flooding (Dalton and Jones, 2010). Submergence in the GOM area 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 over 10 mm/yr (0.12 to over 0.39 in/yr). Natural drainage patterns along many areas of the Gulf Coast areas have been severely altered by construction of the Gulf Intracoastal Waterway and other channelization projects associated with its development. Saltwater intrusion resulting from land loss, river channelization, and canal dredging is a major cause of coastal habitat deterioration (Tiner, 1984; National Wetlands Inventory Group, 1985; Cox et al., 1997). Coastal erosion, subsidence, sea-level rise, and storm surge damage can increase community vulnerability to future hazards and can also threaten traditional ways of life. Saltwater intrusion reduces the productivity and species diversity associated with wetlands and coastal marshes (Stutzenbaker and Weller, 1989; Cox et al., 1997). While users of coastal waters may appear to trend towards the relatively affluent, low-income and minority groups may be more dependent on the resources of the Gulf Coast. Several ethnic minority and low-income groups rely substantially on these resources (e.g., refer to Hemmerling and Colten [2003] for an evaluation of environmental justice considerations for south Lafourche Parish).

Coastal land loss from erosion, subsidence, sea-level rise, and storm surge also affect the larger society as a whole, with significant land loss occurring in coastal areas, especially Louisiana, which has created a Coastal Master Plan focused on resolving the land loss crisis (State of Louisiana, Coastal Protection and Restoration Authority, 2012). This affects people and communities by impacting residential areas as well as local businesses and public infrastructure. **Figure 4-28** shows the amount of land that coastal Louisiana has lost from 1932 to 2010. **Figures 4-29 and 4-30** illustrate scientists' projections for future land loss in Louisiana. The moderate scenario assumes more mitigating measures, and the less optimistic scenario shows the projected impact if extensive mitigating measures are not instituted. As evident from these visual depictions, coastal land loss is one of the greatest threats to the stability and future of coastal populations. The Louisiana's 2012 Coastal Master Plan captures the urgency of the land loss crisis: "Every day Louisiana citizens are affected by this catastrophe in ways small and large. Whether it's a family forced to leave a cherished community to move out of harm's way, a local businesses that has trouble obtaining insurance, or investments that lose value because of uncertainty about the future of our landscape, Louisiana's land loss disaster takes a heavy toll" (State of Louisiana, Coastal Protection and Restoration Authority, 2012).

A U.S. Geological Survey study published in 2013, *Economic Vulnerability to Sea-Level Rise along the Northern U.S. Gulf Coast*, applied a coastal economic vulnerability index (CEVI) to the northern Gulf coastal region in order to measure economic vulnerability to sea-level rise (Thatcher et al., 2013). The study attempted to determine which coastal communities may face the greatest challenges with regard to the economic and physical impacts of relative sea-level rise and revealed areas along the Gulf Coast that could most benefit from long-term resiliency planning. Within an area, the presence of a concentration of economically valuable infrastructure combined with physical vulnerability to inundation from sea-level rise resulted in the highest vulnerability rankings (CEVI score). The highest average CEVI score in the GOM coastal region appeared in Lafourche Parish, Louisiana, where there is an extensive amount of valuable infrastructure related to the oil and gas industry, along with high relative sea-level rise rates and high coastal erosion rates. Terrebonne Parish, Louisiana, also received a high CEVI value because of its high level of physical vulnerability and high concentration of energy infrastructure. Due to limitations within the CEVI model, such as subjective weighting of variables, researchers caution that results of the study should remain within a vulnerability context and that CEVI results should only be considered relative measures that are best utilized to provide decisionmakers with a better understanding of the vulnerability of the coastal region's critical infrastructure when making decisions about modifying, protecting, or building new infrastructure in these coastal communities (Thatcher et al., 2013).

Hurricanes, tropical storms, and other wind-driven tidal or storm events are a fact of life for communities living along the Gulf of Mexico coastal zone. The intensity and frequency of hurricanes in the GOM over the last several years has greatly impacted the system of protective barrier islands, beaches, and dunes and associated wetlands along the Gulf Coast. Within the last several years, the Gulf Coast of Texas, Louisiana, Mississippi, Alabama, and to some degree Florida have experienced five major hurricanes (Ivan, Katrina, Rita, Gustav, and Ike), as well as minor hurricanes (Humberto and Isaac). According to a U.S. Geological Survey 5-year, post-Katrina survey, the wetland loss in Louisiana from all four storms (i.e., Hurricanes Katrina, Rita, Gustav, and Ike) totaled 340 mi^2 (881 km^2). The U.S. Geological Survey projects that coastal Louisiana has undergone a net change in land area of about 1,883 mi^2 (4,877 km^2) from 1932 to 2010 (Couvillion et al., 2011). Impacts from future hurricanes and tropical storm events are uncertain. Hazard mitigation funds available through individual states and the Federal Emergency Management Agency also seek to mitigate potential damage to homes in flood zones throughout the GOM. While hurricanes and tropical storms are inevitable, lessons learned from Hurricanes Katrina, Rita, Gustav, and Ike are shaping local and national policies, as well as nongovernmental organizations efforts to protect vulnerable communities. In the decade since Hurricanes Katrina and Rita, the New Orleans Metro Area has been recovering gradually, but unevenly. Population before the 2005 storms was 1.386 million, dropped to 1.040 million in 2006, and increased to 1.252 million in 2014. The number of grocery stores, pharmacies, and drug stores is still lower than 2005 numbers, but the number of gasoline stations, hotels, and restaurants have increased to greater than pre-storm levels (USDOC, Census Bureau, 2015; USDOC, Economics and Statistics Administration, 2015).

Within the last few decades, climate change has become recognized as a serious issue. A study conducted by Elisaveta et al. (2015) focused on the impacts of climate change on the U.S. Gulf Coast and public health. The study found that numerous variables have contributed to the likelihood of extreme climate change impacts to the Gulf coastal region, including subsidence, severe erosion, changing water-use patterns, sea-level rise, storm surge, potential for large-scale industrial accidents, increasing population, and large numbers of vulnerable populations in the region. Climate change impacts may exacerbate existing public health issues and also create new health hazards. Identified climate change impacts include heat-related morbidity/mortality, drought-related malnutrition, flood-related injuries and death, increases in vector-borne diseases, and large-scale migrations. The study suggests various public health adaptation measures such as the creation of educational programs and improved risk communication for vulnerable persons such as the elderly, minority, and low-income populations (Elisaveta et al., 2015).

Incomplete or Unavailable Information

BOEM has identified unavailable information that is relevant to people and communities regarding the impacts of the *Deepwater Horizon* explosion, oil spill, and response. This information cannot be obtained because long-term health impact studies, subsistence studies, and the NRDA process are ongoing, and data from these efforts would be unavailable and unobtainable for some time. In order to fill this data gap, BOEM has used existing information and reasonably accepted scientific methodologies to extrapolate from available information in completing the relevant analysis, including limited information that has been released after the *Deepwater Horizon* explosion, oil spill, and response and studies of past oil spills, which indicate that a low-probability, catastrophic oil spill, which is not part of a proposed lease sale and not likely expected to occur, may have adverse impacts on residents in GOM coastal communities. Research into possible long-term health impacts of the *Deepwater Horizon* explosion, oil spill, and response is ongoing (National Institute of Environmental Health Science, 2014; National Center for Disease Preparedness, 2013 and 2014; Substance Abuse and Mental Health Services Administration and Centers for Disease Control and Prevention, 2013). Because long-term health impacts to coastal populations are unknown, this information may be relevant to the evaluation of impacts from the *Deepwater Horizon* explosion, oil spill, and response; therefore, BOEM would continue to seek additional information as it becomes available and bases the previous analysis on the best information currently available. Although long-term health impacts to people and communities may be relevant to this analysis, BOEM has determined that the unavailable information is not essential to a reasoned choice among alternatives based on the information discussed above.

4.14.3.2.1 Alternative A—Regionwide OCS Lease Sale (The Preferred Alternative)

The potential impacts resulting from the industry's routine activities occur within the larger socioeconomic context of the GOM region. Given the existing, extensive, and widespread support system for the OCS oil- and gas-related industry and its associated labor force, the impacts of routine events related to a proposed lease sale are expected to be **negligible**, widely distributed, and to have little impact. Routine activities related to a single lease sale would be incremental in nature, not expected to change existing conditions, and positive in their contribution to the sustainability of current industry, related support services, and associated employment.

With the exception of a catastrophic accidental event, such as the *Deepwater Horizon* explosion, oil spill, and response, the impacts of oil spills, chemical/drilling-fluid spills, vessel collision, and spill-response activities are not or are not likely to be of sufficient scale or duration to have adverse and disproportionate long-term impacts for people and communities in the analysis area.

Coastal populations experience cumulative impacts that include all human activities and natural processes and events. The cumulative analysis includes impacts that could result from a proposed lease sale combined with all past, present, and future Federal OCS oil- and gas-related lease sales and activities, as well as all past, present, and reasonably foreseeable future actions that are external to Federal OCS oil- and gas-related activities. Within this divided analytical framework of OCS oil-and gas-related and non-OCS oil- and gas-related impacts, the largest quantity, by far, of impact-producing factors for coastal populations occur as non-OCS oil- and gas-related impacts because OCS oil- and gas-related activities form a very small part of the greater, complex socioeconomic structure in the GOM.

4.14.3.2.2 Alternative B—Regionwide OCS Lease Sale Excluding Available Unleased Blocks in the WPA Portion of the Proposed Lease Sale Area

Impacts for social factors are directly related to the level of OCS oil- and gas-related activity in the Gulf of Mexico. Alternative B would result in less OCS oil- and gas-related activity than Alternative A because the WPA (approximately 23 million ac) would not be available for leasing. Alternative A includes the WPA, CPA, and EPA. Alternative B includes the CPA and EPA. Therefore, Alternative B would produce proportionately smaller OCS oil- and gas-related activity than Alternative A, and the impacts of Alternative B would be proportionately less than Alternative A but greater than Alternative C, as described below.

4.14.3.2.3 Alternative C—Regionwide OCS Proposed Lease Sale Excluding Available Unleased Blocks in the CPA/EPA Portions of the Proposed Lease Sale Area

Impacts for social factors are directly related to the level of OCS oil- and gas-related activity in the Gulf of Mexico. Alternative C would result in less OCS oil- and gas-related activity than Alternative A or B because the CPA and EPA (approximately 49 million ac) would not be available for leasing. Alternative A includes the WPA, CPA, and EPA, and Alternative B includes the CPA and EPA. In contrast, Alternative C includes only the WPA. Therefore, Alternative C would produce proportionately smaller OCS oil- and gas-related activity than Alternatives A and B, and the impacts of Alternative C would be proportionately less than either Alternative A or B.

4.14.3.2.4 Alternative D—Alternative A, B, or C, with the Option to Exclude Available Unleased Blocks Subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations

Impacts for social factors are directly related to the level of OCS oil- and gas-related activity in the Gulf of Mexico. Alternative D would have minimal impact on social factors because there are so few unleased blocks subject to the Topographic Features, Live Bottom (Pinnacle Trend), and/or Blocks South of Baldwin County, Alabama, Stipulations. The difference between Alternatives A, B, and C, with and without the exclusionary stipulations is negligible for social factors. The impacts under Alternative D would not be much different and likely not even measurable when compared with the other alternatives. To the extent that Alternative D would generate less OCS oil- and gas-related activities due to the reduced number of blocks available for lease, the impacts of Alternative D would be less than Alternative A, B or C, but this difference would likely be indiscernible.

4.14.3.2.5 Alternative E—No Action

Alternative E would result in no lease sale and, thus, **no** incremental contribution of impacts to social factors beyond a potential negligible to minor negative economic impact on jobs because a single lease sale only contributes to the maintenance of existing employment. Any potential negative impact would be short lived and may not even be measurable.

4.14.3.3 Environmental Justice Determination

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," directs Federal agencies to make a determination as to whether their actions have disproportionate environmental impacts on minority or low-income people. These environmental impacts encompass human health, and social and economic consequences. In 1997, President Clinton issued Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks," requiring Federal agencies to identify and assess environmental health risks and safety risks of its policies, programs, and activities that may disproportionately affect children. In accordance with NEPA and the Executive Orders, BOEM provides opportunities for community input during the NEPA process. Some of the numerous avenues for public outreach employed by BOEM include specific types of notices that are (1) mailed to public libraries; interest groups; industry; ports and docks; local, State, and Federal agencies; and federally recognized Indian Tribes; (2) published in local newspapers; (3) posted on the Internet; and (4) published in the *Federal Register*. The formal scoping process is initiated by the publication of a Notice of Intent, and public scoping meetings are held in several geographically separate cities to allow the public to submit comments and to identify all stakeholders' concerns. All public comments and responses to comments are published in the Draft and Final Supplemental EISs. A detailed discussion of the complete scoping process can be found in **Chapter 5.3**. A summary of the scoping comments for this Multisale EIS can be found in **Chapter 5.3.1**.

When taken as a whole, environmental justice is a complex issue, but making an environmental justice determination is fairly straight-forward when considering OCS leasing decisions. First, OCS lease sales occur in Federal waters 3 mi (5 km) or more from shore. Thus, the leaseholds and the permitted activities of petroleum exploration, extraction, and production that occur on these leaseholds are distant from human habitation, and these activities would not have any impacts on low-income and minority populations. State offshore oil and gas leasing occurs in waters closer to land were petroleum-related activities are generally viewed as having a greater potential for directly impacting coastal communities. Second, this determination considers the results of new lease sales. The OCS Program has been ongoing for many decades; it has already leased large areas in the Gulf of Mexico and, in this context, new lease sales mean only small, incremental increases in the already substantial operations. Most OCS lease sale-related consequences that might arise would be indirect, onshore, and would result from the operations of the extensive infrastructure system that exists to support not only OCS oil- and gas-related activities but also oil and gas activities that occur in State waters and onshore. The amount of Federal OCS contribution to downstream infrastructure use has not yet and, most likely, may never be discovered. Downstream infrastructure moves hydrocarbon product to market and includes gas processing facilities, petrochemical plants, transportation corridors, petroleum bulk storage facilities, and gas and petroleum pipelines. This infrastructure system is both widespread and concentrated (refer to **Chapter 4.14.1**). 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 (Dismukes, 2011; Kaplan et al., 2011).

Potential environmental justice impacts that might arise from these support activities may be only indirectly influenced by BOEM's decisionmaking, and BOEM has no regulatory authority over them. However, BOEM has considered the potential for these impacts on these communities. The onshore support activities that would result from a BOEM leasing decision occur in the context of a very large and long-established oil industry. For the most part, activities generated by a new proposed lease sale occur where there are already ongoing activities, and the two (new activities vs. ongoing activities) are virtually indistinguishable from each other or from established land-use patterns. Each industry sector and its associated impacts are often cumulative and occur within a mix of the impacts of other sectors in each geographic location. Therefore, BOEM has determined that a proposed lease sale would not adversely affect minority and low-income populations in the analysis area.

4.15 Unavoidable Adverse Impacts of a Proposed Action

Unavoidable adverse impacts associated with a proposed action are expected to be primarily short term and localized in nature and are summarized below. Adverse impacts from low-probability catastrophic events, which are not part of a proposed action and not likely expected to occur, could be of longer duration and extend beyond the local area. All OCS oil- and gas-related activities involve temporary and exclusive use of relatively small areas of the OCS over the lifetimes of specific projects. Lifetimes for these activities can be days, as in the case of seismic surveys, or decades, as in the case of a production structure or platform. No activities in the OCS Program involve the permanent or temporary use or "taking" of large areas of the OCS. Cumulatively, however, a multitude of individual projects results in a major use of OCS space.

Air Quality: Unavoidable short-term impacts on air quality could occur after large oil spills because of evaporation and volatilization of the lighter components of crude oil, combustion from surface burning, and aerial spraying of dispersant chemicals. Mitigation of long-term impacts from offshore engine combustion during routine operations would be accomplished through existing regulations and the development of new control emission technology. Short-term impacts from spill events could occur and are likely to be aggravated or mitigated by the time of year the spills take place.

Water Quality: Routine offshore operations would cause some unavoidable adverse impacts to varying degrees on the quality of the surrounding water. Drilling, construction, overboard discharges of drilling mud and cuttings, and pipelaying activities would cause an increase in the turbidity of the affected waters for the duration of the activity periods. This, however, would only affect water in the immediate vicinity of the construction activity or in the vicinity of offshore structures, rigs, and platforms. Mitigation of impacts from these activities would be accomplished through existing NPDES regulations. 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. Spilled oil from a tanker collision would affect the water surface in combination with dispersant chemicals used during spill response. A subsurface spill would subject the surface, water column, and near-bottom environment to spilled oil and gas released from solution, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals.

Unavoidable impacts to onshore water quality would occur as a result of chronic point- and nonpoint-source discharges such as runoff and effluent discharges from existing onshore infrastructure used in support of lease sale activities. Vessel traffic contributes to the degradation of water quality by chronic low-quantity 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.

Coastal Habitats: If an oil spill contacts beaches or barrier islands, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced, and a beach could experience several years of small surface residue balls (also called tarballs) washing ashore over time, causing an aesthetic impact. Sand borrowing on the OCS for coastal restorations involves the taking of a quantity of sand from the OCS and depositing it onshore, essentially moving small products of the deltaic system to another location. If sand is left where it is, it would eventually be lost to the deltaic system by redeposition or burial by younger sediments; if transported onshore, it would be lost to burial and submergence caused by subsidence and sea-level rise.

If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In more heavily oiled areas, wetland vegetation could experience suppressed productivity for several years; in more lightly oiled areas, wetland vegetation could experience die-back for one season. Epibionts (organisms growing) on wetland vegetation and grasses in the tidal zone could be killed, and the productivity of tidal marshes for the vertebrates and invertebrates that use them to spawn and develop could be impaired. Much of the wetland vegetation would recover over time, but some wetland areas could be converted to open water. Some unavoidable impacts could occur during pipeline and other related coastal construction, but regulations are in place to avoid and minimize these impacts to the maximum extent practicable. Unavoidable impacts resulting from dredging, wake erosion, and other secondary impacts related to channel use and maintenance would occur as a result of a proposed action.

Offshore Biological Habitats: Unavoidable adverse impacts would take place if an oil spill occurred and contacted offshore biological habitats, such as *Sargassum* at the surface; fish, turtles, and marine mammals in the water column; or benthic habitats on the bottom. There could be some adverse impacts on organisms contacted by oil, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals that, at this time, are not completely understood, particularly in subsurface environments.

Fish and Invertebrate Resources: Unavoidable adverse impacts from routine operations would take place from discharges from vessels and platforms. These would be minor given the available area for fish habitat. If a large oil spill occurs, the oil, dispersant chemicals, or emulsions of oil droplets and dispersant chemicals could temporarily displace mobile fish species on a population or local scale. There could also be impacts on prey and sublethal impacts on fish.

Birds: Unavoidable adverse impacts from routine operations on birds could result from noise, helicopter and OCS service-vessel traffic, coastal facility and platform lighting, and floating trash and debris. Trans-Gulf migrating species could be affected by lighted platforms, helicopter and vessel traffic, and floating trash and debris. If a large oil spill occurs and contacts bird habitats, some birds could experience lethal and sublethal impacts from oiling, and birds feeding or resting in the water could be oiled and die. Birds coming into contact with oil may migrate more deeply into marsh habitats, out of reach from spill responders seeking to count them or collect them for rehabilitation. Oil spills and oil-spill cleanup activities could also affect the food species for bird species. Depending on the time of year, large oil spills could decrease the nesting success of species that concentrate nests in coastal environments due to direct impacts of the spill and also disruption from oil-spill cleanup activities.

Threatened and Endangered Species: Because a proposed lease sale does not in and of itself make any irreversible or irretrievable commitment of resources that would foreclose the development or implementation of any reasonable and prudent measures to comply with the Endangered Species Act, BOEM may proceed with publication of this Multisale EIS and finalize a decision among these alternatives even if consultation is not complete, as described in Section 7(d) of the ESA (also refer to **Chapter 5.7**). Irreversible loss of individuals that are ESA-listed species may occur after a large oil spill from the acute impact of being oiled or the chronic impact of oil having eliminated, reduced, or rendered suboptimal the food species upon which they were dependent.

Marine Mammals: Unavoidable adverse impacts to marine mammals would be those that also affect endangered and threatened marine mammal species. Routine operation impacts (such as seismic surveys, water quality and habitat degradation, helicopter disturbance, vessel collision, and discarded trash and debris) would be negligible or minor to a population, but they could be lethal to individuals as in the case of a vessel collision. A large oil spill would temporarily degrade habitat if spilled oil, dispersant chemicals, or emulsions of dispersed oil droplets and dispersant chemicals contact free-ranging pods or calving grounds.

Commercial Fisheries and Recreational Fishing: Unavoidable adverse impacts from routine operations are loss of open ocean or bottom areas desired for fishing by the presence or construction of OCS oil- and gas-related facilities and pipelines. Loss of gear could occur from bottom obstructions around platforms and subsea production systems. If a large oil spill occurs, it is unlikely that fishermen would want, or be permitted, to harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species, rendering them unmarketable.

Recreational Resources: Unavoidable adverse impacts from routine operations may result in the accidental loss overboard of some floatable debris that may eventually come ashore on frequented recreational beaches. A large oil spill could make landfall on recreational resources, leading to local or regional economic losses and stigma effects, causing potential users to avoid the area after acute impacts have been removed. Some recreational resources become temporarily soiled by weathered crude oil, and small surface residue balls (also called tarballs) may come ashore long after stranded oil has been cleaned from shoreline areas. Impacts on recreational resources from a large oil spill may, at the time, seem irreversible, but the impacts are generally temporary. Beaches fouled by a large oil spill would be temporarily unavailable to the people who would otherwise frequent them, but only during the period between landfall and cleanup of the oil, followed by an indefinite lag period during which stigma effects recede from public consciousness.

Archaeological Resources: Unavoidable adverse impacts from routine operations could lead to the loss of unique or significant archaeological information if unrecognized at the time an area is disturbed. Required archaeological surveys significantly reduce the potential for this loss by identifying potential archaeological sites prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible. A large oil spill that makes landfall on or near protected archaeological landmarks could cause loss of aesthetic value, contamination of material remains, loss of radiocarbon-dating potential, direct impacts from oil-spill cleanup activities, and/or looting.

Economic and Social Factors: Net economic, political, and social benefits to the U.S. accrue from the production of hydrocarbon resources. Once these benefits become routine, unavoidable adverse impacts from routine operations follow trends in supply and demand based on the commodity prices for oil, gas, and refined hydrocarbon products. Declines in oil and gas prices can lead to activity ramp downs by operators until prices rise. A large oil spill would cause temporary increases in economic activity associated with spill-response activity. An increase in economic activity from the response to a large spill could be offset by temporary work stoppages that are associated with spill-cause investigations and would involve a transfer or displacement of demand to different skill sets. Routine operations affected by new regulations that are incremental would not have much effect on the baseline of economic activity; however, temporary work stoppages or the introduction of several new requirements at one time, which are costly to implement, could cause a drop-off of activity as operators adjust to new expectations or use the opportunity to move resources to other basins where they have interests.

4.16 Irreversible and Irretrievable Commitment of Resources

Irreversible or irretrievable commitment 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.

4.16.1 Coastal Habitats

An irreversible or irretrievable loss of wetlands and associated biological resources could occur if wetlands are permanently lost because of impacts caused by dredging and construction activities that displace existing wetlands or from oil spills severe enough to cause permanent die-back of vegetation and conversion to open water. Construction and emplacement of onshore pipelines in coastal wetlands displace coastal wetlands in disturbed areas that are then subject to indirect impacts like saltwater intrusion or erosion of the marsh soils along navigation channels and canals. Regulatory requirements of the State and Federal water authorities and some local jurisdictions would be applicable to these activities to mitigate these impacts. Ongoing natural and anthropogenic processes in the coastal zone, only one of which is an OCS oil- and gas-related activity, can result in direct and indirect loss of wetlands. Natural losses as a consequence of the coastal area becoming hydrologically isolated from the Mississippi River that built it, sea-level rise, and subsidence of the delta platform in the absence of new sediment added to the delta plain appear to be much more dominant processes impacting coastal wetlands.

4.16.2 Biological Resources

An irreversible loss or degradation of ecological habitat caused by cumulative activity tends to be incremental over the short term. Irretrievable loss may not occur unless or until a critical threshold is reached. It can be difficult or impossible to identify when that threshold is, or would be, reached. 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.

4.16.2.1 Threatened and Endangered Species

Irreversible loss of individuals that are protected species may occur after a large oil spill from the acute impact of being oiled or the chronic impact of oil having eliminated, reduced, or rendered suboptimal the food species upon which they were dependent.

4.16.2.2 Fish and Invertebrate Resources, Deepwater Benthic Communities, Commercial Fisheries, and Recreational Fishing

Irreversible loss of fish and invertebrate resources, including commercial and recreational species, are caused by structure removals using explosives. Fish in proximity to an underwater explosion can be killed. Without the structure to serve as habitat area, sessile, attached invertebrates and the fish that live among them are absent. Removing structures eliminates these special and local habitats and the organisms living there, including such valuable species as red snapper. Continued structure removal, regardless of the technique used, would reduce the net benefits to commercial fishing due to the presence of these structures. However, the Rigs-to-Reef Program would help offset these impacts.

4.16.3 Archaeological Resources

Irreversible loss of a prehistoric or historic archaeological resource can occur if bottom-disturbing activity takes place without the surveys, where required, to demonstrate its absence before work proceeds. A resource can be completely destroyed, severely damaged, or the scientific context badly impaired by well drilling, subsea completions, and platform and pipeline installation, or sand borrowing.

4.16.4 Oil and Gas Development

Leasing and subsequent development and extraction of hydrocarbons as a result of a proposed action represents an irreversible and irretrievable commitment by the removal and consumption of nonrenewable oil and gas resources. The estimated amount of resources to be recovered as a result of a proposed action is presented in **Chapter 3.1**.

4.16.5 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 and work place safety and environmental protection. Nevertheless, some loss of human and animal life may be inevitable from unpredictable and unexpected acts of man and nature (i.e., unavoidable accidents, accidents caused by human negligence or misinterpretation, human error, and adverse weather conditions). Some normal and required operations, such as structure removal, can kill sea life in proximity to explosive charges or by removal of the structure that served as the framework for invertebrates living on it and the fish that lived with it.

4.17 Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

The short-term impacts on various components of the environment in the vicinity of the proposed action are related to long-term impacts and the maintenance and enhancement of long-term productivity.

4.17.1 Short-Term Use

Short-term refers to the total duration of oil and gas exploration and production activities. Extraction and consumption of offshore oil and natural gas is a short-term benefit. Discovering and producing domestic oil and gas now reduces the Nation's dependency on foreign imports. Depleting a nonrenewable resource now removes these domestic resources from being available for future use. The production of offshore oil and natural gas as a result of a proposed action would provide short-term energy, and as it delays the increase in the Nation's dependency on foreign imports, it can also allow additional time for ramp-up and development of long-term renewable energy sources or substitutes for nonrenewable oil and gas. Economic, political, and social benefits would accrue from the availability of these natural resources.

The principle short-term use of the leased areas in the Gulf of Mexico would be for the production of up to 0.211-1.118 BBO and 0.547-4.424 Tcf of gas from a proposed action. The cumulative impacts scenario in this Multisale EIS extends approximately from 2017 to 2066. The 50-year time period is used because it is the approximate longest life span of activities conducted on an individual lease. The 50 years following a proposed lease sale is the period of time during which the activities and impacting factors that follow as a consequence of a proposed lease sale would be influencing the environment.

The specific impacts of a proposed action vary in kind, intensity, and duration according to the activities occurring at any given time (**Chapter 3**). 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 a proposed action 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 (over 25 years), potentially punctuated by more severe impacts as a result of accidental events or a spill. Platform removal is also a short-term activity with localized impacts, including removal of the habitat for encrusting invertebrates and fish living among them. Many of the impacts on physical, biological, and socioeconomic resources discussed in **Chapter 4** are considered to be short term (being greatest during the construction, exploration, and early production phases). These impacts would be further reduced by the mitigating measures discussed in **Chapter 2.2.4**.

The OCS development off Texas and Louisiana has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and specialized recreational fishing equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers.

A proposed action could increase these incidental benefits of offshore development. Offshore fishing and diving have gradually increased in the past three decades, with offshore structures and platforms becoming 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, but this could be offset by the Rigs-to-Reef program.

The short-term exploitation of hydrocarbons for the OCS Program in the Gulf of Mexico may lead to long-term impacts on biologically sensitive resources and areas if a large oil spill occurs. A spill and spill-response activity could temporarily interfere with commercial and recreational fishing, beach use, and tourism in the area where the spill makes landfall and in a wider area based on stigma effects. 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 (refer to **Chapter 4.14**).

4.17.2 Relationship to Long-Term Productivity

Long-term refers to an indefinite period beyond the termination of oil and gas production. Over a period of time after peak oil production has occurred in the Gulf of Mexico, a gradual easing of the specific impacts caused by oil and gas exploration and production would occur as the productive reservoirs in the Gulf have been discovered and produced, and have become depleted. The BSEE estimates that oil production in the GOM peaked at 1.6 MMbbl/day in 2002, declined for a few years and then peaked again in 2009 and 2010 at 1.6 MMbbl/day before declining again. Production rates in 2014 indicate it was another high year (1.4 MMbbl/day). Gas production in the GOM peaked at 14.4 Bcf/day in 1997 and has declined since to 3.4 Bcf/day in 2014. Production has shifted from many smaller reserves on the continental shelf to fewer larger reserves in deep water. Large deepwater oil discoveries have the potential to alter the oil production rate, but the exact effect any one discovery would have or when that discovery would be made is difficult to project due to the difficulties that may be encountered producing these prospects because of their geologic age; burial depth and high-temperature, high-pressure *in-situ* conditions; lateral continuity of reservoirs; and the challenges of producing from ultra-deepwater water depths.

The Gulf of Mexico's large marine ecosystem is considered a Class II, moderately productive ecosystem (mean phytoplankton primary production 150-300 gChlorophyll a/m^2-yr [The Encyclopedia of Earth, 2008]) based on Sea-viewing Wide Field-of-view Sensor (SeaWiFS) global primary productivity estimates (USDOC, NASA, 2003). After the completion of oil and gas production, a gradual ramp-down to economic conditions without OCS oil- and gas-related activity would be experienced, while the marine environment is generally expected to remain at or return to its normal long-term productivity levels that, in recent years, has been described as stressed (The Encyclopedia of Earth, 2008). The Gulf of Mexico's large marine ecosystem shows signs of ecosystem stress in bays, estuaries, and coastal regions (Birkett and Rapport, 1999). There is shoreline alteration, pollutant discharge, oil and gas development, and nutrient loading. The overall condition for the U.S. section of this large marine ecosystem, according to the USEPA's seven primary indicators (Jackson et al., 2000), is good dissolved oxygen, fair water quality, poor coastal wetlands, poor eutrophic condition, and poor sediment, benthos, and fish tissue (The Encyclopedia of Earth, 2008).

To help sustain the long-term productivity of the Gulf of Mexico ecosystem, the OCS Program provides structures to be used as site-specific artificial reefs and fish-attracting devices for the benefit of commercial and recreational fishermen and for sport divers and spear fishers. Approximately 10 percent of the oil and gas structures removed from the OCS are eventually used for State artificial reef programs. Additionally, the OCS Program continues to improve the knowledge and mitigation practices used in offshore development to enhance the safe and environmentally responsible development of OCS oil and gas resources.

The Department of the Interior Mission

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The Bureau of Ocean Energy Management Mission

The Bureau of Ocean Energy Management (BOEM) is responsible for managing development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way.