OCS EIS/EA
BOEM 2017-051

Gulf of Mexico OCS
Proposed Geological and Geophysical Activities

Western, Central, and Eastern Planning Areas

Final Programmatic Environmental Impact Statement

Volume I: Chapters 1-9

U.S. Department of the Interior
Bureau of Ocean Energy Management
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DEPARTMENT NOTE

The Bureau of Ocean Energy Management (BOEM) prepared this Programmatic Environmental Impact Statement (EIS), pursuant to the National Environmental Policy Act, to evaluate the potential environmental effects of multiple geological and geophysical (G&G) activities on the Gulf of Mexico Outer Continental Shelf (OCS). This Final Programmatic EIS was prepared using the best available scientific information and addresses all comments received on the Draft Programmatic EIS, which was made publicly available and provided the opportunity for public comment on BOEM's evaluation. BOEM's goal has always been to provide factual, reliable, and clear analytical statements to inform decisionmakers and the public about potential environmental effects of proposed OCS activities and their alternatives. BOEM views the EIS process as providing a balanced forum for early identification, avoidance, and resolution of potential conflicts. At the completion of this EIS process, a decision will be published in the *Federal Register* for the G&G permit applications pending before BOEM.

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COVER SHEET

Programmatic Environmental Impact Statement
for
Gulf of Mexico OCS Proposed Geological and Geophysical Activities
in the Gulf of Mexico

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

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

Agency	Headquarters' Contact	Region Contact
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ABSTRACT

This Final Programmatic Environmental Impact Statement (EIS) covers the potential significant environmental effects of multiple geological and geophysical (G&G) activities on the Gulf of Mexico (GOM) Outer Continental Shelf (OCS) in the Western, Central, and Eastern Planning Areas (WPA, CPA, and EPA). It evaluates the types of G&G surveys and activities in the three program areas managed by the Bureau of Ocean Energy Management (BOEM): oil and gas; renewable energy; and marine minerals.

The proposed action is a major Federal action requiring an EIS. This document provides the following information in accordance with the National Environmental Policy Act (NEPA) and its implementing regulations, and it will be used in making decisions on the proposals.

This Final Programmatic EIS includes the purpose and background of the proposed action, identification of the alternatives, a scenario of the anticipated level of G&G activities in the program areas across the WPA, CPA, and EPA. A description of the factors and impacts caused by the proposed activities, a description of the affected environment, and an analysis of the potential

environmental impacts under routine and non-routine conditions for the proposed action and alternatives are analyzed. Activities and disturbances associated with the proposed action on biological, physical, and socioeconomic resources are considered in the analyses. The proposed mitigating measures and their potential effects are described. Also, the potential contributions to cumulative impacts resulting from activities associated with the proposed action are analyzed.

It is important to note that this Final Programmatic 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 Final Programmatic 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 335A), 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/GOM-G-G-PEIS/ and http://www.boem.gov/nepaprocess/.

EXECUTIVE SUMMARY

BACKGROUND

The Bureau of Ocean Energy Management (BOEM) is issuing this Programmatic Environmental Impact Statement (EIS) to describe and evaluate the potential environmental impacts related to geological and geophysical (G&G) survey activities in affected Federal and State waters of the Gulf of Mexico (GOM). The G&G surveys will be conducted to provide data to inform business decisions about the development of oil and gas reserves, locate and evaluate marine mineral deposits, provide engineering data for developing renewable energy projects, identify geologic hazards and benthic habitats to avoid, and aid in the location and avoidance of archaeological sites. This Programmatic EIS evaluates G&G survey activities within Program Areas for which BOEM has oversight (i.e., oil and gas, renewable energy, and marine minerals) to investigate offshore oil, gas, methane hydrate resources, non-energy/marine mineral resources, and geologic hazards. The G&G survey activities may occur within the three planning areas (i.e., the Western, Central, and Eastern Planning Areas [WPA, CPA, and EPA]).

This Programmatic EIS establishes a framework for BOEM to guide subsequent NEPA analyses of site-specific actions while identifying and analyzing appropriate mitigation measures to be used during future G&G activities on the Outer Continental Shelf (OCS) in support of the Oil and Gas, Renewable Energy, and Marine Minerals Programs. BOEM will address the impacts of future site-specific actions in subsequent National Environmental Policy Act (NEPA) evaluations (40 CFR § 1502.20) using a tiering process based on this programmatic evaluation.

BOEM is the lead agency for this Programmatic EIS, with the Bureau of Safety and Environmental Enforcement (BSEE) and the National Oceanic and Atmospheric Administration (NOAA) as cooperating agencies. BOEM is the lead Federal agency in providing guidelines for implementing the Oil and Gas, Renewable Energy, and Marine Minerals Programs in the Gulf of Mexico OCS. BOEM and BSEE have a memorandum of agreement (MOA) stating that BSEE will serve as cooperating agency on Bureau of Ocean Energy Management NEPA documents, oversee any requisite environmental monitoring needs, and ensure that post-activity environmental compliance needs are met and documented (**Appendix A**). The NOAA is a cooperating agency for this Programmatic EIS because the scope of the proposed action and alternatives involve G&G survey activities that could impact living marine resources and because the National Marine Fisheries Service (NMFS) is the lead Federal agency in managing and regulating marine mammals and sensitive marine species, including those listed or proposed for listing as threatened or endangered under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA).

This summary provides an overview of the analysis of the proposed action and other alternatives that would allow BOEM to authorize G&G activities within the GOM where it has oversight. The details of the analysis conducted for each alternative and Program Area can be found in the main body of this Programmatic EIS. Additional supporting information can be found in the appendices. The main body of this Programmatic EIS contains the following chapters:

- **Chapter 1 (Introduction)** describes the purpose, objectives, and scope of this Programmatic EIS; describes the role of BOEM, BSEE, and cooperating agencies; provides background information; reviews the *Deepwater Horizon* explosion, oil spill, and response; and explains the regulatory context of this Programmatic EIS.
- **Chapter 2 (Alternatives Including the Proposed Action)** describes the seven alternatives evaluated (including the proposed action), the survey protocols and mitigation measures included in all of the alternatives, and issues to be analyzed; identifies alternatives not analyzed and mitigation measures not included; presents a comparison of potential impacts by alternative; and describes mitigation measures, monitoring, and effectiveness.
- **Chapter 3 (G&G Activities and Proposed Action Scenario)** describes the G&G activities included in each Program Area and the expected level of effort during the 10-year period covered by this Programmatic EIS, identifies and describes the impact-producing factors (IPFs), and provides a cumulative activity scenario for impact analysis.
- **Chapter 4 (Description of the Affected Resources and Impact Analysis)** describes the affected environment and analyzes the potential impacts of each alternative.
- **Chapter 5 (Other NEPA Considerations)** describes the unavoidable adverse impacts, irreversible and irretrievable commitment of resources, and the relationship between short-term uses and long-term productivity.
- **Chapter 6 (Public Involvement and Agency Consultation and Coordination)** describes the consultation and coordination activities with Federal, State, and local agencies, federally recognized Indian Tribes, and other interested parties that occurred during the development of this Programmatic EIS.
- **Chapter 7 (Literature Cited)** describes the technical information on which the analyses within this Programmatic EIS are based.
- **Chapter 8 (Preparers and Reviewers)** describes the technical staff within BOEM, BSEE, NMFS, and the contractors responsible for the content of this Programmatic EIS.

AREA OF INTEREST

The AOI includes the Federal OCS waters of the GOM that are within BOEM's Gulf of Mexico WPA, CPA, and EPA. The AOI also includes the coastal (i.e., State) waters of Texas, Louisiana, Mississippi, Alabama, and Florida, extending from the coastline outside of estuaries seaward 3 nautical miles (nmi) (3.5 miles [mi]; 5.6 kilometers [km]) from Louisiana, Mississippi, and Alabama, and seaward to 9 nmi (10.4 mi; 16.7 km) from the coastlines of Texas and Florida (**Figure ES-1**). BOEM does not approve G&G activities in State waters; however, since G&G

activities in OCS waters can potentially impact resources in State waters (e.g., sound traveling from OCS areas into State waters), for purposes of impacts analysis in this Programmatic EIS, State waters were included in the AOI.

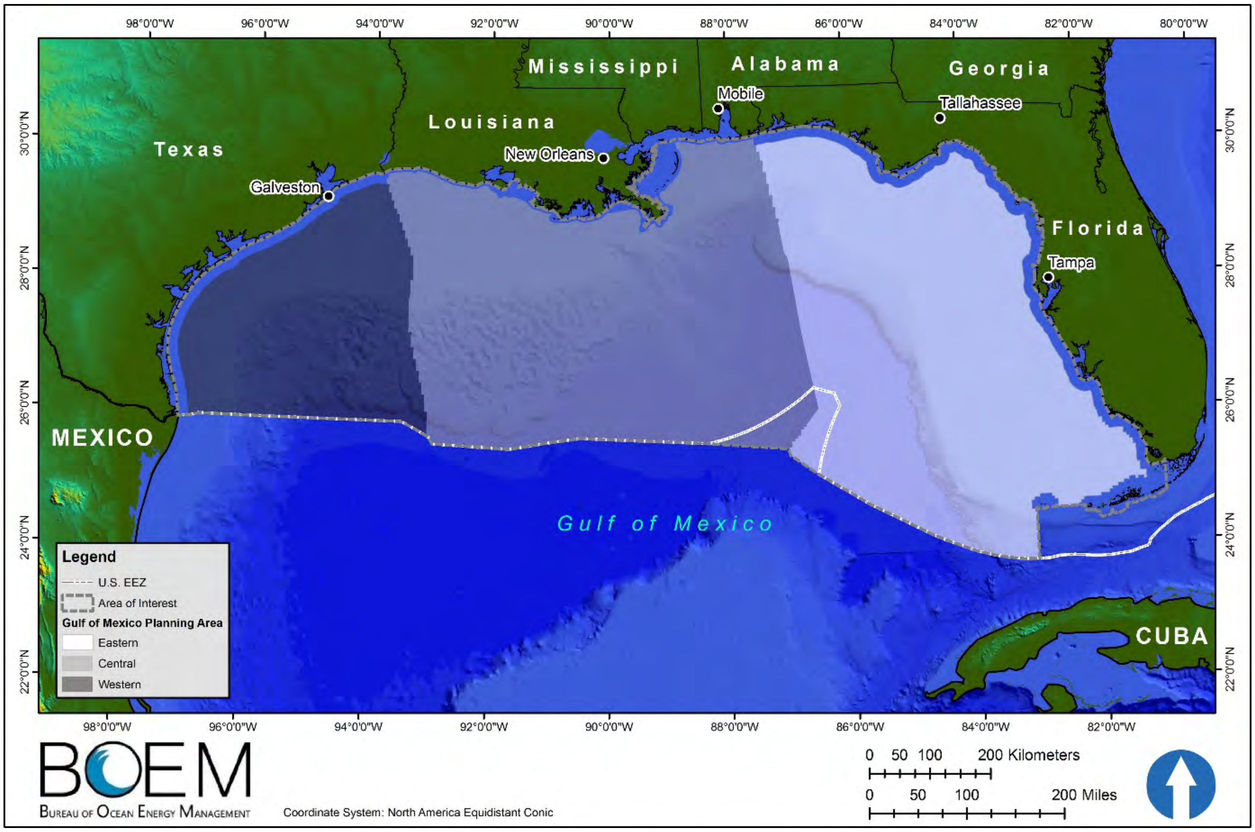


Figure ES-1. Area of Interest for the Proposed Action.

To support the impact analysis, this Programmatic EIS includes resources that inhabit or migrate through the AOI and that may be affected by the proposed action. The AOI inner boundary follows the shoreline along most of the U.S. coast, extending across the mouths of estuaries and bays. State waters are not within BOEM's jurisdiction; the U.S. Army Corps of Engineers (USACE) permits G&G activities in State waters. The USACE also has jurisdiction over such activities, including OCS seafloor structures, in State and Federal waters. Though BOEM does not approve G&G activities in State waters, BOEM is analyzing the potential effects in adjacent State waters in this Programmatic EIS because

(1) NMFS has jurisdiction and MMPA permitting authority in Federal and State waters, and requires an assessment of the potential impacts to the human environment;

(2) the acoustic energy introduced into the environment during G&G activities in Federal waters could affect resources in State waters; and

(3) G&G activities could include interrelated and connected activities in Federal and State waters that would be considered connected actions.

TYPES OF G&G ACTIVITIES ANALYZED

A variety of G&G activities, most of which use sound in some way, are used to characterize the shallow and deep profile of the OCS, including the shelf, slope, and deepwater ocean environment. The G&G surveys are conducted to (1) obtain data for hydrocarbon and mineral exploration and production; (2) aid in siting of oil and gas structures and facilities, 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. In general, G&G activities include the following:

- types of deep-penetration seismic airgun surveys used almost exclusively for oil and gas exploration and development;
- other types of surveys and sampling activities used only in support of oil and gas exploration and development, including electromagnetic surveys, geological test wells, and various remote sensing methods;
- non-airgun high-resolution geophysical (HRG) surveys used in all three Program Areas to detect and monitor geohazards, archaeological resources, and certain types of benthic communities; and
- geological and geotechnical seafloor sampling used in all three Program Areas to assess the suitability of seafloor sediments for supporting structures (e.g., platforms, pipelines, cables, and renewable energy facilities such as wind turbines), or to evaluate the quantity and quality of sand for beach nourishment and coastal restoration projects.

The G&G activities in support of renewable energy development would consist mainly of HRG and geotechnical surveys in Federal and State waters <40 meters (m) (131 feet [ft]) deep. 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 <30 m (98 ft) deep.

Deep-penetration seismic surveys are conducted almost exclusively in support of oil and gas exploration and development, and would be conducted in all three planning areas. For these surveys, vessels tow an airgun or an array of airguns that emit acoustic energy pulses through the overlying water and into the seafloor over long durations and over large areas. Thus, these surveys are one of the most extensive G&G activities that would be conducted and are one of the potentially impactful activities analyzed in this Programmatic EIS.

ALTERNATIVES AND MITIGATION MEASURES

Seven alternatives (A through G) are analyzed in this Programmatic EIS. All G&G activities permitted under the alternatives would need to comply with existing laws and regulations. The alternatives are designed to minimize impacts to resources by avoiding them or by modifying the design of proposed G&G activities. In addition, during the MMPA authorization process, NMFS may require additions or alterations to mitigation measures to minimize or avoid impacts to marine mammals. The mitigation measures required under each alternative are given in **Table ES-1**.

- **Alternative A – Pre-Settlement (June 2013) Alternative:** BOEM would continue to permit/authorize at the current projected activity levels with implementation of standard mitigation measures applied to G&G activities through lease stipulations, issued permits and authorizations as conditions of approvals (COAs), Notices to Lessees and Operators (NTLs), and/or best management practices in place prior to the June 2013 Settlement Agreement.
- **Alternative B – Settlement Agreement Alternative:** BOEM would continue to permit or authorize G&G activities through the use of site-specific NEPA evaluations, lease stipulations, NTLs, best management practices, and COAs with the addition of mitigation measures from the Settlement Agreement for Civil Action No. 2:10-cv-01882 dated June 25, 2013, and the Stipulation to Amend Settlement Agreement dated February 8, 2016 (collectively, the Amended Settlement Agreement). Mitigation measures included in Alternative B include measures carried forward from Alternative A and measures from the Amended Settlement Agreement, such as expansions of the Protected Species Observer (PSO) and Passive Acoustic Monitoring (PAM) Programs, separation distance between simultaneous surveys, a coastal waters' seasonal restriction, and restrictions within the Plaintiff's Areas of Concern.
- **Alternative C – Alternative A Plus Additional Mitigation Measures:** This alternative has been identified as BOEM's Preferred Alternative. BOEM would continue to authorize G&G activities that would include the mitigation measures, monitoring, reporting, survey protocols, and guidance that are included in Alternative A, as well as additional mitigation measures carried forward from Alternative B, including the expanded PSO and PAM Programs; measures carried forward and modified from Alternative B (the requirement of PAM in Mississippi and De Soto Canyons and a change in the timing of the coastal waters' seasonal restriction); and newly introduced measures for survey protocols for non-airgun HRG surveys.
- **Alternative D – Alternative C Plus Marine Mammal Shutdowns:** BOEM would authorize G&G activities and would include all mitigation measures included in Alternatives A and C with the addition of shutdowns of airgun and HRG survey sound sources for all marine mammals, with the exception of bow-riding dolphins within an exclusion zone or actively approaching dolphins.

Table ES-1. Applicability of Mitigation Measures to G&G Surveys by Alternative (indicates which mitigation measure is applicable to an alternative)

Survey Type	Mitigation Measures														Survey Protocol		Seasonal Restrictions and Closures		
	Vessel Strike Avoidance	Marine Debris Guidance	Avoidance of Sensitive Benthic Communities	Avoidance of Historic and Prehistoric Sites	Shallow Hazards Guidance	National Marine Sanctuary Regulations	Military Coordination	Ancillary Activity Guidance	Implement PSO Program	Implement Expanded PSO Program	Minimum Separation Distance	Reduced Level of Activity	Use of PAM Strongly Encouraged	Use of PAM Required	Seismic Airgun Survey Protocol	Non-Airgun HRG Survey Protocol	Coastal Waters Seasonal Restriction	Areas of Concern within the EPA[8]	CPA, EPA, Dry Tortugas, and Flower Garden Banks Closure Areas
Seismic Airgun Surveys	A-G	A-G	A-G	A-G[1]	A-G[1]	A-G	A-G	A-G	A,G	B-F[2] D[3]	B	E	A,G	B-F[4] C-F[5]	A-G	--	B[6] C-F[7]	B	F
Non-airgun HRG Surveys with Frequencies >200 kHz	A-G	A-G	A-G	A-G[1]	A-G[1]	A-G	A-G	--	--	--	--	--	--	--	--	--	--	--	--
Non-airgun HRG Surveys with Frequencies ≤200 kHz	A-G	A-G	A-G	A-G[1]	A-G[1]	A-G	A-G	--	C-F	--	--	--	--	--	--	C-F	--	--	F
Other G&G Surveys	A-G	A-G	A-G	A-G[1]	A-G[1]	A-G	A-G	--	--	--	--	--	--	--	--	--	--	--	--

CPA = Central Planning Area; EPA = Eastern Planning Area; ft = feet; HRG = high-resolution geophysical; kHz = kilohertz; m = meters; OCS = Outer Continental Shelf; PAM = passive acoustic monitoring; PSO = protected species observer.

1 Avoidance of historic and prehistoric sites and sensitive benthic communities applies only to surveys that involve seafloor-disturbing activities. Seismic airgun surveys and non-airgun HRG surveys that do not disturb the seafloor are not required to avoid these sites or features. Non-airgun HRG surveys and most seismic airgun surveys (except those in which cables or sensors are placed in or on the seafloor) do not disturb the seafloor.

2 Expanded to include manatees and all water depths.

3 Expanded from Footnote 2 to include shutdown for all marine mammals, with the exception of bow-riding or actively approaching dolphins (i.e., common bottlenose, Fraser's, Clymene's, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso's), and all water depths.

4 During periods of reduced visibility for surveys in waters deeper than 100 m (328 ft).

5 The PAM required for all airgun surveys at all times in the Mississippi Canyon and De Soto Canyon lease blocks.

6 Applies from (a) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66 ft] isobath) and (b) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the unusual mortality event in the northern Gulf of Mexico.

7 Applies to all coastal waters shoreward of the 20-m (66-ft) isobaths between February 1 and May 31.

8 Does not apply to currently leased OCS lease blocks, any portion of the area encompassed by EPA Lease Sale 226, or neighboring OCS lease blocks adjacent to permitted survey areas but within an otherwise off-limit area.

- **Alternative E – Alternative C at Reduced Activity Levels:** BOEM would authorize G&G activities and would include all mitigation measures included in Alternatives A and C, and BOEM would authorize a reduced level of G&G activity for seismic airgun surveys under two options: Alternatives E1 and E2.
  - Alternative E1 includes a 10 percent reduction in deep-penetration, multi-client seismic airgun surveys.
  - Alternative E2 includes a 25 percent reduction in deep-penetration, multi-client seismic airgun surveys.
- **Alternative F – Alternative C Plus Area Closures:** BOEM would continue to permit G&G activities and require that operators comply with mitigation requirements carried forward from Alternatives A and C, with the addition of area closures to provide additional protection for certain cetaceans and other resources, and distance restrictions based on received sound levels into waters adjacent to the closure areas. The four closure areas are the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Garden Banks Closure Area.
- **Alternative G – No New Activity Alternative:** BOEM would cease issuing permits for new G&G surveys and would not approve new G&G surveys proposed under exploration or development plans. However, G&G activities previously authorized under an existing permit or lease would proceed using mitigation measures described under Alternative A and the expanded PSO and PAM Programs carried forward from Alternative B, but they would not be renewed or reauthorized and, thus, would eventually be phased out. The second part of Alternative G is NMFS' No Action Alternative. For NMFS, denial of MMPA authorizations constitutes NMFS' No Action Alternative, which is consistent with NMFS' statutory obligation under the MMPA to grant or deny applications to authorize incidental take and to prescribe mitigation, monitoring, and reporting with any authorizations.

Resource Areas and Impact-Level Criteria

Baseline environmental characterization and impact analysis for each alternative were conducted for 12 resource areas:

- marine mammals;
- sea turtles;
- fisheries resources and essential fish habitat (EFH);
- benthic communities;
- marine and coastal birds;
- Marine Protected Areas (MPAs);
- *Sargassum* communities;
- commercial fisheries;
- recreational fisheries;
- archaeological resources;
- other marine uses; and
- human resources, land use, and economics.

Impact-level criteria were applied to each resource area 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). The resulting impact-level criteria were broadly defined as

- **Nominal:** Little or no measurable/detectable impact;
- **Minor:** Impacts are detectable, short term, extensive or localized, but less than severe;
- **Moderate:** Impacts are detectable, short term, extensive, and severe; or impacts are detectable, short term or long lasting, localized, and severe; or impacts are detectable, long lasting, extensive or localized, but less than severe; and
- **Major:** Impacts are detectable, long lasting, extensive, and severe.

Resource-specific, impact-level criteria were developed on a resource-specific basis to determine the appropriate impact level for each IPF.

Impact-Producing Factors

The IPFs are G&G activities that, based on their potential to affect the environment, require a thorough analysis in this Programmatic EIS. The IPF candidates were screened and those selected for inclusion are as follows (**Table ES-2**):

- active acoustic sound sources;
- vessel and equipment noise;
- vessel traffic;
- aircraft traffic and noise;
- stand-off distances;
- vessel discharges;
- trash and debris;
- seafloor disturbance;
- geological test well discharges;
- entanglement; and
- accidental fuel spills.

Table ES-2. Preliminary Screening of Potential Impacts (Leopold Matrix)

Resource	Active Acoustic Sound Sources	Vessel and Equipment Noise	Vessel Traffic	Aircraft Traffic and Noise	Stand-Off Distances	Vessel Discharges	Trash and Debris	Seafloor Disturbance	Drilling Discharges	Entanglement	Accidental Fuel Spill
Marine Mammals	+	+	+	+	-	-	+	-	-	+	+
Sea Turtles	+	+	+	+	-	-	+	-	-	+	+
Fisheries Resources and Essential Fish Habitat	+	+	-	-	-	-	+	+	+	+	+
Benthic Communities	+	-	-	-	-	-	+	+	+	-	+
Marine and Coastal Birds	+	+	+	+	-	-	+	-	-	-	+
Marine Protected Areas	+	-	-	-	-	-	+	+	+	-	+
Sargassum and Associated Communities	-	-	+	-	-	+	+	-	-	-	+
Commercial Fisheries	+	-	+	-	+	-	-	+	-	+	+
Recreational Fisheries	+	-	+	-	+	-	-	-	-	-	+
Archaeological Resources	-	-	-	-	-	-	-	+	+	+	+
Other Marine Uses	-	-	+	+	+	-	-	+	-		+
Human Resources, Land Use, and Economics[1]	-	-	-	-	-	-	-	-	-	-	-
Recreational Resources and Tourism	-	-	-	-	-	-	-	-	-	-	-
Air Quality	-	-	+	+	-	-	-	-	-	-	-
Water Quality	-	-	-	-	-	+	+	-	+	-	+
Geography and Geology	-	-	-	-	-	-	-	+	-	-	-
Physical Oceanography	-	-	-	-	-	-	-	-	-	-	-
Coastal Barrier Island Beaches, Seagrass, and Wetlands	-	-	-	-	-	-	-	-	-	-	-

G&G = geophysical and geological.

Key: + indicates a potential impact; - indicates no impact expected; shaded areas = resources that were eliminated from detailed analysis due to limited anticipated impacts associated with G&G activities.

[1] The impact-producing factors do not apply to this resource; however, resource subcomponents have potential impacts from some alternatives.

Cumulative Impacts

Cumulative effects refer to the impact on the environment that results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively major actions taking place over a period of time. Within each resource section in **Chapter 4**, the cumulative analysis considers impacts to environmental and socioeconomic resources that may result from the incremental impact of the proposed action when added to all past, present, and reasonably foreseeable future activities, including non-G&G-related activities such as shipping and marine transportation and commercial fishing, as well as all OCS and State oil- and gas-related activities. The three major topical areas are the OCS Program, Oil and Gas Activities in State Waters, and Other Major Factors Influencing the AOI.

OCS Program: The OCS Program includes activities associated with oil and gas exploration and development, decommissioning, renewable energy development, and marine minerals use. The IPFs associated with OCS Program activities that coincide with the proposed action include vessel and equipment noise (including explosives use [decommissioning]), vessel traffic (support vessel traffic), aircraft traffic and noise, stand-off distance, vessel discharges, seafloor disturbance, geological test well discharges, and accidental fuel spills. All G&G survey activities associated with the OCS Program are included in the proposed action; therefore, G&G activities are not included in the cumulative analysis but instead are addressed in the proposed action impact analysis.

Oil and Gas Activities in State Waters: The Oil and Gas Activities in State Waters Program includes activities associated with oil and gas exploration and development and decommissioning. It is recognized that the types of activities described for OCS Program activities would be the same as the Oil and Gas Activities in State Waters Program and would have the same IPFs. However, oil and gas activities in State waters would include the G&G surveys permitted by other agencies. Therefore, the IPFs that coincide with G&G activities include active acoustic sound sources, vessel and equipment noise, vessel traffic (support vessel traffic), aircraft traffic and noise, stand-off distance, trash and debris, seafloor disturbance, geological test well discharges, entanglement, and accidental fuel spills.

Other Major Factors Influencing the AOI: The other major factors influencing the AOI program include activities associated with deepwater ports; commercial and recreational fishing; shipping and marine transportation; ocean dredged material disposal site; existing, planned, and new cable infrastructure; military activities; scientific research; maintenance dredging of Federal channels; coastal restoration programs; Mississippi River hydromodification; extreme climatic events; climate change and sea-level rise; and natural oil seeps. The IPFs associated with activities undertaken as part of other major factors influencing the AOI and that coincide with the proposed action include active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, stand-off distance, vessel discharges, trash and debris, seafloor disturbance, entanglement, and accidental fuel spills.

IMPACT CONCLUSIONS BY RESOURCE FOR ALTERNATIVES A THROUGH G

The analysis conducted in this Programmatic EIS identifies the change from present conditions for issues (principal effects identified for analysis) resulting from the relevant actions related to the proposed action. Baseline environmental characterization and impact analysis for seven alternatives (A through G) were conducted for the 12 resource areas listed previously considering the IPFs (G&G activities with the potential to affect the environment of the AOI). The levels of impacts determined by resource and applicable IPF across the seven alternatives are presented in **Tables ES-3 and ES-4**. Those resources that are determined to have no or nominal impacts across all alternatives (i.e., benthic communities, *Sargassum* communities, recreational fisheries, and other marine uses) are not discussed in this **Executive Summary**. The analysis of impacts for all resource areas under Alternatives A through G are discussed in detail in **Chapter 4**. The differences in impacts between those identified under Alternative A and those identified for Alternatives B through G are discussed by resource and the relevant IPF. The IPFs and impact-level criteria applied during the impact assessment remain the same for all alternatives for each resource. The conclusions of impact assessment for alternatives are presented below.

Impact Conclusions for Marine Mammals

Impacts to marine mammals from all IPFs associated with deep-penetration seismic airgun surveys may result in extensive (i.e., affecting large numbers of individuals) short-term but not severe impacts with possible, albeit limited, physical injury or possible mortality (resulting only from vessel collisions). Some of the mitigation measures included in the alternatives provide a level of protection to various target species and afford a reduced level of impacts to those target species and biologically important periods and geographic locations (e.g., seasonal restrictions in coastal waters afford protection to individual members of the bay, sound, and estuary stocks during their calving season, as well as coastal stocks of common bottlenose dolphins, Atlantic spotted dolphins, and individual manatees that may occur in coastal and inshore waters; the EPA Closure Area provides protection targeted to the Bryde's whale, with protection afforded to other species present in the closure area; and the CPA Closure Area provides targeted protection to the sperm whale, with protection afforded to other species within the closure area). However, when impacts from deep-penetration seismic airgun surveys to all marine mammals within the AOI during the 10-year timeframe of this Programmatic EIS are considered for the impact-level determination, the overall impact level is **moderate**, depending on the stock, for Alternatives A through E, **minor** for Alternative F, and **no impact** for Alternative G due to no new activities.

Minor impacts are expected for shallow-penetration seismic airgun surveys and non-airgun HRG surveys for Alternatives A through F based on exposure modeling. Impacts from vessel and equipment noise are assessed as **nominal** to **minor** for Alternatives A through F because many marine mammal species produce and perceive low- to mid-frequency sounds; furthermore, the effect of increased ambient noise on marine mammals could mask biologically significant sounds. Vessel collisions with marine mammals are likely to be avoided; however, if a collision did occur, it could result in mortality. Therefore, depending on whether or not a collision did occur, **nominal** to **moderate** impacts are expected for Alternatives A through F.

Table ES-3. Impact Levels by Resource and Applicable Impact-Producing Factor Across Alternatives A Through G, as Discussed in **Chapter 2.13**

Resource and Impact-Producing Factor		Alternative[1]						
		A	B	C	D	E	F	G*
Marine Mammals								
Active Acoustic Sound Sources	Deep-Penetration Airguns	Mod	Mod[2,3,4,5]	Mod[2,4,5]	Mod[2,5,7]	Mod[2,4,5]	Min[2,3,4,5]	No Impact
	Shallow-Penetration Airguns	Min	Min[2,3,4,5]	Min[2,4,5]	Min[2,5,7]	Min[2,4,5]	Min[2,3,4,5]	No Impact
	HRG Equipment	Min	Min	Min[6]	Min[6]	Min[6]	Min[6]	No Impact
Vessel and Equipment Noise		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Vessel Traffic		Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	No Impact
Aircraft Traffic and Noise		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Trash and Debris		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Entanglement		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Accidental Fuel Spills		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Cumulative (incremental increase)		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min
Sea Turtles								
Active Acoustic Sound Sources	Airguns	Min	Min	Min	Min	Min	Min	No Impact
	HRG Equipment	Nom-Min	Nom-Min	Nom-Min[6]	Nom-Min[6]	Nom-Min[6]	Nom-Min[6]	No Impact
Vessel and Equipment Noise		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Vessel Traffic		Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	No Impact
Aircraft Traffic and Noise		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Trash and Debris		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Entanglement		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Accidental Fuel Spills		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Cumulative (incremental increase)		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min
Fisheries Resources and Essential Fish Habitat								
Active Acoustic Sound Sources	Airguns	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
	HRG Equipment	Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Vessel and Equipment Noise		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Trash and Debris		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Seafloor Disturbance		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Drilling Discharges		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Entanglement		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Accidental Fuel Spills		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Cumulative (incremental increase)		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min

Table ES-3. Impact Levels by Resource and Applicable Impact-Producing Factor Across Alternatives A Through G, as Discussed in **Chapter 2.13** (continued)

Resource and Impact-Producing Factor		Alternative[1]						
		A	B	C	D	E	F	G
Benthic Communities								
Active Acoustic Sound Sources	Airguns	Nom	Nom	Nom	Nom	Nom	Nom	No Impact
	HRG Equipment	Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Trash and Debris		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Seafloor Disturbance		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Drilling Discharges		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Accidental Fuel Spills		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Cumulative (incremental increase)		Nom	Nom	Nom	Nom	Nom	Nom	No-Nom
Marine and Coastal Birds								
Active Acoustic Sound Sources	Airguns	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom	Nom-Min	No Impact
	HRG Equipment	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Vessel and Equipment Noise		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Vessel Traffic		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Aircraft Traffic and Noise		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Trash and Debris		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Accidental Fuel Spills		Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	No Impact
Cumulative (incremental increase)		Nom	Nom	Nom	Nom	Nom	Nom	Nom
Marine Protected Areas								
Active Acoustic Sound Sources	Airguns	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	No Impact
	HRG Equipment	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Trash and Debris		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Seafloor Disturbance		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Drilling Discharges		No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No Impact
Accidental Fuel Spills		Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	Nom-Mod	No Impact
Cumulative (incremental increase)		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No-Nom
Sargassum Communities								
Vessel Traffic		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Vessel Discharges		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Trash and Debris		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Accidental Fuel Spills		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Cumulative (incremental increase)		Nom	Nom	Nom	Nom	Nom	Nom	No-Nom

Table ES-3. Impact Levels by Resource and Applicable Impact-Producing Factor Across Alternatives A Through G, as Discussed in **Chapter 2.13** (continued)

Resource and Impact-Producing Factor		Alternative[1]						
		A	B	C	D	E	F	G
Commercial Fisheries								
Active Acoustic Sound Sources	Airguns	Min	Min	Min	Min	Min	Min	No Impact
	HRG Equipment	Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Vessel Traffic		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Stand-Off Distance		Min	Min	Min	Min	Nom-Min	Min	No Impact
Seafloor Disturbance		Min	Min	Min	Min	Min	Min	No Impact
Entanglement		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	No Impact
Accidental Fuel Spills		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Cumulative (incremental increase)		Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom-Min	Nom
Recreational Fisheries								
Active Acoustic Sound Sources	Airguns	Nom	Nom	Nom	Nom	Nom	Nom	No Impact
	HRG Equipment	Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Vessel Traffic		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Stand-Off Distance		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Accidental Fuel Spills		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Cumulative (incremental increase)		Nom	Nom	Nom	Nom	Nom	Nom	Nom
Archaeological Resources								
Seafloor Disturbance		Nom-Maj	Nom-Maj	Nom-Maj	Nom-Maj	Nom-Maj	Nom-Maj	No Impact
Drilling Discharges		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Entanglement		Nom-Maj	Nom-Maj	Nom-Maj	Nom-Maj	Nom-Maj	Nom-Maj	No Impact
Accidental Fuel Spills		Nom	Nom	Nom	Nom	Nom	Nom	No Impact
Cumulative (incremental increase)		Nom	Nom	Nom	Nom	Nom	Nom	No-Nom
Multiple-Use Areas								
Vessel Traffic		No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom
Aircraft Traffic and Noise		No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom
Stand-Off Distance		No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom
Seafloor Disturbance		No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom	No-Nom
Accidental Fuel Spills		Nom	Nom	Nom	Nom	Nom	Nom	Nom
Cumulative (incremental increase)		Nom	Nom	Nom	Nom	Nom	Nom	Nom

Table ES-3. Impact Levels by Resource and Applicable Impact-Producing Factor Across Alternatives A Through G, as Discussed in **Chapter 2.13** (continued)

Resource and Impact-Producing Factor	Alternative [1]						
	A	B	C	D	E	F	G
Human Resources, Land Use, and Economics							
Land Use and Infrastructure	Ben-Min	Ben-Min	Ben-Min	Ben-Min	Ben-Min	Ben-Min	Min-Mod
Environmental Justice	Ben-Nom	Ben-Nom	Ben-Nom	Ben-Nom	Ben-Nom	Ben-Nom	Min
Demographics	Ben-Nom	Ben-Min	Ben-Min	Ben-Min	Minor	Minor	Min-Mod
Economics	Ben-Min	Ben-Mod	Ben-Min	Ben-Mod	Min-Mod	Min-Mod	Mod-Maj

Note: Impacts are categorized as Beneficial, Major, Moderate, Minor, or Nominal (refer to **Chapter 4.1.2** for definitions).

Ben = Beneficial Impact; G&G = geological and geophysical; HRG = high- resolution geophysical; No = No Impact; Nom = Nominal Impact; Min = Minor Impact; Mod = Moderate Impact; Maj = Major Impact.

[1] Alternative A = Pre-Settlement (June 2013) Alternative, Alternative B = Settlement Agreement Alternative, Alternative C = Alternative A Plus Additional Mitigation Measures, Alternative D = Alternative C Plus Marine Mammal Shutdowns, Alternative E = Alternative C at Reduced Activity Levels, Alternative F = Alternative C Plus Area Closures, and Alternative G = No New Activity Alternative.

[2] Provides protection to coastal marine mammal species (i.e., common bottlenose dolphins, manatees, and Atlantic spotted dolphins) when they are reproducing (calving) and increases the fitness values of the reproducing species.

[3] Provides protection for whale species (i.e., Bryde’s, beaked, sperm, and dwarf and pygmy sperm whales) and manatees providing localized reduction in sound exposure and associated impacts for those species.

[4] Provides protection to bay, sound, and estuary stocks of common bottlenose dolphins, individual coastal stocks of common bottlenose dolphins and Atlantic spotted dolphins, and manatees; individual beaked whales and sperm whales, as well as potentially calving sperm whales; and the small population of geographically and genetically distinct Bryde’s whales in the Gulf of Mexico.

[5] Provides protection to vocalizing marine mammals.

[6] Provides protection to all marine mammals and sea turtles, with additional protection (shutdown) for sperm, Bryde’s, beaked, dwarf and pygmy sperm whales, and manatees.

[7] Provides protection for all marine mammals except bow-riding dolphins (i.e., common bottlenose, Fraser’s, Clymene’s, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso’s).

Table ES-4. Impact Levels for Marine Mammals from Airguns and the Species Groups Protected Across Alternatives A through G, as Discussed in **Chapters 2.13 and 4.2**

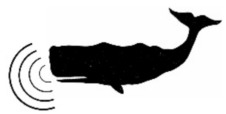
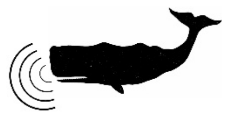
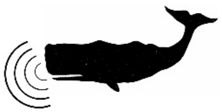
Resource and Impact-Producing Factor		Alternative						
		A	B	C	D	E	F	G*
Marine Mammals								
Active Acoustic Sound Sources	Airguns	Mod	Mod	Mod	Mod	Mod	Min	Min
Additional protection afforded to marine mammal species groups from mitigation measures								
								
								
								
								
								
								

Table ES-4. Impact Levels for Marine Mammals from Airguns and the Species Groups Protected Across Alternatives A through G, as Discussed in **Chapters 2.13** and **4.2** (continued)

	Coastal marine mammal species (i.e., common bottlenose dolphins, manatees, and Atlantic spotted dolphins) when they are reproducing (calving) or bay, sound, and estuary stocks of bottlenose dolphins, individual coastal stocks of common bottlenose dolphins, and Atlantic spotted dolphins as applicable.
	Manatees and their offspring.
	Vocalizing marine mammals.
	Sperm, dwarf, and pygmy sperm whales.
	All marine mammals.
	Bryde's whale and/or the genetically distinct Bryde's whales in the Gulf of Mexico, as applicable.
	Calving sperm whales.
	Except bow-riding or actively approaching dolphins (i.e., bottlenose, Fraser's, Clymene's, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso's).
	Beaked whales.

Potential impacts to marine mammals from an accidental fuel spill are expected to range from **nominal** to **minor**, depending on the numbers of individuals coming into contact with the spilled fuel and their exposure time as well as the exposure of federally listed species to the spilled fuel, for all alternatives except Alternative G. Other IPFs affecting marine mammals are assessed as **nominal** for Alternatives A through F and **no impact** for Alternative G. Behavioral impacts anticipated as a result of the proposed action that are analyzed in this Programmatic EIS are short-term disruption of behavioral patterns, abandonment of activities, and/or temporary displacement from discrete areas. Due to the extensive mitigations in the proposed action, no serious injuries or mortalities are anticipated.

Impact Conclusions for Sea Turtles

Impacts to sea turtles are assessed as **minor** for airgun surveys for Alternatives A through D and F because they are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Due to the reduced level of proposed activities under Alternative E, the impact level is expected to be **minor**. Due to no new activity under Alternative G, there would be **no impact** from any IPF. In addition, some protection is afforded to sea turtles under Alternatives B through F to reduce the extent of potential permanent threshold shift auditory injuries from implementation of the expanded PSO Program, but not significantly enough to change the overall impact level. For Alternatives A through F, **nominal** to **minor** impacts are expected for non-airgun HRG surveys. Impacts to sea turtles from vessel traffic would range from **nominal** to **moderate** (if a collision occurred) for Alternatives A through F because the support vessels associated with G&G activities travel at higher speeds and the potential for collisions increases at night and at times of reduced visibility. Potential impacts to sea turtles from an accidental fuel spill are expected to range from **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick) for all alternatives, except Alternative G (**no impact**). Impacts from entanglement and entrapment would be **nominal** for all alternatives except Alternative G, which would be **no impact**. Other IPFs affecting sea turtles are assessed as **nominal** for Alternatives A through F and **nominal** declining to **no impact** under Alternative G.

Impact Conclusions for Fisheries Resources and Essential Fish Habitat

Impacts to fish resources and EFH are assessed as **nominal** to **minor** for airgun surveys as well as vessel and equipment noise under Alternatives A through F based on the potential to disrupt spawning aggregations or schools of important prey species, the mobile and temporary nature of most surveys, the small area of the seafloor affected during surveys, and the possibility of fishes temporarily moving away from noise that is affecting them. Due to no new activity under Alternative G, there would **no impact** to fish and EFH from any IPF. Impacts from an accidental fuel spill range from **nominal** to **minor** for Alternatives A through F based on the location of the event and presence of fish or buoyant eggs and larvae. There would be **no impact** from an accidental fuel spill under Alternative G due to no new activity. Other IPFs affecting fish resources and EFH are assessed as **nominal** for all alternatives with the exception of entanglement for Alternative G, which would be **no impact** as there would be no new activity.

Impact Conclusions for Benthic Communities

Impacts to benthic communities are assessed as **nominal** for all applicable IPFs and alternatives, except Alternative G, due to the existing protective measures in place for avoiding known sensitive communities during seafloor-disturbing activities and the prevalence of soft bottom in the AOI. In addition, active acoustic sound sources have not been determined to have impacts to benthic communities. Due to no new activity under Alternative G, there would be **no impact** to benthic communities from any IPF.

Impact Conclusions for Marine and Coastal Birds

Impacts to marine and coastal birds are assessed as **nominal** to **minor** for active acoustic sound sources, vessel and equipment noise, vessel traffic, and aircraft traffic and noise for Alternatives A through D and F. Due to the reduced level of proposed activities under Alternative E, the impact level for seismic airgun surveys is expected to be **nominal**. Due to no new activity under Alternative G, there would be **no impact** to coastal and marine birds from any IPF. Impacts from an accidental fuel spill are **nominal** under most circumstances, may increase to **minor** based on timing and location, and could increase to **moderate** if a listed species or its prey is directly impacted across all alternatives.

Impact Conclusions for Marine Protected Areas

Impacts to MPAs are assessed based on the impact levels presented across all resources that may occur within the boundaries of MPAs. Therefore, impacts from active acoustic sound sources range from **nominal** to **moderate** for all alternatives except Alternative G. Due to no new activity under Alternative G, there would be **no impact** to MPAs from any IPF. Impacts from accidental fuel spills range from **nominal** to **moderate** for all alternatives (except Alternative G, which would be reduced to **nominal**), eventually declining to **no impact**.

Impact Conclusions for *Sargassum* and Associated Communities

Impacts to *Sargassum* and associated communities are assessed as **nominal** for Alternatives A through F based on the widespread patchy distribution of *Sargassum* mats and the propensity of *Sargassum* mats to be undisturbed by physical displacement. Species that utilize *Sargassum* as habitat for all or some of their life cycle (e.g., fish, sea turtles, and invertebrates) would be spatially limited and short term. No serious damage to *Sargassum* and associated fauna is expected to occur for all alternatives. Due to no new activity under Alternative G, there would be **no impact** to *Sargassum* from any IPF.

Impact Conclusions for Commercial Fisheries

Impacts to commercial fisheries are assessed as **minor** for airgun surveys for Alternatives A-F. Impacts from airgun surveys are expected to be intermittent and temporary. Because fishing equipment could be damaged, the potential for impacts are reduced by several measures, and any impacts would be spatially localized and temporary. Impacts from entanglement are assessed as **nominal** to **minor** for all alternatives except Alternative E2, which would be **nominal**, and Alternative G, which would be **no impact**. Impacts from stand-off distance are assessed as **minor** for all alternatives except Alternatives E2 and G. Under Alternative E2 (25% reduction in line miles of deep-penetration seismic airgun surveys), a decrease in impacts from **minor** to **nominal** is expected for stand-off distance impacts because these types of surveys typically have the larger stand-off distance requirements and large arrays. Impacts from seafloor disturbance are assessed as **minor** for all alternatives, except Alternative G which would be **no impact**. Impacts from non-airgun HRG sound sources, vessel traffic, and accidental fuel spills are assessed as **nominal** for Alternatives A through F due to the limited and localized activities; however, G&G activities could overlap with productive fishing grounds. Due to no new activity under Alternative G, there would be **no impact** to commercial fisheries from any IPF.

Impact Conclusions for Recreational Fisheries

Impacts to recreational fisheries are assessed as **nominal** for all alternatives for all applicable IPFs due to the short-term and localized interactions between recreational fishing and G&G activities, except for Alternative G. Impacts under Alternative G would be **no impact**.

Impact Conclusions for Archaeological Resources

Impacts to archaeological resources from seafloor disturbance and entanglement are assessed as **nominal** to **major**, depending on the type of survey and whether site-specific information regarding potential archaeological resources is available, for all alternatives, except Alternative G. Under Alternative G, impacts would be reduced to **no impact**. Impacts from drilling discharges and accidental fuel spills are assessed as **nominal** for all alternatives, except for Alternative G. Due to no new activity under Alternative G, there would be **no impact** to archaeological resources from any IPF.

Impact Conclusions for Multiple-Use Areas

Impacts to other space use in multiple-use areas is assessed as **no impact** to **nominal** for all alternatives for all applicable IPFs because many of the components of other marine uses are expected to be conducted in support of or in coordination with G&G activities for all three Program Areas. In addition, activities would be of relatively short duration, with the time and extent dependent upon the type of G&G activity. Due to no new activity under Alternative G, changes in space use in multiple-use areas would range from **no impact** to **nominal.**

Impact Conclusions for Human Resources, Land Use, and Economics

Impacts to land use and coastal infrastructure are expected to be **beneficial** (positive) to **minor** for Alternatives A through F and **minor** to **moderate** for Alternative G. Impacts to environmental justice are expected to be **beneficial** (positive) to **nominal** for Alternatives A through F and **minor** for Alternative G. Impacts to demographics are expected to be **beneficial** (positive) to **nominal** for Alternatives A through D; **minor** for Alternatives E and F; and **minor** to **moderate** for Alternative G. For regional economic factors, the selection of Alternatives A through D or F would support current activity levels in industries that depend on G&G surveying, which would have **beneficial** (positive) economic impacts. However, the alternatives would also entail some negative economic impacts arising from costs, inefficiencies, accidental events, and supply chain impacts. These negative impacts are expected to be **minor** for Alternatives A and C. The negative impacts could become **moderate** for Alternatives B, D, E, and F, depending on the ultimate introduced costs and inefficiencies, as well on how the offshore oil and gas industry adjusts its practices. The negative impacts of Alternative G would be **moderate** to **major** since it would substantially disrupt existing industries, supply chains, and energy consumers.

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ABBREVIATIONS AND ACRONYMS

μPa	mircopascal
μs	microsecond
2D	two-dimensional
3D	three-dimensional
4D	four-dimensional
ac	acre
AIS	Automated Identification System
ANSI	American National Standards Institute
AOI	Area of Interest
API	American Petroleum Institute
bbl	barrel
BIA	biologically important area
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
B.P.	before present
BP	British Petroleum
BSE	bay, sound, and estuary
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Clean Air Act
CATEX	categorical exclusion
CEQ	Council on Environmental Quality
CetMap	Cetacean Density and Distribution Mapping Working Group
CFR	Code of Federal Regulations
CG	Coast Guard (also: USCG)
CHIRP	compressed high-intensity radiated pulse
cm	centimeter
CMP	Coastal Management Program
CMSP	Coastal and Marine Spatial Planning
COA	condition of approval
COP	construction and operations plan
Coral SSC/AP	Joint Coral Scientific and Statistical Committee and Coral Advisory Panel
COST	continental offshore strategic test
CPA	Central Planning Area
CPT	cone penetrometer test
CSEM	controlled source electromagnetic
CV	coefficient of variation
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibel
dB re 1 μPa	decibels referenced to 1 micropascal
dB re 1 $\mu Pa^2 \bullet s$	decibels referenced to 1 micropascal per second
DOI	Department of the Interior (also: USDOI)
DP	dynamically positioned

DPS	Distinct Population Segment
EA	environmental assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIA	economic impact area
EIS	environmental impact statement
EP	Exploration Plan
EPA	Eastern Planning Area
EPAct	Energy Policy Act
ESA	Endangered Species Act
EWTA	Eglin Water Test Area
FAA	Federal Aviation Administration
FGBNMS	Flower Garden Banks National Marine Sanctuary
FKNMS	Florida Keys National Marine Sanctuary
FMC	Fishery Management Council
ft	feet
ft/s	feet per second
ft^2	square feet
FWS	Fish and Wildlife Service
G&G	geological and geophysical
gal	gallon
GAP	General Activities Plan(s)
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
GOMESA	Gulf of Mexico Energy Security Act
GOMEX	Gulf of Mexico Range Complex
GS	Geological Survey (also: USGS)
GT	gross tons
ha	hectare
HAPC	Habitat Area of Particular Concern
HRG	high-resolution geophysical
Hz	hertz
IBA	Important Bird Area
IHA	Incidental Harassment Authorization
in	inch
in^3	cubic inch
IPF	impact-producing factor
ITA	Incidental Take Authorization
ITR	Incidental Take Regulation
IUCN	International Union for Conservation of Nature
JIP	Joint Industry Program
kHz	kilohertz
km	Kilometer
km^2	square kilometer
kn	knot

LNG	liquefied natural gas
LOA	Letter of Authorization
LOOP	Louisiana Offshore Oil Port
m	meter
m/s	meters per second
m/s^2	meters per second squared
m^2	square meter
MARAD	Maritime Administration
MARPOL	International Convention for the Prevention of Pollution from Ships
MBES	multi-beam echosounder
MBTA	Migratory Bird Treaty Act
mi	mile
mi^2	square miles
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOA	Memoranda of Agreement
MPA	Marine Protected Area
mph	miles per hour
MPPRCA	Marine Plastic Pollution Research and Control Act
MPRSA	Marine Protection, Research, and Sanctuaries Act
ms	millisecond
MSA	metropolitan statistical area
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MT	magnetotelluric
MW	megawatt
MWA	Military Warning Area
NAZ	narrow azimuth
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve
NGO	nongovernmental organization
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
nmi	nautical mile
NMS	National Marine Sanctuary
NMSA	National Marine Sanctuaries Act
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NRDC	Natural Resources Defense Council
NREL	National Renewable Energy Laboratory
NSF	National Science Foundation
NTL	Notice to Lessees and Operators

NWR	National Wildlife Refuge
OBC	ocean-bottom cable
OBN	ocean-bottom node
OBS	ocean-bottom seismometer
obs/km	observations per transect kilometer
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ODMDS	ocean dredged material disposal site
ONMS	Office of National Marine Sanctuaries
OPA	Oil Pollution Act
OPAREA	U.S. Navy Operating Areas
OREP	Office of Renewable Energy Programs
OSP	optimum sustainable population
P.L.	Public Law
PAH	polycyclic aromatic hydrocarbon
PAM	passive acoustic monitoring
PBR	potential biological removal
PDARP/PEIS	Programmatic Damage Assessment and Restoration Plan/Programmatic Environmental Impact Statement
PSO	protected species observer
PTS	Permanent Threshold Shift
RAF	risk assessment framework
RESTORE Act	Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act
RHA	Rivers and Harbors Act
rms	root mean square
ROD	Record of Decision
ROV	Remotely Operated Vehicle
SAFMC	South Atlantic Fishery Management Council
SAP	Site Assessment Plan
SAR	Stock Assessment Report
SBES	single-beam echosounder
SBF	synthetic-based fluid
ScOT	Screening Out Team
SEL	sound exposure level
SEL_{cum}	cumulative sound exposure level
SPL	sound pressure level
SPL_{p-p}	peak-to-peak sound pressure level
SPL_{peak}	peak sound pressure level
SPL_{rms}	sound pressure level root mean square
SVP	sound velocity profile
SWD	seismic while drilling
Task Force	Gulf Coast Ecosystem Task Force
TMA	target motion analysis
Trustee Council	Natural Resource Damage Assessment Trustee Council

TTS	Temporary Threshold Shift
U.S.	United States
U.S.C.	United States Code
UME	Unusual Mortality Event
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard (also: CG)
USDHS	U.S. Department of Homeland Security
USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior (also: DOI)
USDOT	U. S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey (also: GS)
VSP	vertical seismic profile
WAZ	wide azimuth
WBF	water-based fluid
WPA	Western Planning Area
yd^3	cubic yards

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

INTRODUCTION

1 INTRODUCTION

The Bureau of Ocean Energy Management's (BOEM) mission is to manage development of U.S. Outer Continental Shelf (OCS) energy and mineral resources in an environmentally and economically responsible way. BOEM, as the lead Federal agency, is preparing this Programmatic Environmental Impact Statement (EIS) to describe and evaluate the potential environmental impacts related to reasonably foreseeable geological and geophysical (G&G) survey activities in Federal and affected State waters of the Gulf of Mexico (GOM), as mandated in the Outer Continental Shelf Lands Act (OCSLA). The Bureau of Safety and Environmental Enforcement (BSEE) and the National Oceanic and Atmospheric Administration (NOAA) are serving as cooperating agencies. **Appendix A** provides the Memoranda of Agreement (MOAs) between BOEM and the cooperating agencies describing the obligations of the agencies concerning the preparation of this Programmatic EIS, and **Chapter 6.3.3** further discusses the cooperating agency status and roles.

This Programmatic EIS addresses potential environmental impacts of BOEM's Oil and Gas, Renewable Energy, and Marine Minerals Programs and focuses particularly on the environmental impacts of off-lease and on-lease geological (bottom sampling and test drilling) and geophysical surveys (deep-penetration, high-resolution geophysical [HRG], electromagnetic, deep stratigraphic, and remote sensing).

The area evaluated (Area of Interest, or AOI) includes the Federal OCS waters of the GOM that are within BOEM's Gulf of Mexico Western, Central, and Eastern Planning Areas (WPA, CPA, and EPA). The AOI also includes the coastal (i.e., State) waters of Texas, Louisiana, Mississippi, Alabama, and Florida, extending from the coastline outside of estuaries seaward 3 nautical miles (nmi) (3.5 miles [mi]; 5.6 kilometers [km]) from Louisiana, Mississippi, and Alabama, and seaward to 9 nmi (10.4 mi; 16 km) from the coastlines of Texas and Florida (**Figure 1.1-1**). BOEM does not approve G&G activities in State waters; however, since G&G activities in OCS waters can potentially impact resources in State waters (e.g., sound traveling from OCS areas into State waters), for purposes of impacts analysis in this Programmatic EIS, State waters were included in the AOI.

1.1 PROPOSED ACTION AND PURPOSE AND NEED

1.1.1 Proposed Action

BOEM's proposed action is the issuance of permits or authorizations for G&G activities in the GOM. The proposed action specifically includes the following:

(1) continuance of G&G operations in the GOM subject to regulatory authorities including, but not limited to, 30 CFR parts 551, 580, and 585; Section 11 and Subsections 8(k) and 8(p) of the OCSLA; and Section 388(a) of the Energy Policy Act of 2005 (EPAct); and

(2) continuance of G&G activities conducted under a lease as described in 30 CFR part 550 (**Appendix B, Section 2.1.15**).

The activities included in BOEM's permitting or authorization processes cover G&G activities associated with the exploration, development, and/or scientific research of oil, gas, sulfur, other minerals (e.g., sand), and alternative energy-related resources. For oil and gas activities, there are different phases of G&G activities, including pre-lease, on-lease, and post-lease activities. Prior to a lease sale, a permit must be obtained from BOEM before conducting pre-lease G&G activities on any unleased OCS lands or on lands under lease to a third party (30 CFR §§ 551.4(a) and (b)). Surveys done by a lessee in support of a BOEM-issued oil and gas lease that are on and around geospatial lease boundaries are regulated under the terms of a lease agreement and are referred to as "ancillary activities" or "on-lease activities" (refer to 30 CFR § 550.207). Post-lease G&G surveys are performed after a lease sale has been held and leases issued, and include engineering studies used to guide the placement of production facilities and pipelines in deep water and activities undertaken to meet archaeological requirements. **Tables 1.1-1 and 1.1-2** provide additional information regarding activities performed during these phases.

NOAA's National Marine Fisheries Service's (NMFS) proposed action will be a direct outcome of responding to BOEM's petition for incidental take regulations (ITRs) and related requests for letters of authorization (LOAs), as well as to incidental harassment authorization requests, under the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. §§ 1361 *et seq*.). The U.S. citizens seeking to obtain authorization for the incidental take of marine mammals must submit requests (in the form of an application). Once NMFS determines that an application is complete; NMFS has a corresponding duty to determine whether and how to authorize take of marine mammals incidental to the activities described in an application. The requirements of Sections 101(a)(5)(A) and (D) of the MMPA and NMFS' implementing regulations (50 CFR part 216 subpart I) establish and frame NMFS' proposed action. To authorize the incidental take of small numbers of marine mammals, NMFS evaluates the best available scientific information to determine whether the total taking by the specified activity during the relevant period would have a negligible impact on the affected marine mammal species or stocks and whether the activity would have an unmitigable adverse impact on their availability for relevant subsistence uses. The NMFS cannot issue an incidental take authorization (ITA) if it cannot make those findings in the affirmative. The NMFS also must prescribe permissible methods of taking and other means of affecting the least practicable adverse impact on the affected species or stocks and their habitat and the requirements pertaining to the monitoring and the reporting of such taking.

1.1.2 Purpose and Need

The purpose of the proposed action is to gather state-of-the-practice data about the ocean bottom and subsurface. These data, collected through G&G activities, would provide information about (1) the potential locations and extents of oil and gas reserves, (2) the locations for placement of oil and gas or renewable energy installations and excavation of marine mineral resources, (3) the composition and volume of identified seafloor sediment deposits (e.g., marine minerals required for wetland, beach, and coastal restoration projects), (4) the identification of possible seafloor or shallow-depth geologic hazards, and (5) the location of potential archaeological resources and benthic habitats that should be avoided.

Current G&G data and information are required to support leasing, resource assessment, and planning decisions while taking into account environmental stewardship and protection. The G&G data also further support BOEM's mandate that the OCS be made available for expeditious and orderly development, subject to environmental safeguards, while maintaining competition for the OCS resources, including, but not limited to (1) the exploration and development of oil and gas resources, (2) the assessment of sites for renewable energy facilities, (3) the preservation of marine archaeological resources in compliance with Sections 106 and 110 of the National Historic Preservation Act (NHPA), and (4) the use of marine mineral resources in the three GOM planning areas to support beach restoration and nourishment projects.

The proposed action is needed to have access to and use of the best available information obtained from G&G activities in order to make informed business, management, design, stewardship, and environmental protection decisions. Such decisions are an integral part of several OCS programs, including oil and gas (e.g., location, extent, fair market value of resources, and orderly development of hydrocarbon reserves), renewable energy (e.g., engineering decisions regarding the construction of renewable energy projects), and marine minerals (e.g., informed estimates regarding the composition and volume of marine mineral resources). This information would also be used to ensure (1) the issuance of permits and authorizations follows OCSLA's principles of activities being conducted in a technically safe and environmentally sound manner, (2) the proper use and conservation of OCS energy resources, (3) the receipt of fair market value for the leasing of public lands, (4) the development of current estimates of potential reserves, and (5) the efficient future production of resources.

This Programmatic EIS would enable BOEM to fulfill statutory responsibilities associated with permitting or authorizing G&G activities in connection with activities conducted in support of the Oil and Gas, Renewable Energy, and Marine Minerals Programs on the Gulf of Mexico OCS. This Programmatic EIS also would support NMFS' authorization of the incidental take of marine mammals under the MMPA for these same activities. Since the issuance of an ITA would allow for the taking of marine mammals, consistent with the provisions under the MMPA and incidental to the G&G activities, NOAA considers this issuance to be a major Federal action subject to the National Environmental Policy Act (NEPA). Therefore, NOAA's National Marine Fisheries Service intends to adopt this Programmatic EIS as the NEPA documentation associated with authorizing incidental take of marine mammals. In addition, NMFS and the Office of National Marine Sanctuaries (ONMS) may rely on the analysis within this Programmatic EIS to support consultation efforts under the Endangered Species Act (ESA), Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and National Marine Sanctuaries Act (NMSA). These responsibilities include assessing the reasonably foreseeable impacts to the marine environment from G&G activities, meeting listed and protected species consultation requirements, and incorporating measures to protect resources present in the GOM.

1.1.3 Area of Interest

The AOI is the area in which the activities of the proposed action would take place and, therefore, the area of potential effect by the proposed action. The AOI includes the Federal OCS waters of the GOM that are within BOEM's Gulf of Mexico WPA, CPA, and EPA. The AOI also includes the coastal (i.e., State) waters of Texas, Louisiana, Mississippi, Alabama, and Florida, extending from the coastline outside of estuaries seaward 3 nmi (3.5 mi; 5.6 km) from Louisiana, Mississippi, and Alabama, and seaward to 9 nmi (10.4 mi; 16.7 km) from the coastlines of Texas and Florida (**Figure 1.1-1**). BOEM does not approve G&G activities in State waters; however, since G&G activities in OCS waters can potentially impact resources in State waters (e.g., sound traveling from OCS areas into State waters), for purposes of impacts analysis in this Programmatic EIS, State waters were included in the AOI. While this Programmatic EIS analyzes the entire AOI, it is important to note that the impacted areas for renewable energy and the marine minerals program's activities are only a small portion of the entire AOI (i.e., the marine minerals program AOI is 1.11 percent of the AOI covered by this Programmatic EIS).

This Programmatic EIS addresses resources that are found in or migrate through the AOI and that may be affected by the proposed action. The AOI inner boundary follows the shoreline along most of the coast but extends across the mouths of estuaries and bays as necessary. State waters are not within the jurisdiction of BOEM, but rather the State itself and the U.S. Army Corps of Engineers (USACE), both of whom permit these activities in State waters.

Though BOEM does not approve G&G activities in State waters. BOEM is analyzing the potential effects in adjacent State waters in this Programmatic EIS because

(1) NMFS has jurisdiction and MMPA permitting authority in Federal and State waters, and requires an assessment of potential impacts to the human environment;

(2) the acoustic energy introduced into the environment during G&G activities in Federal waters could affect resources in State waters; and

(3) G&G activities could include interrelated and connected activities in Federal and State waters that would be considered connected actions.

In December 2013, the U.S. Congress approved the U.S.-Mexico Transboundary Hydrocarbons Agreement (Public Law [P.L.] 113-67, the Bipartisan Budget Act of 2013), which aims to facilitate joint development of oil and natural gas in part of the GOM. This, coupled with recent reforms in Mexico, could transform Mexican GOM waters into a more developed oil and gas landscape with infrastructure development and cross-border pipelines.

The opening of these waters to leasing would make it possible for U.S. lessees to enter into voluntary agreements with a licensee of the United Mexican States to develop transboundary reservoirs. The Agreement Between the United States of America and the United Mexican States

Concerning Transboundary Hydrocarbon Reservoirs in the Gulf of Mexico (Transboundary Agreement) contains a stipulation that applies only to lease blocks or portions of lease blocks located within 3 statute miles (4.8 km) of the maritime or continental shelf boundary with Mexico (formerly known as the "buffer zone").

In January 2015, Mexico issued rules for seismic exploration and, while new leasing has had a slow start following Mexican constitutional reforms, geophysical companies are moving forward aggressively to acquire data in Mexican waters of the GOM. To date, at least nine companies have permits either pending or approved, and two-dimensional (2D) and three-dimensional (3D) data collection has begun. Many of these companies have permits from BOEM for U.S. waters as well. For instance, Mexico's Petróleos Mexicanos (PEMEX) can now partner with international companies that have the experience and capital required to explore Mexico's deep water and shale resources.

In reference to G&G data, the actual ownership of the seismic data is retained on the U.S. side by the geophysical contractors or by the lessees who may have contracted for exclusive ownership of those data. The contractors sell licenses for the usage of those seismic data to potential lessees. Exploration and production companies may also purchase and retain such proprietary data from contractors (USDOI, BOEM, 2015a).

1.2 BACKGROUND

Section 18 of OCSLA directs the U.S. Department of the Interior (USDOI or DOI) to conduct environmental studies and prepare any EIS required in accordance with OCSLA and with Section 102(2)(C) of NEPA (42 U.S.C. § 4332(2)(C)). To implement this and other energy and mineral responsibilities, the Secretary of the Interior designated BOEM as the agency responsible for leasing submerged OCS lands for development and production and for approving operational plans. OCSLA also directs BOEM to ensure G&G data are obtained in a technically safe and environmentally sound manner. The G&G activities are subject to various permits, authorizations, and notices. BOEM oversees G&G data acquisition and permitting activities pursuant to regulations at 30 CFR parts 550, 551, 580, and 585; Subsections 8(k) and 8(p) of OCSLA; and Section 388(a) of EPAct (USDOI, BOEM, 2013a).

This Programmatic EIS establishes a framework for subsequent NEPA analyses of site-specific actions and also identifies and analyzes potential mitigation measures for use in future G&G activities on the Gulf of Mexico OCS involving all three of BOEM's program areas (i.e., Oil and Gas, Renewable Energy, and Marine Minerals). BOEM will address the potential impacts of future site-specific actions in subsequent NEPA evaluations (40 CFR § 1502.20) using a tiered process based on this programmatic evaluation.

In conjunction with this Programmatic EIS, BOEM submitted its MMPA application to NMFS, requesting the issuance of regulations governing the authorization of incidental take of marine mammals in the GOM under Section 101(a)(5) of the MMPA on behalf of oil and gas and geophysical companies for geophysical-permitted (authorized) and ancillary activities. In addition to

NEPA, the G&G surveys conducted in support of marine mineral beach nourishment or coastal restoration projects under a non-competitive lease, and renewable energy projects, would separately comply with the ESA, MMPA, and other relevant laws, regulations, and Executive Orders as deemed appropriate by all agencies on a project-by-project basis.

The NMFS intends to use this Programmatic EIS as the NEPA documentation associated with the issuance of incidental "take" authorizations and rule-making process under the MMPA for the incidental taking of marine mammals during G&G survey activities. Additional information regarding these agencies, roles, and regulations is provided in **Chapter 6 and Appendix B**.

1.2.1 History of G&G Environmental Review in the GOM

In 1976, the U.S. Geological Survey (USGS or GS) completed an EIS evaluating the impacts of policies and procedures set forth in proposed regulations for G&G surveys within the Gulf of Mexico OCS. In 1984, the Minerals Management Service (MMS; BOEM's predecessor)[1] completed a Programmatic Environmental Assessment (EA) that analyzed the potential impacts of G&G activities in the GOM (USDOI, MMS, 1984). Based on information available at the time, MMS concluded no significant impact was expected. The MMS further determined that the vast majority of G&G activities could be categorically excluded[2] from additional NEPA review and this determination was adopted as department policy by the USDOI. The Council on Environmental Quality (CEQ) concurred with that determination.

In 2005, the Minerals Management Service's NEPA team determined that seismic surveys using air or water guns and solid or liquid explosives should not be categorically excluded, and required further analysis under NEPA. In 2006, MMS narrowed the application of the categorical exclusions (CATEXs) (C9/C13 in the existing Department Manual) to exclude seismic surveys using airguns and in December 2009, narrowed the application of CATEXs again to exclude all deep-penetration seismic airgun surveys, HRG surveys, and vertical seismic profile (VSP) surveys.

[1] On May 19, 2010, DOI Secretary Salazar announced in Secretarial Order 3299 that MMS would be reorganized into two new bureaus within the USDOI, each reporting to the Assistant Secretary of Land and Minerals Management, as well as the Office of Natural Resources Revenue (USDOI, 2010a). The two bureaus would come to be known as BOEM and BSEE. BOEM administers leasing and plans, environmental studies, NEPA analyses, resource evaluations, economic analyses, and the renewable energy and marine minerals programs. The BSEE administers all field operations including permitting and research, inspections, research, offshore regulatory programs, oil-spill response, and newly formed training and environmental compliance functions. After the new organizations were announced, on June 18, 2010 (USDOI, 2010b), the Secretary issued Secretarial Order 3302 that, for the interim, changed the name of MMS to the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). On October 1, 2011, BOEM and BSEE were officially created and succeeded BOEMRE.

[2] Categorical exclusions (CATEXs) are "a category of actions which do not individually or cumulatively have a significant effect on the human environment . . . and for which, therefore, neither an environmental assessment nor an environmental impact statement is required" (40 CFR § 1508.4).

However, MMS continued to allow HRG surveys without airguns to be approved under the CATEXs if no extraordinary circumstances were identified.

During site-specific analyses for a variety of G&G survey activities, including geological sampling and geophysical surveys using airguns, BOEM conducts a site-specific environmental review that determines if an additional NEPA analysis in the form of an EA or EIS must be prepared for the proposed activity or if a CATEX may be appropriate. In the event that an action cannot be categorically excluded, the decision to prepare an EA will be made by the Regional Supervisor, Office of Environment or the Chief, Environmental Division. Currently, EAs are prepared for G&G activities that include airguns, such as high-resolution surveys, 2D and 3D seismic surveys, ocean bottom nodes, ocean bottom cables, and any non-airgun activities that could impact benthic or archaeological resources such as geologic cores and grab samples.

1.2.2 Petition for Authorization to Take Marine Mammals Incidental to Conducting Oil and Gas Exploration Activities in the Gulf of Mexico

On December 20, 2002, MMS petitioned NMFS for rulemaking under Section 101(a)(5)(A) of the MMPA to authorize any potential take of sperm whales (*Physeter macrocephalus*) incidental to operators conducting seismic surveys during oil and gas exploration activities in the GOM. On March 3, 2003, NMFS published a notice of receipt of the petition and requested comments and information from the public (*Federal Register*, 2003a), later extended to April 16, 2003 (*Federal Register*, 2003b). The MMS prepared a Programmatic EA for the petition, which was completed in July 2004. Based on the Programmatic EA's findings, BOEM submitted a revised petition in September 2004 to request incidental take regulations for the incidental take of all NMFS-protected marine mammals considered to routinely inhabit the GOM and to potentially be impacted by seismic surveys related to oil and gas exploration and development activities.

Based on review of public comments received on the 2002 petition, the 2004 revised MMPA petition, and the 2004 Programmatic EA, the NMFS determined, and the MMS agreed, that an EIS was warranted and published a Notice of Intent (NOI) to prepare an EIS in November 2004 (*Federal Register*, 2004). This decision was based on a combination of the following factors:

- public concern over impacts of oil and gas exploration activities on the marine environment, which includes marine mammals;
- proposed use of computer modeling as one of two methods for calculating incidental take levels for marine mammals and sea turtles for a geographic area where multiple seismic sources may be operating simultaneously;
- incorporation of a scientifically based risk assessment for marine mammals;
- possible use of energy criteria rather than pressure criteria to calculate marine mammal take levels, especially to calculate potential multiple exposures; and

- incorporation of new acoustic guidelines for assessing impacts of sound on marine mammals (*Federal Register*, 2004).

After the NOI was published, NOAA worked on development of the EIS with MMS serving as a cooperating agency. In 2008, NOAA requested that MMS be a co-lead agency; however, a Memorandum of Understanding (MOU)/MOA was not finalized until 2013 after the reorganization of MMS. After further evaluation following scoping, the two agencies determined that, pursuant to 40 CFR §§ 1501.5 and 1501.6, BOEM should serve as the lead agency and NOAA should serve as a cooperating agency.

BOEM provided NMFS with a revised MMPA petition on April 18, 2011, incorporating updated information and analyses since the 2004 petition. The NMFS published an NOI of the petition on June 14, 2011 (*Federal Register*, 2011).

On May 10, 2013, BOEM announced its intent to prepare a Programmatic EIS and reopened a second public scoping period under NEPA to gather public comments on the content and issues to consider in the Programmatic EIS (*Federal Register*, 2013a). This Programmatic EIS is being prepared to serve as the programmatic NEPA analysis from which BOEM will tier its site-specific NEPA analyses for BOEM to permit or authorize G&G activities under the OCSLA; to provide necessary information and assessment under NEPA to support NMFS' authorization of the incidental take of marine mammals under the MMPA for G&G activities on the OCS; and to support additional coordination and consultation requirements under other statutes, including the ESA, MSFCMA, Coastal Zone Management Act (CZMA), NMSA, and NHPA. These statutes are further described in **Appendix B**.

1.2.3 Litigation Settlement

On June 30, 2010, the Natural Resources Defense Council (NRDC) et al. (the "Plaintiffs") filed a Complaint for Declaratory and Injunctive Relief (the "Complaint") alleging that BOEM's predecessor had violated NEPA by concluding that no EIS was required to assess the impact of G&G exploration for mineral resources in the Gulf of Mexico OCS. A settlement was reached between the parties (i.e., NRDC et al.; USDOI; and industry intervenors) on June 24, 2013 (the "Settlement Agreement"). The Settlement Agreement provided that all proceedings in the litigation were stayed for 30 months from the day in which the Settlement Agreement was approved (thus indicating expiration on December 25, 2015) or until the terms of the Settlement Agreement were satisfied, whichever came first.

On February 10, 2016, the parties formally agreed to extend the stay until final action by the agencies or September 25, 2017, whichever occurs first, and to modify some conditions in the Settlement Agreement (Amendment). The terms of the Amended Settlement Agreement are fully considered in this Programmatic EIS. More detailed information regarding the Settlement Agreement and Amendment can be found in **Appendix C** and on BOEM's website at http://www.boem.gov/Civil-Action-No-2-10-cv-01882-Settlement-Agreement. Highlights of the Amended Settlement Agreement's content are discussed in the following sections.

1.2.3.1 Interim Mitigation Measures

While the stay is in effect, BOEM is required to analyze the following mitigation measures as potential conditions of approval (COAs) for permit applications for deep-penetration seismic surveys in EAs specific to permitting decisions for individual deep-penetration seismic surveys (i.e., airgun surveys) and in this Programmatic EIS. Industry has included these measures in their applications for permits and authorizations for the duration of the stay. These interim mitigation measures are presented in detail as Alternative B (**Chapter 2**), and the impact analyses are presented in **Chapter 4**.

(1) **Seasonal Restrictions for Coastal Waters** – The permittee shall not operate any airguns or airgun arrays in Federal coastal waters of the GOM shoreward of the 20-meter (m) (66-foot [ft]) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath] between March 1 and April 30. The Amendment to the Settlement Agreement also extended the seasonal restriction on deep-penetration seismic airgun surveys to be in effect from January 1 to April 30 for those portions of Area of Concern 3 (**Appendix C**) falling within the boundaries of the Unusual Mortality Event (UME) designated by NOAA (**Figure 2.2-1**).

(2) **Expansion of NTL 2016-BOEM-G02** (replaces NTL 2012-BSEE-G02) – The permittee will comply with this Notice to Lessees and Operators (NTL) with the following changes: the provision in paragraph 4 on page 3 of NTL 2016-BOEM-G02 (i.e., that a permittee will shut down immediately all airguns ceasing seismic operations at any time a whale (excluding marine mammal species in the Family Delphinidae, which includes killer whales [*Orcinus orca*], pilot whales [*Globicephala macrorhynchus*], and all of the dolphin species) is detected entering or within the exclusion zone; the permittee may re-commence seismic operations and ramp-up of airguns only when the exclusion zone has been visually inspected for at least 30 minutes to ensure the absence of marine mammals and sea turtles shall apply to manatees (*Trichechus manatus latirostris*) as well as whales, and this NTL will apply to all deep-penetration seismic surveys in the GOM regardless of water depth.

(3) **Minimum Separation Distances** – When operating in the designated Areas of Concern (refer to **Chapter 2.4**, Alternative B, for details on Areas of Concern identified by Plaintiffs in the Settlement Agreement), simultaneous deep-penetration seismic surveys (i.e., airgun surveys) will maintain a separation distance of 40 km (25 mi) between active sound sources. When outside the Areas of Concern, the separation distance shall be 30 km (19 mi). This separation requirement does not apply to multiple ships operating in a

coordinated survey, such as a wide azimuth (WAZ) survey, and need not be maintained if unsafe or during unfavorable weather conditions.

(4) **Seismic Restriction in the EPA** – Deep-penetration seismic surveys (i.e., airgun surveys) will not be conducted within the portion of the Areas of Concern falling within the EPA. This restriction does not apply to currently leased blocks, any portion of the area encompassed by EPA Lease Sale 226, or neighboring blocks adjacent to permitted survey areas but within an otherwise off-limit area.

(5) **Passive Acoustic Monitoring (PAM)** – Deep-penetration seismic airgun surveys occurring during periods of reduced visibility in waters deeper than 100 m (328 ft) will include PAM as a part of the Protected Species Observer (PSO) Program.

(6) **Reporting Requirements** – Operators will provide biweekly reports on the seismic survey and confirm compliance with required mitigation measures.

In addition, while the stay is in effect, applicants for deep-penetration seismic survey permits agreed to provide the following information to BOEM:

(1) **Non-Duplicative Surveys** – The applicant must provide an explanation for why the proposed deep-penetration seismic survey is not unnecessarily duplicative of previously conducted surveys, taking into account technology, targeted formations, geographic areas of surveys, and other relevant considerations.

(2) **Lowest Practicable Source Levels** – The applicant must provide an estimate of the total energy output in decibels (root mean square [rms]), referenced to a standard pressure, for each proposed energy source. The applicant must certify that, to the extent practicable, the proposed array is operating at the lowest sound intensity that will achieve the survey's goals. Verification includes confirmation that the array has been calibrated to maximize subsurface illumination while minimizing horizontal noise projection.

The Amendment to the Settlement Agreement amended Article V of the Settlement Agreement to include the following expanded/additional mitigation measures during the stay:

- **Expanded Time Area Closure in Certain Areas of Concern Not Located in the EPA** – Deep-penetration seismic surveying will not be conducted during the period from January 1 through April 30 in the portion of the 20-m (66-ft) isobath outside the EPA that is covered by the recent UME declared for cetaceans by the NOAA (i.e., from the Texas/Louisiana border to the eastern border of Franklin County, Florida).
- **Buffer Zone around Areas of Concern** – A 5-km (3-mi) buffer zone will be established adjacent to and seaward of the 20-m (66-ft) isobath and to the

remaining Areas of Concern that fall within the EPA. Activities in the buffer zones will be subject to the same restrictions and requirements that apply to the areas to which they are adjacent, during the same time periods.

BOEM has modified Alternative B in this Programmatic EIS to reflect the expansion of mitigation measures in Article V of the Settlement Agreement and the resulting analyses.

1.2.3.2 Settlement Agreement Items for Analysis in This Programmatic EIS

In the Settlement Agreement, BOEM agreed to the following:

- Convene an internal panel or panels with sufficient geophysical and environmental expertise to determine whether it would be feasible to develop standards for determining
  - whether a deep-penetration seismic survey is unnecessarily duplicative (refer to **Appendix L**);
  - the lowest practicable source level for a deep-penetration seismic survey (refer to **Appendix L**); and
  - if a draft EIS or EA has not been released prior to the panels' determinations, include the standards if the determination is positive, or the rationale for the determination if the determination is negative, within the EIS or EA.
- To analyze alternatives and mitigating measures in any NEPA document (EIS or EA) for BOEM's Marine Mammal Protection Act application that are similar to mitigation measures described in the Interim Mitigation Measures (refer to **Chapter 4**), including the following:
  - the means to reduce chronic or cumulative exposure of marine mammal populations to noise (refer to **Appendix K**); and
  - the requirements or incentives to use new alternative technologies to accomplish deep-penetration seismic surveys (refer to **Chapter 1.2.3.5**).
- To analyze in any NEPA document (i.e., EIS or EA) for BOEM's Marine Mammals Protection Act application the development of a long-term adaptive monitoring plan (henceforth referred to as the Monitoring Plan) to address potential chronic and cumulative impacts from seismic surveys on marine mammal populations in the GOM.

1.2.3.3 Non-Duplicative Surveys and Lowest Practicable Source Levels Panels

As contemplated in Article VIII of the Settlement Agreement, BOEM convened two panels to evaluate whether it is feasible to develop standards for determining (1) when a deep-penetration seismic survey is unnecessarily duplicative and (2) the lowest practicable source level for deep-penetration seismic surveys. The analyses conducted by these two panels were novel and highly technical. The complexity of their analysis is further exacerbated by the following: (a) the fact that different data acquisition techniques and, as a consequence, algorithmic processing methods, resulting from recent developments in technology to illuminate difficult geologic areas (i.e., subsalt) often influence whether an area needs to be surveyed more than once; and (b) a wide array of confidential business information, trade secrets, intellectual property, and regulatory considerations that must be considered in conjunction.

The panel report and determination on unnecessarily duplicative surveys is presented in **Appendix L, Section 2**. The panel consisted of internal BOEM subject-matter experts assisted by outside experts from the Marine Mammal Commission and the geophysical industry. The panel met numerous times since 2013 to more explicitly define “unnecessarily duplicative” and then to discuss, evaluate, and determine whether standards could be created to assess if a newly proposed seismic survey were “unnecessarily duplicative” of previous surveys. The final determination of this panel was that development of such standards is feasible and can be accomplished under existing statutes and regulations (refer to **Appendix L, Section 1** for more detail). The analysis of non-duplicative surveys, which is a requirement under the Settlement Agreement, is discussed further in **Chapter 2.14.3**.

The panel’s determination on evaluating the feasibility of creating standards on the lowest practicable sound source is presented in **Appendix L, Section 1** as well. As above, this panel consisted of BOEM and other Federal Government subject-matter experts, who were assisted by outside experts from industry. This panel also met numerous times since 2013 to identify and define key technology and parameters needed to appropriately determine the feasibility of creating standards to evaluate “lowest practicable sound sources.” The determination of the panel is that it is not feasible at this time to create such standards given the variability involved in using sound sources that best capture data sought without minimizing the quality of that data, as inadequate data quality could lead to additional surveying (refer to **Appendix L, Section 1** for more detail). The panels’ reports can be found in **Appendix L**.

1.2.3.4 Monitoring Plan

A monitoring plan related to high-energy seismic surveys in the GOM is currently under development (“monitoring plan”). The development process will culminate in an adaptive monitoring plan that will generate information to inform future management actions. The process for how the adaptive monitoring plan will be implemented will be described in detail in the monitoring plan.

The monitoring plan has been designed to correspond with the life of the ITR (i.e., 5 years). The monitoring plan will be adaptively implemented under a framework of annual review and recommendation, as appropriate. Accordingly, the monitoring plan is both long-term and adaptive, and addresses potential cumulative or chronic impacts from seismic surveys on marine mammal populations in the Gulf of Mexico. This plan is analyzed below, consistent with the Settlement

Agreement. This analysis is not intended to provide a detailed description of how the monitoring plan will be implemented. Again, that detailed description will be provided in the monitoring plan.

The monitoring plan will consist of two "tiers" of monitoring. The first tier will be informed by the aggregation of records of data required to be submitted by individual geophysical survey operators pursuant to the terms of LOAs issued under the ITR. The LOA-specific monitoring requirements will ultimately be dictated by terms of the final ITR and operator-specific LOAs. The ITR-based monitoring requirements are generally intended to collect (1) information about the specific impacts of the incidental take authorized under LOAs and (2) data that inform the assessment of the overall impact of the incidental take authorized during the 5-year period of the ITR. These requirements are intended to result in an "increased knowledge of the species [and] the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities…" (50 CFR § 216.104(a)(13)).

The second tier of monitoring will be informed by research and data collection that occurs separate from the legal requirements of LOAs or G&G permits. These voluntary industry efforts can help to improve the understanding about the species in the GOM potentially impacted by survey activities, the status of their populations, and actual versus potential impacts. These efforts can also inform the development and evaluation of promising technologies for the reduction of risk. The NMFS and BOEM expect to work with industry to jointly identify and develop such second-tier monitoring activities. Such activities could include, as appropriate, relevant industry data collection and research, as well as collaborative efforts among industry and other parties. Data and information collected through such non-regulatory efforts may include, but would not be limited to, marine mammal physiological and/or behavioral data, and data related to the basic distribution, abundance, and habitat use by marine mammal species.

These two separate "tiers" of monitoring will allow for the compilation, review, and adaptive integration of resultant data and information through an informal process. These data and information will be used to develop recommendations that may inform regulatory actions and non-regulatory monitoring efforts. Specifically, the initial version of the monitoring plan will describe an iterative and dynamic process of (1) identifying monitoring objectives, (2) conducting monitoring and reporting, (3) assessing monitoring outcomes, and (4) developing recommendations to inform regulatory actions and non-regulatory monitoring efforts.

In general, the monitoring plan would include mechanisms for consideration of reports, data aggregation, reviews, and other information and data generated by the regulated industry and responsible regulatory agencies. The monitoring plan would also establish a regular, periodic data and information exchange meeting (Periodic Review) between the regulated industry and responsible regulatory agencies. This Periodic Review would include, at a minimum, discussion of the following:

- mandatory standardized data reports provided by individual LOA holders under the ITRs;

- aggregation and analysis of those mandatory reports into an annual (or other time period) summary dataset; and
- a review of other relevant research activities undertaken by industry and other parties over the preceding year.[3]

Collectively, these components would form the bases for adaptive management recommendations that may result in changes to the monitoring and mitigation requirements included in LOAs (as long as they are consistent with then-applicable ITRs) or to the monitoring requirements of future ITRs. The NMFS would be responsible for deciding whether to implement the recommendations as part of the MMPA regulatory process. Additionally, the Periodic Review could inform planning to address mutually identified high-priority information gaps, data needs, or potential technological innovations through non-regulatory efforts. Each Periodic Review is expected to facilitate the assessment of relative benefits and costs of monitoring and mitigation requirements placed upon individual LOA holders, allowing for future adjustments to LOA requirements consistent with the terms of existing ITRs or as reflected in changes to future ITRs.

To the extent permitted by applicable law, any final products (e.g., reports) are expected to be made available for public review, absent any information protected from disclosure, such as proprietary confidential business information.

The monitoring plan will have clear and explicit monitoring goals identified by the regulated industry and regulatory agencies during the initial start-up meetings after issuance of the ITR. The Periodic Review would address progress toward monitoring goals. This process is expected to increase confidence in regulatory decisions and reduce concerns about potential environmental risks. Also, as part of the Periodic Review, a monitoring requirement may be evaluated and determined to be impracticable, not feasible with current scientific or technical capabilities, or of limited or no value to the regulatory process, thus leading to recommendations that, if implemented, may free resources and effort for emergent questions or rising priorities.

The Monitoring Plan will be used to analyze information related to G&G activities and to ensure that actual incidental take remains within the amount estimated and authorized by NOAA through the MMPA process. The monitoring program in and of itself is not expected to change any impacts evaluated in this Programmatic EIS, regardless of the alternative. Where the monitoring program could indirectly change potential impacts in the future is if the monitoring program identified different impacts from G&G activities and changes in marine mammal populations or informed the regulatory agencies that mitigations were not effective or could be modified or replaced to offer additional protections to the species. This would help to focus the effort of regulatory agencies and

[3] For example, the Sound and Marine Life Joint Industry Program (SAML JIP) regularly conducts multi-partner research and data collection (publicly reported on its website at www.soundandmarinelife.org) that is relevant to the mitigation of environmental risk in the GOM from industry activities.

industry to issues of biological significance and to adaptively manage both the permitting processes to identify feasible and effective mitigations. Over the 5 years that the ITRs will be in effect, the monitoring program is also expected to add to information regarding species generally and would help to identify, over the term of the rule, chronic or cumulative impacts on the species and potential ways to consider and address these impacts.

1.2.3.5 Incentives for the Use of Noise Reduction Technology

For any permittee that proposes and employs noise reduction technology for reducing or attenuating the sound produced by seismic arrays while conducting deep-penetration seismic surveys, BOEM shall (1) waive permitting fees, (2) exempt the permittee from the requirements of Paragraphs V.C and V.F of the Amended Settlement Agreement (**Appendix C**), and (3) reduce the buffers referenced in Paragraph I.D.5 of the Amended Settlement Agreement from 5 km to 1 km (3.1 mi to 0.6 mi). For purposes of this provision, what constitutes noise reduction technology shall lie within BOEM's sole discretion. BOEM will notify all other parties of any applications received or permitted pursuant to this provision during the parties' regular status conferences, which is described in Paragraph XII.A of the Amended Settlement Agreement.

1.2.4 Environmental Baseline and the *Deepwater Horizon* Explosion, Oil Spill, and Response

The information included in this Programmatic EIS considers the potential changes to the baseline conditions of physical, biological, and economic resources that resulted from the *Deepwater Horizon* explosion, oil spill, and response (**Chapter 4**).

On April 20, 2010, the *Deepwater Horizon* offshore drilling platform, a semi-submersible exploratory drilling rig owned by Transocean Ltd. and leased to a British Petroleum (BP) P.L.C. affiliate, exploded and subsequently sank in 4,992 ft (1,522 m) of water in the GOM, approximately 80.5 km (50 mi) off the coast of Louisiana. The drilling rig was in the process of temporarily abandoning the exploratory *Macondo* well. This incident resulted in the loss of 11 lives and released an estimated 3.19 million barrels (bbl) (134 million gallons [gal]) of oil from the compromised well. In addition, approximately 43,810 bbl (1.84 million gal) of dispersants were applied to the waters of the spill area, both on the surface and at the wellhead on the seafloor (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016).

Approximately 9,000 vessels were involved over the course of the *Deepwater Horizon*'s oil spill response and cleanup. On the most demanding day of the response, more than 6,000 vessels, 82 helicopters, 20 fixed-wing aircraft, and 47,849 personnel/responders were employed; 229,271 km^2 (88,522 mi^2) of fisheries were closed; 168 visibly oiled wildlife were collected; 1,157 km (719 mi) of containment boom was deployed; 26 controlled in-situ burns were conducted, burning 59,550 bbl of oil; 291 km (181 mi) of shoreline were heavily to moderately oiled; 68,530 gal of dispersant were applied, and 27,097 bbl of oil were recovered (USDHS, CG, 2011a). For more information about *Deepwater Horizon*, go to http://response.restoration.noaa.gov/deepwater-horizon-oil-spill and http://www.deepwaterhorizoneconomicsettlement.com/docs.php.

On August 16, 2010, the CEQ issued the “Report Regarding MMS’s NEPA Policies, Practices, and Procedures as They Relate to OCS Oil and Gas Exploration and Development,” providing recommendations from review of relevant NEPA documents, consultation with agency experts, and review of public comments for BOEM to improve NEPA practices and procedures. Since the *Deepwater Horizon* explosion, oil spill, and response, BOEM has undertaken several in-depth evaluations under NEPA to assess the potential impacts to the marine resource areas also considered in this Programmatic EIS. The following assessments are incorporated by reference: *Gulf of Mexico OCS Oil and Gas Lease Sales: 2015 and 2016; Western Planning Area Lease Sales 246 and 248—Final Environmental Impact Statement* (USDOI, BOEM, 2014a) and *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—Final Multisale Environmental Impact Statement* (USDOI, BOEM, 2017a).

The potential changes to baseline environmental conditions following an occurrence such as the *Deepwater Horizon* explosion and oil spill are addressed in **Chapter 4.1.5**.

1.2.5 Model Overview

Below is an overview of model methods, assumptions, and modeled exposures. Further details on the modeling effort for this Programmatic EIS are located in **Appendices D and N**.

Model Methodology

Exposure estimates presented in this Programmatic EIS were computed from modeled sound levels received by simulated (modeled) animals (animats) for several types of geophysical surveys. Animals and sources are constantly moving relative to the environment and in relation to each other. The sound fields generated by the sources are shaped by various physical parameters, and the sound levels ultimately received by an animal are a complex function of location and time. The basic modeling approach was to use acoustic models to compute the 3D sound fields and their variations in time. Simulated animats were modeled moving through these fields to sample the sound levels in a manner similar to how real animals would experience these sounds, allowing an exposure history to be recorded for all animats. A best estimate of the number of animats exposed to levels exceeding effects threshold criteria (refer to the **Appendices D and N**) were determined and then adjusted by the number of animals expected in the area based on density information. This creates an estimate of the potential number of animals exposed to the various sound levels. This estimate alone does not reflect the actual physical or behavioral impacts to marine mammals but rather a conservative, but reasonable, estimate as none of the relevant mitigations examined in this Programmatic EIS were included in the impact modeling.

Source

Airgun exposure predictions are based on a single nominal 8,000 cubic inches (in^3) airgun array, which was used as a realistic representative proxy after discussions with individual geophysical companies. An 8,000-in^3 array is reasonable because this falls within the range of typical airgun sources currently used in the GOM, which are roughly 4,000 to 8,400 in^3. The horizontal modeling of the 8,000-in^3 array should give sound pressure results similar to the other configurations. The output of an airgun array is directly proportional to the firing pressure and to the number of guns. However, the sound pressure (peak amplitude) generated by the array is not linear but instead is proportional to the cube root of the volume of that array. For example, doubling the size of the airgun array from 4,000 in^3 to 8,000 in^3 only adds approximately 3 decibels to the source pressure level. It should be noted that airgun arrays are configured geometrically so as to direct the seismic energy downward into the seafloor (known as tuning the array); the model fully recognizes this directionality and accounts for the lower sound energy radiated at shallower angles and at specific bearings in computing the exposure levels. The size of actual airgun arrays used over a 10-year period may vary greatly, resulting in different, possibly fewer and lower exposures. Additionally, the analysis does not include future sources and characteristics, (e.g., vibroseis and e-source airgun) array configurations, or survey geometries.

Propagation

Acoustic propagation in the Gulf of Mexico is complex and routinely changing due to variations in the Loop Current (and its eddies) and weather (including hurricanes). Additionally, it needs to address a wide range of water depths (i.e., shelf, slope, and deep waters) as well as strong freshwater runoff from the Mississippi River and other rivers. In order to capture this variability, the acoustic propagation modelling examined the historic sound velocity profiles (SVP) for the entire U.S. Gulf of Mexico throughout the entire year (refer to **Appendix D**). These SVPs were analyzed for similarities and ultimately grouped into seven zones or areas with SVPs of similar structure or characteristics. These seven zones also included consideration of bathymetric, oceanographic, and biological factors in their definition. The SVP analysis also identified the need to capture seasonal variations by modelling the summer and winter seasons, which were referred to in **Appendix D** as extremes but only in the sense of representing the bounds of realistic environmental variability. The profiles selected to model each of these seven zones are reasonable representatives of the family of SVPs for that zone and reflect an average of feasible conditions. Within each of the geographic boundaries for each modeled zone, multiple sites were selected to serve as the actual acoustic location for a modeled source in order to capture the propagation for that zone. The sites selected for these locations included consideration of the overall characteristic of the zone (e.g., it should be representative of the zone and not an extreme case), the proximity of the adjacent zones, the location of important bathymetric or oceanographic features, and, if possible, any important information on biologically important factors (e.g., migratory routes and animal concentrations). Finally, the three-dimension propagation fields for each of the zones were examined by modeling multiple azimuthal planes radiating out from the source location. For additional detail, refer to **Appendix D**.

Density and Abundance

Cetacean density models developed by Duke University and collaborators (including NOAA's marine mammal scientists) (Roberts et al., 2016) were used in the modeling effort for this Programmatic EIS. These peer-reviewed density models provide the best available scientific information regarding marine mammal occurrence in the Gulf of Mexico.

Differences may be noted between the abundance estimates provided by NOAA's Stock Assessment Reports (SARs) and those predicted by Roberts et al. (2016), with the latter typically providing higher estimates. The differences between these two sets of density estimates are the results of different methodologies. The two key differences in methodology are as follows:

(1) Roberts et al. (2016) modeled expected cetacean density through a habitat-based approach using multiple years of marine mammal surveys, while NOAA's Stock Assessment Report process (as described through the "Guidelines for Preparing Stock Assessment Reports Pursuant to the 1994 Amendments to the MMPA" [e.g., USDOC, NMFS, 2016a]) estimates density using traditional distance sampling and only the most recent NMFS-conducted survey. While these two approaches are compatible and based on a common statistical framework (distance sampling), they may produce different results, in part because the Roberts et al. (2016) approach better captures interannual variability while results produced through the SARs approach will necessarily be dependent on observations of marine mammals in the most recent survey only. For example, for the Clymene dolphin, NMFS' surveys in 2003-2004 produced an abundance estimate of 6,575 animals (CV = 0.36), but the 2009 surveys produced an abundance estimate of only 129 animals (CV = 1.00). Distribution of many species (including the Clymene dolphin) is determined by highly variable oceanographic characteristics rather than fixed bathymetric features, meaning that abundance estimates based on a single survey should be viewed with caution.

(2) The second key methodological difference, which likely results in the pattern of higher abundance estimates produced by Roberts et al. (2016), is correction for negative bias in the detection of marine mammals during the survey effort. Such a correction is necessary in order to produce the most accurate density models and abundance estimates possible. Roberts et al. (2016) corrected for availability bias, which occurs when one assumes that animals are always available to be observed despite being submerged (and unavailable for detection) for varying periods of time, and for perception bias, which occurs when one assumes that an animal is always detected when on a survey trackline, when in fact animals may not be detected due to sea state or other factors. The NMFS has not historically made these corrections in producing its SARs estimates for the Gulf of Mexico, therefore, systematically

underestimating abundance. Correction is particularly critical for long-diving and/or cryptic taxa, such as the sperm whale, beaked whales, or *Kogia* spp.

Roberts et al. (2016) provide taxon-specific supplementary reports that detail possible reasons for differences between their estimates and NMFS' Stock Assessment Report estimates. Please refer to these reports for a more in-depth discussion.

Based on the above rationale, the Roberts et al. (2016) methodology was determined to be the most reasonable and was therefore used in the modeling effort for this Final Programmatic EIS because it more accurately estimates marine mammal density and abundance in the GOM.

Threshold

The "Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing—Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts" (USDOC, NMFS, 2016a) used best available information and was issued in August 2016 after public notice and multiple opportunities for comment. This Programmatic EIS has been revised to include the 2016 Technical Guidance issued by NMFS, and updated modeling results using this guidance are included in **Appendix N**. This represents the best available scientific information and criteria issued by NOAA.

The guidance from NMFS reflects the latest and best available science, was prepared by an expert agency, and was peer and publicly reviewed. The comments regarding NMFS' criteria are not within the scope of this Programmatic EIS. The NMFS responded to public comments on the guidance (*Federal Register*, 2016a).

Model Assumptions

In any modeling process, it is necessary to make certain simplifying assumptions to address the complexity because the model inherently cannot reasonably cover every possible real world scenario. Some of the key assumptions used in the model effort include the assumptions below.

(1) Mitigation was not included in the model predictions but will occur during actual surveys. There is no generally accepted scientific consensus on how to quantify mitigation effectiveness. Therefore, implementation of mitigation could not be readily incorporated into the model. There is a reasonable expectation that mitigations have some value in reducing the number or intensity animal exposures. For this Final Programmatic EIS, subject-matter experts have synthesized qualitative and quantitative information to assess potential effects to marine mammals, which is included in **Chapter 4.2**.

(2) The level of effort, i.e., the number of surveys, is based on industry input and historical data; however, the actual number of surveys for the next 10 years may differ from the estimated and modeled level of effort.

(3) Airgun exposure predictions are based on a single nominal 8,000-in^3 airgun array, which was used as a realistic representative proxy after discussions with individual companies. An 8000-in^3 array is reasonable because this falls within the range of typical airgun sources currently used in the GOM, which are roughly 4,000 to 8,400 in^3. The size of actual airgun arrays used over a 10-year period may vary greatly, resulting in different, possibly fewer and lower exposures. Additionally, the analysis does not include future sources and characteristics, (e.g., vibroseis and e-source airgun) array configurations, or survey geometries.

Modeled Exposures

There was some confusion in the Draft Programmatic EIS regarding the distinction between the terms "exposure" and "take." BOEM has tried to clarify language in this Programmatic EIS to be more consistent in using terminology. "Take" is a specific legal term used in the ESA and MMPA. The estimation of takes of listed species and the evaluation of the effects of an action on ESA-listed species and critical habitat and on marine mammals are ultimately under the purview of the appropriate services charged with implementation of those statutes (namely, NOAA and the U.S. Fish and Wildlife Service [FWS]). The focus of NEPA, however, is broader. It mandates that Federal agencies, prior to undertaking a major action, identify and analyze potentially significant impacts to the environment from the proposed action and the alternatives and from direct and indirect effects, and to consider the incremental contribution to the cumulative effects. The NEPA analysis is to be made available to the public and to inform the decisionmaker in reaching his or her ultimate decision.

The NEPA analyses are not limited to criteria mandated by other statutes. Therefore, BOEM's analysis is intended to evaluate impacts from the proposed action and alternatives to all relevant resources, regardless of whether it would also be a compliance or consultation trigger under another statute. For these reasons, BOEM has clarified language in this Programmatic EIS to more consistently refer to modeled and quantified "exposures" to certain sound levels for analyzing impacts. The determination of what qualifies as an individual "take," which has a specific legal meaning under the ESA and MMPA, will ultimately be determined by NOAA through its MMPA Incidental Take Authorization development process and when a specific request for authorization for G&G survey activities is received.

While in many situations exposure to certain thresholds of sound may ultimately be confirmed by NOAA as appropriate for estimating incidental take, BOEM has determined that it would be premature to equate those terms at this time. While NOAA's estimate of take is based on specific harassment criteria, the modeling in this Programmatic EIS went further and estimated exposures relative to those thresholds as well as to other risk assessment schemes available in the literature (e.g., Wood et al., 2012). This approach is reasonable under the circumstances and serves to fully inform the public and decisionmaker of the potential impacts to the resources analyzed, regardless of whether those impacts implicate terms of art under other statutes.

Therefore, exposure estimates used in this Programmatic EIS are not the same as a "take" or an injury to an animal. Where there is an overlap between noise sources and the frequencies of sound used by marine life, there may be concerns related to how such sound may interfere with important biological functions. Noise, either natural or anthropogenic, can adversely affect marine life in various ways: inducing alteration of behavior; reducing communication ranges or orientation capability; temporarily or permanently damaging the auditory or other systems; and/or, in extreme cases, causing habitat avoidance or even death (e.g., Richardson et al., 1995; NRC, 2003a and 2005; Nowacek et al., 2007; Southall et al., 2007). BOEM expects that the majority of exposures are likely to result in only minor behavioral impacts, such as short-term disruption of behavioral patterns, abandonment of activities, and/or temporary displacement from discrete areas rather than long-term physiological effects such as permanent hearing loss. Given the MMPA definition, these disruptions may qualify as "takes." Potential noise impacts may also be additive or synergistic to those of other human stressors. While determining the biological significance of noise exposure impacts remains challenging (NRC, 2005), significant strides have been made in quantifying the effects of noise on marine mammals (USDOI, BOEM, 2014b).

In conclusion, while the results of the study may be conservative because of operational assumptions used to construct the modeling, they are the most credible, science-based information available at this time. The question of implementing mitigation in the modeling was considered at length. Inclusion of the mitigations in the development of the model would likely have decreased the amount of estimated take for the different situations modeled. There are currently no generally accepted metrics on the effectiveness of mitigation. Therefore, inclusion of a quantification of mitigation effects was not reasonable. Though mitigation could be not considered directly in the modeling effort, it is incorporated in the interpretation of the modeling results in the impact analysis presented in **Chapter 4.2**. It is reasonable to conclude that the proposed mitigation measures would likely reduce the potential impacts to marine mammals though the amount of such reduction cannot be quantified at this time.

Implementation of the mitigations selected in the Record of Decision (ROD) will be documented under the Monitoring Plan discussed in **Chapter 1.2.3**. Even with the limitations of modeling described, this model remains the best available method of evaluating the exposure of marine mammals to G&G activity. As described in **Chapter 1.2.6**, a new methodology is being developed that will build on the current modeling work. BOEM will consider this new approach in assessing the potential impacts to marine mammals from G&G activity once it becomes final.

Modeling Component Updates

In July 2016, NMFS released the final version of the *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing—Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts* (USDOC, NMFS, 2016b). This document provided acoustic guidelines (specifically those that identify the onset of Permanent Threshold Shift [PTS] or Temporary Threshold Shift [TTS]) to be used when conducting impact analyses for marine mammals. As NMFS stated in their Executive Summary, "While the Technical Guidance's acoustic thresholds are more complex than those used to date in most cases by NMFS, they reflect the current state of the scientific knowledge regarding the characterization of sound that have the potential to impact marine mammal hearing sensitivity." Throughout the development of this new guidance, BOEM provided comments and review. Additionally, besides changes to the threshold values, this guidance also introduced revised frequency weighting curves. Changes to both the acoustic thresholds and the frequency weighting curves need to be considered when assessing the impact that the new guidance will have on the impact numbers.

In developing the Draft Programmatic EIS, BOEM made a reasonable effort to consider the best-available scientific information in modeling potential auditory injury for marine mammals. Following completion of NMFS' Technical Guidance, this Final Programmatic EIS has been revised accordingly. Refer to **Appendix N** for the updated model results incorporating the Technical Guidance. Refer also to **Chapter 4.2** for updates to the impact analyses.

1.2.6 Risk Assessment Framework

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 the information 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 or 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 identified in this Programmatic EIS relates to the development of a novel analytical method to evaluate the effects of human-induced noise on marine mammal populations. A research collaboration of world-leading scientists in underwater sound, marine mammal hearing, and marine mammal behavior recently convened to produce an acoustic Risk Assessment Framework (RAF) that is meant to provide biologically meaningful context to interpret the significance of assumed exposures to marine mammal populations (Southall Environmental Associates, Inc., 2016).

In order to evaluate the effects of activities on marine mammal populations, one must begin with an estimate of individual exposure to noise above given received levels of sound (e.g., exposures of marine mammals to potentially injurious or disturbing noise). These results must then be interpreted (typically more qualitatively and narratively) as to what these numbers mean with regard to biological significance to marine mammal populations. However, the RAF analysis is expected to yield a more quantitatively rigorous, transparent, and repeatable analysis while integrating the best available science. The RAF also integrates risk assessment methods used by industry.

In broad terms, the acoustic RAF will consider the results of conventional assessments (e.g., exposure estimates) and, through a rigorous analytical methodology, interpret what the estimates mean within the context of key biological and population parameters (e.g., population size, life history factors, compensatory ability of the species, animal behavioral state, source-animal proximity, relative motion, variance in density estimates, aversion), as well as other biological, environmental, and anthropogenic factors. The end result provides an indication of the biological significance of these exposure numbers for each affected marine mammal stock/population (i.e., yielding the severity of impact and vulnerability of stock/population information), as well as forecasting the likelihood of any such impact. This effort will incorporate the latest acoustic impact modeling, which used NMFS' 2016 Technical Guidance (USDOC, NMFS, 2016b).

While the RAF currently focuses on airguns, it also can be adapted for other noise-producing activities and different locations, i.e., other than the GOM.

While the RAF data remain in development, BOEM's subject-matter experts acquired and used newly available, scientifically credible information to determine exposure estimates. BOEM's subject-matter experts also determined what other additional information was not available or absent, or would require exorbitant expenditures, or could not be obtained regardless of cost in the timeframe contemplated (and agreed upon per the Settlement Agreement) for production of this Programmatic EIS. Where gaps remained, BOEM's subject-matter experts exercised best professional judgment to extrapolate impact analyses of anticipated exposure numbers using accepted methodologies based on credible information. While incomplete or unavailable information could affect the impact analyses of marine mammal stocks/populations in the GOM and BOEM's decisionmaking, BOEM has determined that the agency can make an informed decision at this time without this information. BOEM's subject-matter experts have applied other scientifically credible information using accepted approaches and research methods, such as that used in the *Acoustic Propagation and Marine Mammal Exposure Modeling of Geological and Geophysical Sources in the Gulf of Mexico*, which was conducted by JASCO Applied Sciences (refer to **Appendices D and N**).

Therefore, BOEM determined that the RAF is relevant to reasonably foreseeable significant adverse impacts and would be useful but is not essential to a reasoned choice among alternatives at the programmatic stage. The RAF results will be evaluated when available and will be analyzed in light of later site-specific reviews of proposed activities (whether at the BOEM permitting, MMPA rulemaking, or LOA stages). Ongoing ESA consultation provides another opportunity for review and synthesis of the RAF results, once they are available, and may help identify additional mitigations or conditions, as appropriate. Nevertheless, even if the RAF data could be deemed essential at this programmatic stage, BOEM has considered this information gap, determined that the RAF study and resulting data cannot be obtained within the timeline of this Programmatic EIS, can be incorporated into later permitting and authorizations once the data is available, and has used in its place the best available existing scientific data using accepted methodologies to meet its NEPA obligations and to move forward with a programmatic decision.

1.3 REGULATORY FRAMEWORK

1.3.1 Federal Laws, Regulations, and Agreements

Federal laws, regulations, and Executive Orders that apply to this proposed action are described in **Table 1.1-1,** with additional information contained in the MMS report *OCS Regulatory Framework for the Gulf of Mexico Region* (Cameron and Matthews, 2016). These regulations and requirements include the following:

- National Environmental Policy Act (NEPA) (42 U.S.C. §§ 4321 *et seq.*);
- Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. §§ 1331 *et seq.*, as amended);
- Marine Mammal Protection Act (MMPA) (16 U.S.C. §§ 1361-1407);
- Endangered Species Act (ESA) (16 U.S.C. § 1531);
- Coastal Zone Management Act (CZMA) (16 U.S.C. §§ 1451 *et seq.*);
- Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. §§ 1801 *et seq.*, as amended);
- Clean Air Act (CAA) (42 U.S.C. §§ 7401 *et seq.*, as amended);
- Clean Water Act (CWA) (33 U.S.C. §§ 1251 *et seq.*);
- Rivers and Harbors Act (RHA) (33 U.S.C. §§ 401, 403, and 407);
- National Historic Preservation Act (NHPA) (54 U.S.C. §§ 300101 *et seq.*);
- Marine Protection, Research, and Sanctuaries Act (MPRSA) (33 U.S.C. §§ 1401 *et seq.*);
- National Marine Sanctuaries Act (NMSA) (16 U.S.C. §§ 1431 *et seq.*);
- Migratory Bird Treaty Act (MBTA) and Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds (16 U.S.C. §§ 703-712 and *Federal Register*, 2001);
- Executive Order 12114: Environmental Effects Abroad of Major Federal Actions (*Federal Register*, 1979);
- Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations (*Federal Register*, 1994);
- Executive Order 12989: Economy and Efficiency in Government Procurement Through Compliance With Certain Immigration and Naturalization Act Provisions (*Federal Register*, 1996);
- Executive Order 13089: Coral Reef Protection Act (*Federal Register*, 1998);

- Executive Order 13547: Stewardship of the Ocean, Our Coasts, and the Great Lakes (*Federal Register*, 2010);
- Executive Order 13158: Marine Protected Areas (MPA) (*Federal Register*, 2000a);
- Executive Order 13175: Consultation and Coordination with Indian Tribal Governments (*Federal Register,* 2000b);
- Marine Plastic Pollution Research and Control Act (MPPRCA) (33 U.S.C. §§ 1901 *et seq.*);
- Fishermen's Contingency Fund (FCF) (50 CFR part 296); and
- Outer Continental Shelf Transboundary Hydrocarbon Agreements Authorization Act (H.R. 1613).

Details of these laws and regulations are further discussed in **Appendix B**.

1.3.2 State Laws, Regulations, and Agreements

While Texas, Louisiana, Mississippi, Alabama, and Florida State waters are not within the jurisdiction of BOEM, the AOI may encompass adjacent State waters for reasons described in **Chapter 1.1.3**. State-issued permits may be required for activities in State waters. State regulations are further detailed in **Appendix B**.

1.4 Programmatic Approach to the NEPA Process

BOEM has prepared this Programmatic EIS in accordance with the following (details provided in **Appendix B**):

- National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. §§ 4321 *et seq*.);
- Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR parts 1500 through 1508);
- DOI Manual, Part 516;
- DOI Regulations Implementing NEPA (43 CFR part 46); and
- Executive Order 12114: Environmental Effects Abroad of Major Federal Actions.

The NEPA process is designed to ensure environmental impacts of proposed major Federal actions are considered in the decision-making process. Federal agencies are encouraged to integrate the NEPA process at the earliest stage to ensure planning and decisions reflect environmental values, avoid delays, and address potential conflicts (40 CFR § 1501.2).

The NEPA review must fully disclose and discuss significant environmental impacts and inform decision-makers and the public of reasonable alternatives to the proposed Federal action. It also must address any adverse environmental effects that cannot be avoided or mitigated, the relationship between short-term uses and long-term productivity of the environment, and any irreversible and irretrievable commitments of resources involved in the proposed action.

In addition to compliance with NEPA, preparation of this Programmatic EIS will help ensure the necessary documentation and analyses to support informed decisions regarding future OCSLA permit and MMPA authorization actions related to G&G activities on the OCS. This Programmatic EIS provides information that can be used when complying with other applicable laws, including the ESA, MSFCMA, NMSA, NHPA, and CZMA.

Given the scope and frequency of proposed G&G activities, their potential cumulative impacts, and the pending petition for NMFS' incidental take regulations for the category of G&G activities, BOEM determined that a Programmatic EIS under NEPA is appropriate. The specific details (e.g., location, timing, and proposed activities to be permitted) will not be known until BOEM receives individual applications for permits. This Programmatic EIS provides a programmatic-level evaluation for reasonably foreseeable G&G activities that could be utilized for any of the three program areas (i.e., oil and gas, renewable energy, and marine minerals) for which BOEM has oversight. The most recent programmatic NEPA coverage for G&G activities in Federal waters of the GOM was prepared in 2004.

The analysis in this Programmatic EIS supports BOEM's and NOAA's planning level decisions for permitting G&G activities. It provides a comprehensive analysis of a broad range of direct, indirect, and cumulative impacts associated with G&G activities across a breadth of marine resource areas in addition to other past, present, and reasonably foreseeable projects in the area. This Programmatic EIS establishes a framework for BOEM and NOAA for subsequent environmental documents related to site-specific actions, and identifies and analyzes appropriate mitigation measures to be used programmatically or considered at future site-specific levels (tiered analysis). The DOI Manual, Part 516, Chapter 15, provides guidance for implementing NEPA and lists activities that could be categorically excluded or require an EIS.

The scope of this Programmatic EIS does not include a NEPA analysis that evaluates a specific plan for oil and gas exploration or development, a specific permit or authorization for a G&G survey, authorization for use of marine minerals, or renewable energy leasing in the GOM, and it does not authorize an OCS lease sale. However, BOEM and NOAA will prepare sufficient in-depth tiered analyses, as appropriate, to authorize specific activities. Subsequent (tiered) analyses will be based on project-specific factors when a specific G&G activity authorization is requested.

The scenario analyzed in this Programmatic EIS for projected G&G activity levels extends over a 10-year period (**Chapter 3**). The 10-year period is a practical limit for making activity projections and does not imply that impacts on resources that have been evaluated are no longer valid beyond this date. All G&G activities permitted or authorized under the proposed action would be expected to comply with existing and future applicable laws and regulations. Compliance with existing and future applicable laws and regulations – by BOEM as well as individual operators and lessees, as required – may result in additional mitigation measures or changes to the measures described here.

A NEPA evaluation for approving the OCS plans that actualize leases for oil and gas exploration and development is not part of this proposed action.

1.5 OBJECTIVES AND SCOPE

The objectives of this Programmatic EIS are to

- characterize potential future G&G activities in the AOI over a 10-year period;
- describe the proposed action, including the purpose and need for BOEM and NOAA;
- identify and analyze direct, indirect, and cumulative impacts that could result from the proposed action; and
- evaluate alternatives and mitigation measures that are practical and feasible to ensure potential impacts to the human environment are minimized.

A variety of G&G techniques are used to characterize the shallow and deep structure of the shelf, slope, and deepwater environments of the GOM. The G&G surveys are conducted to (1) obtain data for hydrocarbon and mineral exploration and production; (2) aid in siting of oil and gas structures and facilities, renewable energy structures and facilities, and pipelines; (3) locate and monitor use of potential sand and gravel resources for coastal restoration projects; (4) identify possible seafloor or shallow-depth geologic hazards; and (5) locate potential archaeological resources and benthic habitats that should be avoided. The selection of a specific technique or suite of techniques is driven by data needs and the target of interest. The specific equipment used as part of G&G activities evaluated in this Programmatic EIS is described in **Chapter 3**, and detailed descriptions of G&G activities are provided in **Chapter 3 and Appendix F**. The scenario for the G&G activity levels projected in **Chapter 3 and Tables 3.2-1 through 3.2-5** is for a 10-year period. The G&G activities include the following:

- types of deep-penetration seismic (i.e., airgun) surveys used almost exclusively for oil and gas exploration;
- other types of surveys and sampling activities used only in support of oil and gas exploration, including electromagnetic surveys, deep stratigraphic and shallow test drilling, and various remote-sensing methods;
- non-airgun HRG surveys used in all three program areas to detect and monitor geohazards, archaeological resources, and certain types of benthic communities; and

- geological and geotechnical bottom sampling (e.g., grab samples, vibracores) used in all three program areas to assess the suitability of seafloor sediments for supporting structures (e.g., platforms, pipelines, cables, wind turbines) or to evaluate the quantity and quality of sand, gravel, or shell resources for beach nourishment and coastal restoration projects.

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 OVERVIEW

The alternatives considered in this analysis are briefly described as follows:

- Alternative A – Pre-Settlement (June 2013) Alternative;
- Alternative B – Settlement Agreement Alternative;
- Alternative C – Alternative A Plus Additional Mitigation Measures (Preferred Alternative);
- Alternative D – Alternative C Plus Marine Mammal Shutdowns;
- Alternative E – Alternative C at Reduced Activity Levels;
- Alternative F – Alternative C Plus Area Closures; and
- Alternative G – No New Activity Alternative.

Alternatives A through F would allow BOEM to permit and/or authorize G&G activities in support of BOEM's three Program Areas (i.e., Oil and Gas, Renewable Energy, and Marine Minerals) within the AOI. Alternative G, the No New Activity Alternative, meets the CEQ requirement for including a No Action Alternative. The general purpose of this evaluation is to analyze the potential impacts to the marine environment under the suite of mitigation measures proposed for each alternative. Only G&G activities directly permitted or authorized by BOEM, or interrelated or interconnected activities occurring in State waters and closely related to BOEM authorizations, are considered within the AOI. While State waters are not within BOEM's jurisdiction, the AOI encompasses adjacent State waters for three reasons, which are described in **Chapter 1.1.3**.

2.2 ADDITIONAL INFORMATION APPLICABLE TO THE ALTERNATIVES

Alternatives evaluated in this Programmatic EIS include different mitigation measures to provide protection of specific resources. As defined by the CEQ, mitigation includes (1) avoiding an impact by not taking a certain action or parts of an action; (2) minimizing an impact by limiting the degree or magnitude of the action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating an impact over time through preservation and maintenance operations during the life of the action; and (5) compensating for an impact by replacing or providing substitute resources or environments. Of these, BOEM's regulated programs primarily use avoidance and minimization as the main, and most effective, strategies for environmental protection.

To ensure clarity in application, survey protocols and mitigation measures (as may be applicable to a specific Program Area) common to all seven alternatives (i.e., Alternatives A through G) are summarized in the following subsections, as well as in **Table 2.2-1**, and are detailed in **Appendix B, Section 1**. Federal statutes, regulations, and Executive Orders that apply to the proposed action are described in **Table 1.1-1, Chapter 1.3.1, and Appendix B** and are detailed in the "OCS Regulatory Framework for the Gulf of Mexico Region" (Cameron and Matthews, 2016). Many of the mitigation measures are based on existing regulations and NTLs that are available on BOEM's website (http://www.boem.gov/Notices-to-Lessees-and-Operators/), that would be included as COAs, and that are contained in the following documents:

- "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting" (NTL 2016-BOEM-G01) requires vigilant watch for marine mammals and sea turtles, specifies vessel speeds and required distance for vessels to keep away from marine mammals and sea turtles and outlines reporting requirements;
- "Marine Trash and Debris Awareness and Elimination" (NTL 2015-BSEE-G03) provides information on the marine trash and debris awareness training video and slide show as well as reporting requirements (expires on November 30, 2018);
- "Biologically-Sensitive Underwater Features and Areas" (NTL 2009-G39) establishes protection zones around the core of the Pinnacle Trend feature and prohibits any contact with the seafloor;
- "Deepwater Benthic Communities" (NTL 2009-G40) provides measures for protecting high-density deepwater benthic communities by requiring a set-back distance for seafloor-disturbing activities;
- "Archaeological Resource Surveys and Reports" (NTL 2005-G07) provides archaeological survey and reporting requirements;
- "Shallow Hazards Program" (Section VI.B of NTL 2008-G05) provides the requirements for shallow hazards surveys and reporting for seafloor-disturbing activities;
- "National Marine Sanctuary Program Regulations" (15 CFR part 922) provides a listing of prohibited or otherwise regulated activities for National Marine Sanctuaries (NMSs); and
- "Military Warning and Water Test Areas" (NTL 2014-BOEM-G04) provides contact information for required coordination for activities within military warning areas.

Additional regulations and mitigation measures applicable to surveys performed for the Oil and Gas Program are detailed in **Appendix B, Section 1**. These measures are included in existing NTLs as follows:

- "Revisions to the List of OCS Blocks Requiring Archaeological Resource Surveys and Reports" (NTL 2011-JOINT-G01) supersedes NTL 2008-G20 and provides additions and modifications to the list of OCS lease blocks that require archaeological surveys and reports;
- "Shallow Hazards Program" (NTL 2008-G05) provides the requirements for inclusion in Exploration Plans (EPs) and Development Operations Coordination Documents (DOCDs), requirements for shallow hazards surveys and reporting, and guidance on how to prepare for EP operations; and
- "Ancillary Activities" (NTL 2009-G34) provides notification, follow-up reporting, and review requirements.

BOEM has not issued permits for the acquisition of geophysical data or geotechnical sampling on the OCS for renewable energy development. The G&G activities for renewable energy activities are typically performed under a lease, and the results of such surveys and testing are required under BOEM's renewable energy regulations at 30 CFR part 585 for the submission of a Site Assessment Plan (SAP) (30 CFR § 585.610(b)), a Construction and Operations Plan (COP) (30 CFR § 585.626(a)), or General Activities Plan (GAP) (30 CFR § 585.645(a)). Guidelines applicable to G&G surveys under the Renewable Energy Program include the following:

- "Guidelines for Providing Archaeological and Historic Property Information" pursuant to 30 CFR part 585; and
- "Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information" pursuant to 30 CFR part 585.

There are no additional mitigation measures applicable to surveys performed for the Marine Minerals Program that are not included above in the regulations and mitigation measures for G&G surveys.

All seismic airgun surveys in the GOM currently require implementation of the Seismic Airgun Survey Protocol (**Appendix B, Attachment 1**), which specifies the following mitigation measures:

- an exclusion zone;
- ramp-up requirements;
- visual monitoring by PSOs prior to and during seismic airgun surveys; and
- array shutdown requirements for seismic airgun surveys performed in water depths >200 m (656 ft) in the CPA and WPA and for all seismic airgun surveys performed in the EPA.

The purpose of the Seismic Airgun Survey Protocol is to minimize the potential for injury to marine mammals and sea turtles and to avoid most opportunities for Level A harassment of marine mammals. The protocol specifies the conditions under which airgun arrays can be started and those under which they must be shut down. It also includes the recommended but optional use of PAM to help detect vocalizing marine mammals. The protocol requirements apply specifically to airguns and not non-airgun HRG sources such as side-scan sonars; boomers, sparkers, and CHIRP (compressed high-intensity radiated pulse) subbottom profilers; and single-beam or multibeam depth sounders that may be operating concurrently during seismic airgun surveys.

The Seismic Airgun Survey Protocol is based on NTL 2016-BOEM-G02 ("Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program") and provides the requirements applicable to all seismic airgun surveys (excluding ancillary activities [refer to NTL 2009-G34]) for all alternatives evaluated in this Programmatic EIS. However, additional mitigation requirements are required for various alternatives (i.e., Alternatives B through F). Also, activities in <200 m (656 ft) of water in the CPA and WPA do not require the mitigations described in NTL 2016-BOEM-G02, though the Settlement Agreement (Alternative B) currently requires it.

In addition to the NTLs and guidance noted above that are applicable to specific Program Areas, all G&G surveys will incorporate marine mammal monitoring consistent with the Monitoring Plan being developed by BOEM, NMFS, and the anticipated regulated parties (**Chapter 1.2.3.4**). Also, the Monitoring Plan provides BOEM with the ability to adjust compliance measures based on new information, new technologies, monitoring results, and specific program needs throughout the timeframe of this Programmatic EIS. The Monitoring Plan is being developed based on the application requirements for "take" under the MMPA. Monitoring requirements will be included in the ITRs that NMFS may promulgate in response to the Bureau of Ocean Energy Management's MMPA application. After issuance of ITRs, NMFS would issue individual annual ITAs under Sections 101(a)(5)(A) of the MMPA for G&G surveys and ancillary activities in the form of Letters of Authorization (LOAs). The G&G surveys conducted in support of marine mineral and renewable energy projects would comply separately with the ESA, MMPA, and other relevant statutes as deemed appropriate by all agencies. The NTLs and COAs may be modified or revised with new baseline mitigation measures and applicable terms and conditions of any future ESA Section 7 consultations, the MMPA, and other regulatory requirements.

Summarized characterizations of each alternative are provided in the following subsections and detailed in **Appendix B, Section 1**. Additionally, **Tables 2.2-1 and 2.2-2** provide a comparison summary of the mitigation measures for each alternative.

Exposure Versus Take of Listed Species

BOEM and NMFS do not equate every exposure to sound by a listed species or marine mammal as a "take" as defined in Section 101(A)(5)(A-D) of the MMPA or under the ESA, as discussed in **Chapter 1.2.5**. Using model estimates often requires assuming a conservative but reasonable scenario, which may overestimate exposures. For a full discussion of the model methodology and limitations, refer to **Chapter 1.2.5**.

2.3 ALTERNATIVE A – PRE-SETTLEMENT (JUNE 2013) ALTERNATIVE

2.3.1 Description

Under Alternative A, BOEM would continue to permit or authorize G&G activities at the current projected activity levels with implementation of standard (pre-settlement) mitigation measures applied to those activities through lease stipulations, permits, and authorizations, typically as COAs. Currently, BOEM implements seismic survey mitigation measures for marine mammals and sea turtles in the GOM through terms and conditions, as well as through conservation recommendations of biological opinions developed for lease sales.

2.3.2 Mitigation Measures

All G&G survey activities supporting the Oil and Gas, Renewable Energy, and Marine Minerals Programs permitted or authorized under Alternative A would be required to comply with all statutes, regulations, lease stipulations, and mitigation measures identified in **Chapter 2.2** and detailed in **Appendix B, Section 1**. The mitigation measures included in Alternative A are the measures that were in place prior to the Settlement Agreement (refer to **Appendix C**). This alternative includes no mitigation measures proposed since the Settlement Agreement, and the measures listed below as part of Alternative A are italicized within the subsequent alternative descriptions to distinguish them from newly proposed measures, which appear in the regular font. Guidance provided in NTLs and requirements promulgated through regulations (Oil and Gas Program surveys only) become enacted as mitigation measures once adopted as COAs or stipulations in permits, plans, or other authorizations. For NMFS' purpose, these measures would be considered for inclusion in ITRs and/or ITAs issued under the MMPA.

The standard mitigations implemented for Alternative A are presented in **Tables 2.2-1 and 2.2-2**, are detailed in **Appendix B, Section 1**, and include the following:

- guidance for vessel strike avoidance;
- guidance for marine debris awareness;
- avoidance of sensitive benthic resources;
- guidance for avoidance of historic and prehistoric sites;
- guidance for shallow hazards surveying and reporting;
- regulations for activities in or near NMSs;
- guidance for military coordination;
- guidance for ancillary activities (Oil and Gas Program only); and

- implementation of the Seismic Airgun Survey Protocol: PSO and PAM Programs (refer to **Tables 2.2-1 and 2.2-2** for PSO and PAM details that apply to each alternative) as outlined in NTL 2016-BOEM-G02.

2.3.3 Rationale

The use of acoustic sources while conducting G&G operations may have an impact on marine wildlife, including marine mammals and sea turtles. Some marine mammals, such as the sperm whale, and all sea turtles that inhabit the GOM are protected under the ESA, and all marine mammals are protected under the MMPA. The purpose of the operational measures included in Alternative A is to minimize the potential for injury to marine mammals and sea turtles.

Alternative A examines the potential impacts to the environment from G&G survey operations implementing the mitigation measures used in the GOM prior to the Settlement Agreement. Implementation of the Seismic Airgun Survey Protocol affords protection for marine mammals by reducing Level A exposures in deep water.

2.4 ALTERNATIVE B – SETTLEMENT AGREEMENT ALTERNATIVE

2.4.1 Description

Under Alternative B (Settlement Agreement Alternative), G&G activities would include implementation of mitigation, monitoring, and reporting as well as mitigation measure requirements outlined in the Settlement Agreement for Civil Action No. 2:10 cv-01882 dated June 25, 2013, as discussed in **Chapter 1.2.3** and as provided in **Appendix C**. The Settlement Agreement was, by its original terms, to expire in December 2015. On February 10, 2016, the parties formally agreed to extend the stay until final action by the agencies or September 25, 2017, whichever occurs first. The extended Settlement Agreement amended Article V of the Settlement to include expanded/additional mitigation measures during the stay. Under Alternative B, BOEM would continue to permit or authorize G&G activities through the use of site-specific NEPA evaluations, lease stipulations, NTLs, best management practices, and COAs as provided in the Settlement Agreement as amended. Under this alternative, Amended Settlement Agreement requirements, existing NTLs, COAs, and best management practices – including required mitigation, monitoring, and reporting – would remain in effect.

The Amended Settlement Agreement puts in place interim mitigation measures, which are analyzed under Alternative B. While the stay (temporary suspension of the judicial proceedings) is in effect, BOEM has agreed to analyze the interim mitigation measures listed in **Chapter 2.4.2** as potential COAs for permits or authorizations to conduct deep-penetration seismic airgun surveys. Analyzing the interim mitigation measures does not obligate BOEM to require them as part of a resulting permit or authorization. However, BOEM typically is implementing these measures as COAs in permits and authorizations.

The Amended Settlement Agreement is a temporary and voluntary agreement between the parties performing and regulating G&G activities in the GOM and not a G&G regulatory framework adopted by BOEM. Under Alternative B, the temporary provisions of the Amended Settlement Agreement, as described in **Chapter 2.4.2**, may be formally adopted into the process BOEM uses for issuing future G&G permits. For NOAA's purpose as a cooperating agency, these measures would be considered for inclusion in ITRs issued under the MMPA.

2.4.2 Mitigation Measures

The G&G surveys permitted or authorized under Alternative B would be required to comply with the interim mitigation measures outlined in the Amended Settlement Agreement (**Appendix C**). Alternative B consists of all mitigation measures except guidance for ancillary activities, which were in place prior to the Settlement Agreement (included in Alternative A, **Chapter 2.3** and which are in italics below), as well as the newly proposed mitigation measures (shown in the regular font). All mitigation measures required for Alternative B are included in **Chapter 1.2.3**; presented in **Tables 2.2-1 and 2.2-2**; detailed in **Appendix B, Section 1**; and provided below:

- *guidance for vessel strike avoidance;*
- *guidance for marine debris awareness;*
- *avoidance of sensitive benthic resources;*
- *guidance for avoidance of historic and prehistoric sites;*
- *guidance for shallow hazards survey and reporting;*
- *regulations for activities in or near NMSs;*
- *guidance for military coordination;*
- *implementation of the Seismic Airgun Survey Protocol: PSO and PAM Programs (refer to* ***Tables 2.2-1 and 2.2-2*** *for PSO and PAM details that apply to each alternative) as outlined in NTL 2016-BOEM-G02;*
  - implementation of the expanded PSO Program (manatees and depth): expanded to include manatees as well as whales (excluding marine mammal species in the Family Delphinidae, which includes killer whales, pilot whales, and all of the dolphin species) and would apply to all authorizations for deep-penetration seismic airgun surveys in the AOI regardless of water depth; and
  - implementation of the expanded PAM requirement (low visibility): the required use of PAM during periods of reduced visibility for all deep-penetration seismic airgun surveys in water depths >100 m (328 ft);
- implementation of a 5-km (3-mi) buffer zone adjacent to and seaward of the 20-m (66-ft) isobath and to the Areas of Concern that fall within the EPA as per the

Amendment to the Settlement Agreement. Activities in the buffer zones will be subject to the same restrictions and requirements that apply to the Areas of Concern to which they are adjacent, during the same time periods (**Figure 2.2-1 and Chapter 2.4.3**);

- implementation of a minimum separation distance of 40-km (25-mi) between simultaneous deep-penetration seismic airgun surveys when operating in the designated Areas of Concern identified by Plaintiffs in the Settlement Agreement (**Figure 2.2-1 and Chapter 2.4.3**);
- coastal waters' seasonal restrictions on deep-penetration seismic airgun surveys from (1) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath) and (2) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the UME in the northern GOM (**Figure 2.2-1 and Chapter 2.4.3**); and
- restriction of deep-penetration seismic airgun surveys in the Areas of Concern within the EPA (including the buffer zone referenced earlier) (**Figure 2.2-1 and Chapter 2.4.3**).

In addition to the mitigation measures above, the following requirements for reporting and information that are not included in the Seismic Airgun Survey Protocol (**Appendix B, Attachment 1**) would be included in all permits or authorizations under Alternative B:

- **Reporting Requirements** – Operators shall provide biweekly reports on the seismic survey and confirm compliance with required mitigation measures.
- **Application Requirements** – For confirmation of survey non-duplicity and use of the lowest practicable sound source, the applicant must provide
  - written justification explaining why the proposed deep-penetration seismic airgun survey is not unnecessarily duplicative of previously conducted surveys; and
  - an estimate of total energy output per impulse in decibels (rms) with respect to each energy source to be used, and verify in writing that the airgun arrays, to the furthest extent practicable, use the lowest sound intensity level that still achieves the survey's goals.

2.4.3 Rationale

The Amended Settlement Agreement (**Appendix C**) requires BOEM to evaluate the agreement's mitigation measures in this Programmatic EIS. The mitigation measures are intended to reduce cumulative or chronic exposures of marine mammal populations to noise (e.g., limiting concurrent surveying and the total amount of survey activity in portions of the GOM).

The interim mitigation measures included in the Amended Settlement Agreement go beyond the mitigation measures included in Alternative A and afford additional protection for all marine mammals, with some mitigation measures focused on protection of specific species. These mitigation measures include the expansion of the PSO Program to include the required use of PAM for all surveys performed in water depths >100 m (328 ft) during times of reduced visibility, which reduces the potential for Level A exposures. (Note: Some operators voluntarily implemented PAM prior to the conditions of the 2013 Settlement Agreement.)

The Settlement Agreement includes four geographic "Areas of Concern" identified by Plaintiffs (**Figure 2.2-1**). Within these areas, the Settlement Agreement establishes mitigation measures, including seasonal restrictions (refer to Area of Concern 3); closures for all deep-penetration seismic airgun surveys (portions of Areas of Concern 2, 3 and 4) in the EPA; and a minimum separation distance between simultaneous deep-penetration seismic airgun surveys when operating in any Area of Concern. The Amendment to the Settlement Agreement amended Article V (**Appendix C**) to include a 5-km (3-mi) buffer zone adjacent to and seaward of the 20-m (66 ft) isobath and to the remaining Areas of Concern that fall within the EPA. The Amendment to the Settlement Agreement also extended the seasonal coastal restriction on deep-penetration seismic airgun surveys to be in effect from January 1 to April 30 for those portions of Area of Concern 3 (**Appendix C**) falling within the boundaries of the UME designated by NOAA (**Figure 2.2-1**).

2.5 ALTERNATIVE C – ALTERNATIVE A PLUS ADDITIONAL MITIGATION MEASURES (PREFERRED ALTERNATIVE)

2.5.1 Description

Under Alternative C, G&G activities would continue to be authorized and would include the mitigation measures, monitoring, reporting, survey protocols, and guidance that were in place prior to the Settlement Agreement (included in Alternative A, **Chapter 2.3**, and which are in italics in **Chapter 2.5.2**), as well as additional mitigation and temporal measures for survey protocols for seismic airgun and non-airgun HRG surveys. A Monitoring Plan is being developed by industry (**Chapter 1.2.3.4**) and would allow for adaptive management of mitigation measures for all three Program Areas (i.e., Oil and Gas, Renewable Energy, and Marine Minerals) if warranted by new information, new technologies, monitoring results, and specific program needs throughout the timeframe of this Programmatic EIS.

In accordance with Section 1502.14(e) of NEPA's implementing regulations, BOEM has identified Alternative C as the Preferred Alternative. The "agency's Preferred Alternative" is the alternative that the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors. BOEM did not identify a Preferred Alternative in the Draft Programmatic EIS. BOEM has reviewed the totality of the record generated by this Programmatic EIS in the public review period to assist in identifying an agency Preferred Alternative. BOEM believes the additional mitigation under Alternative C would minimize the potential for injury to marine mammals and sea turtles, and provide additional protection for coastal stocks of common bottlenose dolphins while not causing undue burden to the G&G industry.

Alternative C provides the best balance of environmental protection with minimal impacts to industry (less impactful to industry than Alternatives B and D through G).

2.5.2 Mitigation Measures

The G&G surveys permitted or authorized under Alternative C would be required to comply with all the mitigation measures included in Alternative A (shown in italics) plus additional measures listed here. Mitigation measures carried forward from previous alternatives are italicized and underlined within subsequent alternative descriptions (unless carried from Alternative A [italics only]) to distinguish them from newly proposed measures, which appear in the regular font. The mitigation measures required for Alternative C are presented in **Tables 2.2-1 and 2.2-2**; detailed in **Appendix B, Section 1**; and include the following:

- *guidance for vessel strike avoidance;*
- *guidance for marine debris awareness;*
- *avoidance of sensitive benthic resources;*
- *guidance for avoidance of historic and prehistoric sites;*
- *guidance for shallow hazards survey and reporting;*
- *regulations for activities in or near NMSs;*
- *guidance for military coordination;*
- *guidance for ancillary activities (Oil and Gas Program only);*
- *implementation of the Seismic Airgun Survey Protocol: PSO and PAM Programs (refer to **Tables 2.2-1 and 2.2-2** for PSO and PAM details that apply to each alternative) as outlined in NTL 2016-BOEM-G02:*
  - <u>*implementation of expanded PSO Program (manatees and depth): expanded to include manatees as well as whales (excluding marine mammal species in the Family Delphinidae, which includes killer whales, pilot whales, and all of the dolphin species) and would apply to all authorizations for deep-penetration seismic airgun surveys in the AOI regardless of water depth*</u>;
  - <u>*implementation of expanded PAM requirement (low visibility): the required use of PAM during periods of reduced visibility for all deep-penetration seismic airgun surveys in water depths >100 m (328 ft)*</u>; and
  - implementation of expanded PAM requirement (canyons): the required use of PAM for all deep-penetration seismic airgun surveys at all times in the Mississippi Canyon and De Soto Canyon lease blocks (**Figure 2.2-1**);
- implementation of the Non-Airgun HRG Survey Protocol; and

- coastal waters' seasonal restrictions from February 1 to May 31, modified from Alternative B (**Figure 2.3-1**).

2.5.3 Rationale

The purpose of the mitigation measures included in Alternative C is to further minimize the potential for injury to marine mammals and sea turtles, to avoid most opportunities for Level A harassment of marine mammals, and to provide additional protection for coastal stocks of common bottlenose dolphins (*Tursiops truncatus*). This alternative was developed based on the Alternative A mitigation measures. However, in Alternative C, the seasonal restrictions for coastal waters are modified to protect reproducing dolphins, and requirements to use PAM in the Mississippi Canyon and De Soto Canyon blocks are included. (Note: Some operators voluntarily implemented PAM prior to the conditions of the 2013 Settlement Agreement.) Although there is no fixed reproductive season for common bottlenose dolphins in the GOM, there does appear to be a peak in calf and neonate strandings falling within the boundaries of the UME in the northern GOM from February to May (now closed and determined by NMFS to be largely unrelated to seismic activities); therefore, the restriction was extended to incorporate this timeframe. In addition, the inclusion of the expanded PSO Program for all surveys performed in water depths >100 m (328 ft) and for all deep-penetration seismic airgun surveys performed in the Mississippi Canyon and De Soto Canyon lease blocks, reduces the potential for Level A exposures to marine mammals (including manatees), targeting vocalizing Bryde's, sperm, and deep-diving Odontocetes. Implementation of the Non-Airgun HRG Survey Protocol would further reduce exposure of marine mammals to acoustic sources that fall within their hearing range (≤200 kilohertz [kHz]), resulting in fewer Level A exposures.

Unlike Alternative B, the minimum separation distances and restrictions in the EPA were not carried forward to Alternative C.

2.6 ALTERNATIVE D – ALTERNATIVE C PLUS MARINE MAMMAL SHUTDOWNS

2.6.1 Description

Under Alternative D, G&G activities would continue to be authorized and would include the mitigation measures, monitoring, reporting, survey protocols, and guidance included in Alternative C (**Chapter 2.5**), as well as additional mitigation and temporal measures for Seismic Airgun and Non-Airgun HRG Survey Protocols and the development of the Monitoring Plan.

2.6.2 Mitigation Measures

The G&G surveys permitted or authorized under Alternative D would be required to comply with all the mitigation measures included in Alternative C (**Chapter 2.5**) and are shown in italics and are underlined, which are the mitigation measures, monitoring, reporting, survey protocols, and guidance that were in place prior to the Settlement Agreement (included in Alternative A, **Chapter 2.3**, and in italics below), and an additional measure that expands the PSO shutdown to include all marine mammals except animals that actively approach the vessel to bow ride (presented in the regular font). In the GOM, bow-riding dolphin species include common bottlenose, Fraser's

(*Lagenodelphis hosei*), Clymene's (*Stenella clymene*), rough-toothed (*Steno bredanensis*), striped (*Stenella coeruleoalba*), spinner (*Stenella longirostris*), Atlantic spotted (*Stenella frontalis*), pantropical (*Stenella attenuate*), and Risso's (*Grampus griseus*) dolphins. The mitigation measures required for Alternative D are presented in **Tables 2.2-1 and 2.2-2**; detailed in **Appendix B, Section 1**; and listed below:

- *guidance for vessel strike avoidance;*
- *guidance for marine debris awareness;*
- *avoidance of sensitive benthic resources;*
- *guidance for avoidance of historic and prehistoric sites;*
- *guidance for shallow hazards survey and reporting;*
- *regulations for activities in or near NMSs;*
- *guidance for military coordination;*
- *guidance for ancillary activities (Oil and Gas Program only);*
- *implementation of the Seismic Airgun Survey Protocol: PSO and PAM Programs (refer to **Tables 2.2-1 and 2.2-2** for PSO and PAM details that apply to each alternative) as outlined in NTL 2016-BOEM-G02:*
  - implementation of the expanded PSO Program (non-bow-riding delphinids): expanded to include shutdown for all marine mammals with the exception of bow-riding or actively approaching dolphins (i.e., common bottlenose, Fraser's, Clymene's, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso's dolphins) and would apply to all authorizations for deep-penetration seismic airgun surveys in the AOI regardless of water depth;
  - *implementation of expanded PAM requirement (low visibility): the required use of PAM during periods of reduced visibility for all deep-penetration seismic airgun surveys in water depths >100 m (328 ft)*; and
  - *implementation of expanded PAM requirement (canyons): the required use of PAM for all deep-penetration seismic airgun surveys at all times in the Mississippi Canyon and De Soto Canyon lease blocks (**Figure 2.2-1**)*;
- *implementation of the Non-Airgun HRG Survey Protocol*; and
- *coastal waters' seasonal restrictions from February 1 to May 31, modified from Alternative B (**Figure 2.3-1**)*.

2.6.3 Rationale

The purpose of the mitigation measures included in Alternative D is to further minimize the potential for injury to marine mammals and sea turtles, to avoid most Level A harassment of marine mammals, and to increase protection for marine mammals. This alternative was developed based on the Alternative C mitigation measures, but includes added protection for all marine mammals species – including manatees, but not bow-riding dolphins (i.e., common bottlenose, Fraser's, Clymene's, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso's) – with the inclusion of an expanded PSO Program to avoid most opportunities for Level A exposures to marine mammals in all water depths. Additionally, implementation of the Non-Airgun HRG Survey Protocol further reduces exposure of marine mammals to acoustic sources that fall within their hearing range (≤200 kHz), resulting in fewer Level A exposures to marine mammals.

2.7 ALTERNATIVE E – ALTERNATIVE C AT REDUCED ACTIVITY LEVELS

2.7.1 Description

Under Alternative E, G&G activities would continue to be authorized with the mitigation measures described for Alternative C, including the development of the Monitoring Plan. However, BOEM would require a reduced level of activity (calculated in line miles) for deep-penetration, multi-client seismic airgun surveys. Projected scenarios for oil and gas exploration seismic airgun survey levels are discussed in **Chapter 3.2.1**. Alternative E includes two proposed options to reduce seismic airgun survey impacts (i.e., activities and/or exposures) to marine species and the overall acoustic sounds in the GOM. Activities could be conducted in any of the OCS planning areas. BOEM may place an overall limit on survey line miles and issue permits on a first come-first serve basis as a means of implementing Alternative E. However, BOEM does not expect that the method of implementing this reduction of line miles would influence the potential impacts as considered in this Programmatic EIS. Any specific method of implementation may be specified further through an NTL or other guidance.

2.7.2 Mitigation Measures

The G&G surveys permitted or authorized under Alternative E would be required to comply with all of the mitigation measures included in Alternative C (**Chapter 2.5**) and are shown in italics and are underlined, which are the mitigation measures, monitoring, reporting, survey protocols, and guidance that were in place prior to the Settlement Agreement (included in Alternative A, **Chapter 2.3**, and in italics below), as well as a reduced level of activity (calculated in line miles) for deep-penetration, multi-client seismic airgun surveys (presented in the regular font). The required mitigation measures for Alternative E are presented in **Tables 2.2-1 and 2.2-2**; detailed in **Appendix B, Section 1**; and listed here:

- *guidance for vessel strike avoidance;*
- *guidance for marine debris awareness;*
- *avoidance of sensitive benthic resources;*

- *guidance for avoidance of historic and prehistoric sites;*
- *guidance for shallow hazards survey and reporting;*
- *regulations for activities in or near NMSs;*
- *guidance for military coordination;*
- *guidance for ancillary activities (Oil and Gas Program only);*
- *implementation of the Seismic Airgun Survey Protocol: PSO and PAM Programs (refer to **Tables 2.2-1 and 2.2-2** for PSO and PAM details that apply to each alternative) as outlined in NTL 2016-BOEM-G02:*
  - *implementation of expanded PSO Program (manatees and depth): expanded to include manatees as well as whales (excluding marine mammal species in the Family Delphinidae, which includes killer whales, pilot whales, and all of the dolphin species) and would apply to all authorizations for deep-penetration seismic airgun surveys in the AOI regardless of water depth*;
  - *implementation of expanded PAM requirement (low visibility): the required use of PAM during periods of reduced visibility for all deep-penetration seismic airgun surveys in water depths >100 m (328 ft)*; and
  - *implementation of expanded PAM requirement (canyons): the required use of PAM for all deep-penetration seismic airgun surveys at all times in the Mississippi Canyon and DeSoto Canyon lease blocks (**Figure 2.2-1**)*;
- *implementation of the Non-Airgun HRG Survey Protocol*; and
- *coastal waters' seasonal restrictions from February 1 to May 31, modified from Alternative B (**Figure 2.3-1**)*.

Under Alternative E, all mitigation measures described above (same as Alternative C) would apply, but with a reduced level of activity. Alternative E contains two options:

- **Alternative E1** – A reduction (in line miles) of deep-penetration, multi-client seismic activities by 10 percent from the estimated levels projected within a given calendar year (**Table 2.7-1**); and
- **Alternative E2** – A reduction (in line miles) of deep-penetration, multi-client seismic activities by 25 percent from the estimated levels projected within a given calendar year (**Table 2.7-2**).

Each calendar year reduction would be determined independently of the reductions applied in previous calendar years. Therefore, the total survey reduction (in line miles) for each calendar year will be based on the total survey activities (in line miles) proposed by industry for that given year.

2.7.3 Rationale

This alternative is based on Alternative C and includes added measures to reduce seismic airgun survey activities. The purpose of the mitigation measures included in Alternative E is to minimize the potential for injury to marine mammals and sea turtles, to provide additional measures to avoid opportunities for Level A harassment of marine mammals, and to provide additional protective measures for marine mammals. This alternative may provide additional protection to these and other resources in the GOM by reducing the level of deep-penetration seismic airgun surveys by 10 or 25 percent.

2.8 Alternative F – Alternative C Plus Area Closures

2.8.1 Description

Under Alternative F, G&G activities would continue to be authorized and would include the mitigation measures, monitoring, reporting, survey protocols, and guidance included in Alternative C (**Chapter 2.5**), which are the mitigation measures, monitoring, reporting, survey protocols, and guidance that were in place prior to the Settlement Agreement (included in Alternative A, **Chapter 2.3**, and in italics below), as well as additional mitigation and temporal measures for Seismic Airgun and Non-Airgun HRG Survey Protocols plus the addition of area closures for all seismic airgun surveys at all times in four deepwater areas to protect certain cetacean species and other resources. The area closures are the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Garden Banks Closure Area, as shown in **Figure 2.8-1**. All of the closure areas or a subset of the closures areas could be selected as part of this alternative.

2.8.2 Mitigation Measures

Under Alternative F, currently authorized G&G activities in the closure areas would be allowed to continue subject to the terms and conditions of existing permits or authorizations and without being required to implement additional mitigation measures. All new G&G surveys permitted or authorized under Alternative F would be required to comply with the mitigation measures included in Alternative C (**Chapter 2.5**) and are shown in italics and underlined, which are the mitigation measures, monitoring, reporting, survey protocols, and guidance that were in place prior to the Settlement Agreement (included in Alternative A, **Chapter 2.3**, and in italics below) plus the additional closure areas described earlier and presented in the regular font. In addition, airgun surveys conducted outside the closure areas would be required to remain at a distance such that received sound levels at the closed-area boundaries would not exceed the threshold for Level B harassment – currently 160 dB re 1 μPa (decibels referenced to 1 micropascal) – as determined by field verification of sound levels or sound field modeling. BOEM expects that, through the development of ITRs, there may be a mechanism to implement standardized exclusion zones such that the received sound levels at the closed-area boundaries would not exceed the threshold for Level B harassment. Regarding implementation, BOEM has the ability to enforce the distance from the closure areas through the site-specific permit review process and appropriate COAs. Also, these areas would be closed to all geophysical activities except non-airgun HRG surveys in which one or more active acoustic sound sources would be operating at frequencies >200 kHz. The mitigation measures required for Alternative F are presented in **Tables 2.2-1 and 2.2-2**; detailed in **Appendix B, Section 1**; and listed here:

- *guidance for vessel strike avoidance;*
- *guidance for marine debris awareness;*
- *avoidance of sensitive benthic resources;*
- *guidance for avoidance of historic and prehistoric sites;*
- *guidance for shallow hazards survey and reporting;*
- *regulations for activities in or near NMSs;*
- *guidance for military coordination;*
- *guidance for ancillary activities (Oil and Gas Program only);*
- *implementation of the Seismic Airgun Survey Protocol: PSO and PAM Programs (refer to **Table 2.2-1 and 2.2-2** for PSO and PAM details that apply to each alternative) as outlined in NTL 2016-BOEM-G02:*
  - – *implementation of expanded PSO Program (manatees and depth): expanded to include manatees as well as whales (excluding marine mammal species in the Family Delphinidae, which includes killer whales, pilot whales, and all of the dolphin species) and would apply to all authorizations for deep-penetration seismic airgun surveys in the AOI regardless of water depth*;
  - – *implementation of expanded PAM requirement (low visibilty): the required use of PAM during periods of reduced visibility for all deep-penetration seismic airgun surveys in water depths >100 m (328 ft)*; and
  - – *implementation of expanded PAM requirement (canyons): the required use of PAM for all deep-penetration seismic airgun surveys at all times in the Mississippi Canyon and De Soto Canyon lease blocks (**Figure 2.2-1**)*;
- *implementation of the Non-Airgun HRG Survey Protocol*;
- *coastal waters' seasonal restrictions from February 1 to May 31, modified from Alternative B (**Figure 2.3-1**)*;
- no new seismic airgun and non-airgun HRG surveys in the CPA, EPA, Dry Tortugas, and Flower Garden Banks closure areas (**Figure 2.8-1**); and

- airgun surveys conducted outside of the closure areas would be required to remain at a distance such that received sound levels at the closed-area boundaries would not exceed the threshold for Level B harassment – currently 160 dB re 1 μPa – as determined by field verification of sound levels or sound field modeling.

2.8.3 Rationale

The purpose of the mitigation measures included in Alternative F is to further minimize the potential for injury to marine mammals and sea turtles, to avoid most opportunities for Level A harassment of marine mammals, and to protect specific target species of marine mammals. Selection of the closure areas (**Figure 2.8-1**) was based on densities of target species relative to other areas of the AOI as well as biological importance to certain species, including the endangered sperm whale, Bryde's whale (*Balaenoptera edeni*) (LaBrecque et al., 2015), beaked whales (i.e., Blainville's beaked whale [*Mesoplodon densirostris*], Gervais' beaked whale [*Mesoplodon europaeus*], and Cuvier's beaked whale [*Ziphius cavirostris*]), and additional marine resources found within the closure areas.

The CPA Closure Area targets sperm whales and beaked whales for protection. The CPA Closure Area has been expanded from the Amended Settlement Agreement Area of Concern 1 (**Figure 2.2-1**) based on sighting data. The CPA Closure Area supports relatively high densities of sperm whales and beaked whales. Based on satellite tracking studies conducted by Jochens et al. (2008), the home range of tagged sperm whales within the northern GOM is broad, comprising nearly the entire GOM in waters deeper than 500 m (1,640 ft). Home range is defined as an area over which an animal or group of animals regularly travels in search of food or mates that may overlap with those of neighboring animals or groups of the same species. By contrast, the composite core area (defined as a section of the home range that is utilized more thoroughly and frequently as primary locales for activities such as feeding) of GOM sperm whales generally includes the Mississippi Canyon, Mississippi River Delta, and, to a lesser extent, the Rio Grande Slope (Jochens et al., 2008). These data support the fact that sperm whales aggregate in the Mississippi Canyon area, including the proposed CPA Closure Area, but regularly move across the northern GOM continental slope. Movements or seasonal migrations of beaked whales are not known, though it is likely that their distributional patterns depend on the movement of mesoscale hydrographic features (USDOC, NMFS, 2016b).

The EPA Closure Area was designed to protect cetaceans, primarily targeting the Bryde's whale given the small population size and apparent preference for this area. Bryde's whales that inhabit the northern GOM may represent a resident stock and, based on sightings data from surveys that uniformly sampled the entire oceanic northern GOM, mostly occur in a very restricted area of the northeastern GOM between the 100- and 400-m (328- and 1,312-ft) isobaths. The EPA Closure Area was refined from the Area of Concern 2 from the Amended Settlement Agreement (**Figure 2.2-1**) to partially correspond with the year-round Biologically Important Area for this population in the GOM (LaBrecque et al., 2015) but was expanded to the 400-m (1,312-ft) contour north of 27.5º N. latitude to incorporate additional Bryde's whale sightings.

The Dry Tortugas Closure Area targets sperm and beaked whales and has been expanded from the Amended Settlement Agreement Area of Concern 4 (**Figure 2.2-1**) based on sighting data. This closure area includes waters bounded by the 200- and 2,000-m (656- and 6,562-ft) isobaths (or U.S. Exclusive Economic Zone [EEZ]) from the northern border of BOEM's Howell Hook leasing area to 81.5° W. longitude. Acoustic data suggest that beaked whale densities are high in this area. In addition, it is possible that sperm whales may use this area for calving based on the number of calves that have been sighted (Hildebrand et al., 2012).

The Flower Gardens Closure Area was designed to protect the marine resources found within the Flower Garden Banks National Marine Sanctuary (FGBNMS), such as various species of stony corals, sponges, anemones, jellies, bony fishes, rays, sharks, sea turtles, birds, and marine mammals. The FGBNMS is one of 14 federally designated underwater areas in the U.S. protected by NOAA's Office of National Marine Sanctuaries, and it is currently the only NMS located in the GOM.

2.9 ALTERNATIVE G – NO NEW ACTIVITY ALTERNATIVE

2.9.1 Description

Under BOEM's Alternative G (no new activity [i.e., no action] alternative), BOEM would cease issuing permits for new G&G surveys and would not approve G&G surveys proposed under exploration or development plans. Therefore, no routine or accidental activities would occur as part of the proposed action. Any G&G activities previously authorized under an existing permit or lease would proceed but would not be renewed or reauthorized and, thus, would eventually be phased out. These previously permitted activities are considered under the cumulative analysis. **Chapter 3.2 and Appendix F** provide descriptions of the different types of G&G surveys. **Table 2.9-1** provides the projected level of activity these surveys would represent. All previously authorized surveys would be completed with the implementation of standard mitigation measures applied through lease stipulations, COAs, NTLs, or best management practices applied to all authorizations. A cessation of G&G activities would result in the loss of an important tool for exploration to identify the location and size of oil and gas prospects, particularly in deepwater where exploration wells are expensive. Therefore, there is the potential that, without G&G surveys, there could be an increase in exploratory drilling activity. The absence of G&G activities would result in increased costs and environmental risk to industry and could potentially lead to a dramatic reduction in oil and gas activity in the GOM.

Alternative G stipulates that no new on-lease G&G activities related to renewable energy development could be conducted, which would limit the development of renewable energy sources. Under this alternative, no new G&G activities related to marine minerals would be authorized by BOEM for survey activities located in Federal waters that require BOEM authorization. However, surveys for marine minerals in Federal waters that would not require BOEM authorizations, such as those conducted by Federal agencies or their contractors to identify sand, gravel, or shell resources, or those in State waters, could still go forward. The G&G activities that are not regulated by BOEM would still take place in the GOM (e.g., non-airgun HRG surveys for archaeological and benthic resources and off-lease G&G activities for renewable energy). Survey activity for scientific research that is not regulated by BOEM (such as those conducted by USGS, National Science Foundation [NSF], NOAA, and academia), and surveys occurring in State waters, could continue as well. Overall, cessation of G&G activities would also result in the loss of an important tool for identifying areas for the development of renewable energy projects and exploration for non-energy marine minerals such as sand and gravel (or other sediment) for beach nourishment, coastal restoration, and public works projects.

BOEM’s Alternative G would not meet the purpose and need of the proposed action nor would it implement the natural resource development provisions of the OCSLA. These surveys provide information on the location, extent, and fair market value of resources, and the orderly development of hydrocarbon reserves, including safety considerations.

Alternative G has safety and development implications for oil and gas, renewable energy, and marine mineral activities. While G&G activities would continue for existing authorized permits or approvals, no new activities would be permitted or authorized. Oil and gas leasing and future operations require G&G activities in order to evaluate potential reservoirs and to conduct operations in a safe and secure manner. For example, placement of a permanent platform requires a shallow hazards survey and geological sampling (coring) to ensure that the proposed location is free of potential hazards and to determine the geotechnical properties of the substrate to assess stability for placement and anchoring. Under the No Activity Alternative, these activities could not take place for future leases, infrastructure and other related activities may not be as safely constructed or implemented, and development could be suspended.

The No Action Alternative for NMFS is slightly different. For NMFS, denial of MMPA authorizations (either as LOAs issued under ITRs or as Incidental Harassment Authorizations [IHAs]) constitutes NMFS’ No Action Alternative, which is consistent with NMFS’ statutory obligation under the MMPA to grant or deny applications to authorize incidental take and to prescribe mitigation, monitoring, and reporting with any authorizations. This NMFS No Action Alternative presents two potential outcomes. One is that G&G activities will occur in the absence of an MMPA authorization. In this case, (1) the entity conducting the activity would be in violation of the MMPA if takes occur; (2) mitigation, monitoring, and reporting would not be prescribed by NMFS; and (3) mitigation might not be performed voluntarily by the operators. If the G&G activity were conducted under a lease or permit issued by BOEM, the activity would have to conform to mitigation and monitoring measures as specified in applicable lease and lease stipulations, COAs on permit and plans, and best management practices. These measures would not obviate the MMPA requirement that any incidental take be authorized by NMFS or FWS for species under FWS jurisdiction) and that any unauthorized take would be a violation of the MMPA. However, this scenario assumes that some operators will move forward with survey activity, assuming the risk and consequences of potential unauthorized take, and in this case, the impacts to the environment would be the same as those analyzed in Alternatives A through F of this Programmatic EIS.

The second potential outcome of NMFS' No Action Alternative assumes that BOEM would not issue any new permits or approvals for G&G activities and that these activities would cease or be phased out with completion of activity under existing authorizations. This Programmatic EIS assumes for this analysis that, as would be the case under this second outcome, no new activities would occur under NMFS' No Action Alternative. The discussion of this outcome scenario is consistent with the analysis of BOEM's No New Activity Alternative.

2.9.2 Mitigation Measures

Under Alternative G, G&G surveys previously authorized under an existing permit or lease would be required to comply, at minimum, with all the mitigation measures included in Alternative A (**Chapter 2.3** and in italics below). These mitigation measures are presented in **Tables 2.2-1 and 2.2-2**; detailed in **Appendix B, Section 1**; and listed here:

- *guidance for vessel strike avoidance;*
- *guidance for marine debris awareness;*
- *avoidance of sensitive benthic resources;*
- *guidance for avoidance of historic and prehistoric sites;*
- *guidance for shallow hazards survey and reporting;*
- *regulations for activities in or near NMSs;*
- *guidance for military coordination;*
- *guidance for ancillary activities (Oil and Gas Program only); and*
- *implementation of the Seismic Airgun Survey Protocol: The PSO and PAM Programs (refer to* ***Tables 2.2-1 and 2.2-2*** *for PSO and PAM details that apply to each alternative) as outlined in NTL 2016-BOEM-G02).*

2.9.3 Rationale

The regulation at 40 CFR § 1502.14(d) requires the alternatives analysis in an EIS to "include the alternative of no action." Alternative G fulfills this requirement and evaluates the potential impacts from BOEM ceasing to issue permits or authorizations for all G&G surveys that may require a BOEM permit. Previously authorized activities and those not requiring approval from BOEM would continue, but industry would still be subject to the risks and consequences of engaging in activities that result in the incidental take of marine mammals without an authorization from NMFS.

2.10 ISSUES

Issues are defined by the CEQ to represent the principal "effects" that an EIS should evaluate in depth. Scoping identifies specific environmental resources and activities, rather than "causes," as significant issues for development in the EIS. The analysis in the EIS can show the degree of change from present conditions for each issue due to the relevant actions related to the proposed action. Selection of environmental and socioeconomic issues to be analyzed in this Programmatic EIS was based on the following criteria:

- the issue is identified in CEQ regulations as subject to evaluation;
- the relevant resource or activity was identified through agency expertise, through the scoping process, or from G&G-related comments received on past EISs; or
- the resource or activity may be linked to one or more of the impact-producing factors (IPFs) associated with the OCS Program, and a reasonable probability of an interaction between the resource or activity and IPF should exist.

The public scoping process for this Programmatic EIS is described in **Chapter 6**. Public scoping meetings were held in seven cities (Tampa and Fort Walton Beach, Florida; Mobile, Alabama; Gulfport, Mississippi; Galveston, Texas; New Orleans, Louisiana; and Silver Spring, Maryland). In addition to accepting oral and written comments at each public meeting, BOEM accepted written comments by mail and through a dedicated email address. BOEM received a total of 66 comments through email (65%), formal letters (13%), and public meeting testimony (32%). Each comment was read and categorized according to its source and the nature of the information provided in the comment. The scope and content of this Programmatic EIS have been structured to ensure that the issues and concerns expressed by stakeholders during the scoping process are fully addressed (USDOI, BOEM, 2013b).

2.10.1 Issues to be Analyzed

This Programmatic EIS addresses issues associated with various G&G activities, including potential IPFs and related impacts on environmental and socioeconomic resources and activities characteristic of the AOI. In addition, this Programmatic EIS addresses the potential environmental and socioeconomic effects of accidents on AOI resources and considers cumulative impacts (i.e., the incremental impacts on AOI resources associated with the project alternatives).

The following issues were identified for detailed analysis:

- impacts of underwater noise on marine mammals, sea turtles, fishes, marine and coastal birds, benthic communities, Marine Protected Areas (MPAs), commercial and recreational fishing (fish catch), and other marine life;
- impacts of vessel traffic (risk of ship strikes) on marine mammals, sea turtles, marine and coastal birds, and *Sargassum* communities;
- impacts of vessel traffic on fishing, shipping, and other marine uses;
- impacts of aircraft traffic and noise on marine mammals, sea turtles, marine and coastal birds, and other marine uses;

- impacts of entanglement from marine equipment on marine mammals, sea turtles, fishes, other marine life, archaeological sites above the seafloor, and benthic communities;
- impacts of stand-off distances (the area that operators attempt to keep around the source vessel and its towed-streamer arrays clear of other vessel traffic that will result in a space-use conflict with other vessels) on commercial and recreational fishing, shipping, recreational resources, and other marine uses;
- impacts of vessel discharges on *Sargassum* communities;
- impacts of trash and debris on benthic communities, marine mammals, sea turtles, marine and coastal birds, endangered or threatened fish species, *Sargassum* communities, and recreational resources;
- impacts of seafloor-disturbing activities on sensitive benthic communities, including coral and hard/live bottom communities, and chemosynthetic communities;
- impacts of seafloor-disturbing activities on Essential Fish Habitat (EFH), Habitat Areas of Particular Concern (HAPCs), and MPAs;
- impacts of seafloor-disturbing activities on archaeological resources, including historic shipwrecks and prehistoric archaeological sites;
- impacts of drilling discharges on EFH, benthic communities, and archaeological resources; and
- impacts of accidental spills on benthic communities, marine mammals, sea turtles, marine and coastal birds, fishes and EFH, benthic communities, *Sargassum* communities, archaeological resources, recreational resources, MPAs, and other marine uses.

2.10.2 Issues Considered but Not Analyzed

As part of the scoping process, CEQ regulations require agencies to identify and eliminate from detailed study the issues that are not significant to the proposed action, have been covered by prior environmental review, or do not fulfill the purpose and need of the proposed action. **Chapter 4.1.1** describes the screening process for impact analysis and identifies issues that were considered but not analyzed in detail. Examples include impacts of underwater noise on plankton, impacts of seafloor-disturbing activities on geology and sediment quality, impacts of vessel discharges on water quality, and impacts of vessel and aircraft emissions on air quality. As part of the screening process, several resource areas were identified as having no potential impacts from G&G activities. Detailed rationale is included in **Chapter 4.1.1**. The resources eliminated from detailed analysis include the following:

- **Recreational Resources and Tourism.** Because BOEM-regulated G&G activities would occur at least 3 or 9 nmi (3.5 or 10.4 mi; 5.6 or 16.7 km) (depending on the state) away from the coast in Federal waters, any impacts that may occur were determined to be minimal and would not be discernible among any of the alternatives. The G&G activities that would occur in State waters are expected to be minimal and would be authorized by others, such as the USACE, with protective measures in place.

- **Air Quality.** Because there will be a limited extent and duration of most G&G activities, the amount of air pollutants generated would be small, and emissions will be distributed over a broad area of the OCS due to the generally non-stationary nature of G&G activities; therefore, most G&G activities likely would not result in any elevated pollutant concentrations exceeding air quality standards.

- **Water Quality.** Because all vessels in U.S. and international waters are required to adhere to International Maritime Organization regulations under the International Convention for the Prevention of Pollution from Ships (MARPOL) limiting discharges (e.g., treatment of sanitary wastes and maceration of food wastes), avoiding releases of oily water, and prohibiting disposal of solid wastes, expected effects to water quality would be minimal.

- **Geography and Geology.** Due to the nature of the G&G activities, expected effects to sediments are minimal.

- **Physical Oceanography.** Due to ocean current characteristics, water-column density stratification, and vertical current structure, among other factors, which would be considered during planning, operation, and data post-processing of G&G surveys or sampling efforts, no physical oceanographic resources would be affected by the G&G activities.

- **Coastal Barrier Islands, Beaches, Seagrass, and Wetlands.** Because BOEM-regulated G&G activities would occur at least 3 or 9 nmi (3.5 or 10.4 mi; 5.6 or 16.7 km) (depending on the state), few, if any, negative impacts would occur to these resources. Activities that would occur in State waters are expected to be minimal and would be authorized by others with protective measures in place for protection of these resources.

2.11 Alternatives Considered but Not Carried Forward

The following alternatives were identified during the scoping process. For the reasons identified below, they are not considered for detailed analysis in this Programmatic EIS.

2.11.1 Shutdown for All Marine Mammals Within the Level A Harassment Exclusion Zone

Under this alternative, G&G activities would shut down for all marine mammals within the Level A isopleths for potential harassment. This alternative would provide protection from potential exposure to Level A harassment sound levels for all marine mammals identified within the Level A harassment exclusion zone, including bow-riding dolphins or animals that actively approach G&G vessels.

Based on PSO sighting data from 2002 to 2008 (Barkaszi et al., 2012), dolphin sightings occurred within the exclusion zone during active airgun operation and would have resulted in an operational shutdown under this alternative (assuming a 500-m [164-ft] Level A Harassment exclusion zone. These data suggest that this alternative could potentially result in an additional operational down time across the fleet.

Observations recorded by PSOs of bow-riding dolphins within 500 m (164-ft) of an active source do not show observable impacts as they still actively approach vessels and continue to bow-ride while vessels are conducting surveys. The 2002-2008 sighting data (Barkaszi et al., 2012) show differences in the occurrence of bow-riding behavior when comparing sighting records during active and inactive sources; however, the data also show that the closest point of approach for dolphins overall is greater when guns are active verses when guns are silent. This may demonstrate some level of avoidance during active source operations. It is important to note that the bow-riding behavior data referenced above took into account all dolphin sightings and not just sightings within the 500-m (164-ft) exclusion zone. Therefore, less bow-riding behavior is expected during active sources if the approach distances are generally greater in the first place. Overall, there were a greater number of dolphin records within the exclusion zone during active sources than when sources were silent, which is likely a reflection of the percentage of time sources were operating. The available data are not clear in depicting behavioral changes due to source operations, particularly not specifically related to bow-riding behavior.

Therefore, to require shutdown for all bow-riding animals that actively approach the survey vessel is unwarranted and would be overly burdensome to industry, potentially prolonging survey duration and overall cost. BOEM does not consider this alternative reasonable and, thus, will not carry it forward for additional analysis.

2.11.2 Require Alternative Technology Use

Under this alternative, BOEM would not authorize the use of standard, large airguns (≥8,000 in^3) as sound sources for seismic surveys. Industry would have to rely on other measures to obtain accurate data on the location and extent of hydrocarbon resources, including alternative acoustic source technologies that may produce less underwater noise and reduce the potential for impacts on marine life.

Alternative technologies are discussed further in **Appendix F, Section 3** and include the following:

- marine vibroseis (vibrators);
- low-frequency acoustic source (LACS) (patented);
- deep-towed acoustics/geophysical system (DTAGS);
- low-frequency passive seismic (LFPS) methods;
- low-impact seismic array (LISA);
- fiber optic receivers allowing smaller airguns (≤90 in^3); and
- airgun modifications to lessen impacts.

The preceding list is based in part on the Okeanos Seismic Airgun Alternatives Workshop (Weilgart, 2010) and BOEM's Quieting Technologies for Reducing Noise during Seismic Surveying and Pile Driving Workshop (CSA Ocean Sciences Inc., 2014). In 2009, an international multi-disciplinary group of geophysical scientists, seismologists, biologists, and regulators met in Monterey, California, to discuss potential alternatives and modifications to airguns and airgun array configurations in order to minimize the potential impacts from airguns (Weilgart, 2010). The Okeanos Seismic Airgun Alternatives Workshop panelists discussed promising new imaging technologies that are either completely silent or that can lessen the amount of seismic sound required to gather seismic data, thereby still allowing for a reduction of the economic risk of hydrocarbon recovery. The Workshop panelists acknowledged that these technologies are purpose driven and do not work in all circumstances; additionally, most of the technologies are not yet advanced enough to be used commercially. Ultimately, BOEM has determined that alternative technologies are in various stages of development and that none of the systems with the potential to replace airguns as a seismic source are currently financially viable for use on a scale of activity considered in the proposed action scenario (described in **Chapter 3**) without imposing a significant financial burden on industry. The use of alternative technology has been further complicated by the continued development of new and improved acquisition techniques in seismic exploration, including coil surveys, airgun hardware developments, fiber-optic receiver systems, and improved computational capabilities. Essentially, not only are these alternative technologies working to achieve acquisition results that existed 6 years ago, but they also need to compete against the improvements in traditional airgun techniques that have arisen since then.

Marine vibroseis appears to be a promising alternative technology, with several different systems being developed and tested. BOEM is aware that the oil and gas industry has formed a Joint Industry Program (JIP) on Marine Vibroseis whose goal is to develop prototypes and test potential technologies. Another industry-sponsored subset of members from the American Petroleum Institute (API) has been working on three distinct vibroseis prototypes as a condition of the Settlement to litigation filed by NRDC et al. vs. DOI with API et al., as Intervenor-Defendants (refer to **Appendix C**). BOEM acknowledges that these research and development efforts will be necessary to provide new information about the potential viability of marine vibroseis and other technologies for commercial applications as BOEM examines potential environmental impacts of these technologies when compared to existing technologies. Marine vibroseis data theoretically should be comparable to airgun data; however, there are some challenges, especially in deep water. For example, a vibroseis system is designed to produce the most useful portion of the frequency spectrum in a controlled way. This is currently produced by an airgun in a pulsed manner in approximately 10 milliseconds (ms). A vibroseis system is distributing this acoustic energy as a swept (non-pulsed) signal lasting approximately 10 to 15 seconds. At some point in the signal processing of the echoes received by the system, the energy needs to be re-combined so that the geological structure that produced the echoes can be clearly resolved or seen. This requires not only expanded computational power, but also the appropriate configurations of the entire receiver system (hydrophones, streamer configuration, and support systems). Additionally, there are several technical issues with the vibroseis system, ranging from mechanical (e.g., the number of sources in an array, tow-body design and stability, and the number sources required for redundancy and reliability) to electronic (e.g., power supply and cabling issues, and selection of the signals to be sent) to operational (e.g., the best operating depth for the system physically or acoustically and tow speed selection). Even after a vibroseis source system has been fully developed to achieve the desired specifications, the details of how the source integrates into an operationally reliable and useful seismic survey system will require a great deal of effort. Additional discussions of these alternative technologies are included in **Appendix F, Section 3**. Incentives for the use of alternative technologies are presented in **Chapter 1.2.3.5**.

Alternative technologies are in various stages of development; none of the systems with the potential to replace airguns as a seismic source are commercially available for use yet on a scale of activity considered in the proposed action scenario described in **Chapter 3**. Although some alternative technologies are available now or will be in the next several years, none are at a stage where they are anticipated to replace airgun arrays outright; however, some may be able to be used in select environments when commercially available. This alternative would not provide the oil and gas industry or the government with sufficiently accurate data on the location, extent, and properties of hydrocarbon resources nor would it provide the oil and gas industry or the government the character of formation fluids or gases or information on shallow geologic hazards and seafloor geotechnical properties needed in order to explore, develop, produce, and transport hydrocarbons safely and economically. As this alternative does not meet the stated purpose and need, and cannot be analyzed on a programmatic scale at this stage, it has not been carried forward for detailed environmental impact analysis in this Programmatic EIS. Should these technologies become commercially available, BOEM can evaluate them in the future as a stand-alone, site-specific request or in a supplemental programmatic document.

2.11.3 Requirement to Obtain an LOA or IHA Prior to Receiving BOEM's Approval

As noted in the discussion of alternatives, this Programmatic EIS supports two potential agency actions: BOEM's geological and geophysical survey program in the GOM and NMFS' issuance of MMPA authorizations for those G&G activities. It is expected that industry applicants seeking to conduct G&G activities in the GOM would seek both BOEM and NMFS approval. BOEM's authorization would result, directly or indirectly, from lease or permit issuance. The NMFS' authorization would result from an MMPA authorization in the form of an LOA if NMFS issues ITRs or as an IHA if ITRs are not issued or activities are not covered by the ITRs. While industry is not required under the MMPA to obtain an authorization before proceeding, industry is required to seek a BOEM permit or authorization, and an entity conducting G&G activities would be in violation of the MMPA if takes occur without an MMPA authorization. Impacts from G&G activities not authorized by BOEM are not a reasonable scenario to evaluate in this Programmatic EIS as BOEM would enforce compliance with its regulations to prevent activities under its jurisdiction and not permitted to be conducted. The potential impacts of BOEM-approved G&G activities in the GOM, whether or not they are conducted under an NMFS authorization, have been considered in detail in the alternatives discussed in this Programmatic EIS. The issuance of an MMPA authorization prior to receiving a BOEM geological and geophysical permit or authorization does not alter the proposed activities or their impacts as analyzed in the action alternatives, but the mitigations imposed by those authorizations could be altered. The action alternatives analyzed in this Programmatic EIS include the breadth of G&G activities expected to be proposed in the GOM as well as feasible mitigations that are likely to be considered and applied through BOEM approvals and/or MMPA authorizations. Should NMFS determine that additional or different mitigations are warranted when issuing an LOA or IHA, that decision would be subject to additional NEPA review, as appropriate. Any mitigation that NMFS or BOEM applies in the future is expected to reduce or avoid impacts analyzed in this Programmatic EIS. For these reasons, BOEM and NMFS have determined that this alternative (Requirement to Obtain an LOA or IHA Prior to Receiving BOEM Approval) need not be analyzed as a separate alternative in this Programmatic EIS. The potential impacts from G&G activities and mitigations likely to be included in any BOEM approval or NMFS authorization have been analyzed in the action alternatives carried forward for full analysis in this Programmatic EIS.

2.12 Mitigation Measures Considered but Not Carried Forward

The following additional mitigation measures were identified during the scoping process. For the reasons identified under each, they were not carried forward in this Programmatic EIS. However, as discussed previously, in addition to the NTLs and guidance applicable to specific Program Areas, all G&G surveys will follow requirements consistent with the monitoring identified in the ITRs. The monitoring requirements will be adaptive such that they can be modified based on new information, new technologies, monitoring results, and specific program needs throughout the timeframe of this Programmatic EIS. Therefore, as these technologies and mitigation measures advance, they could be included at a later date after evaluation by BOEM prior to imposing as lease stipulations for ancillary activities or COAs on a plan or a G&G permit or authorization.

2.12.1 Active Acoustic Monitoring

Active acoustic monitoring mitigation uses high-frequency sound (e.g., fisheries sonar) to survey a zone of the water column for marine species. The active systems create acoustic "images" for which species' shapes and unique signatures can be determined. Scanning sonar equipment would be mounted on the vessel and would acoustically survey an area while the scan images are monitored by a shipboard observer. This technology has been used with good correlation between shipboard observer sightings and sonar detections for mysticetes (Geoffroy et al., 2012; Pyc et al., 2015). Active acoustics can be used in day or nighttime conditions.

Outside of experimental testing, this methodology has not been employed by seismic surveys as part of a mitigation plan and there are no standardized protocols for operations. Based on Geoffroy et al. (2012), active acoustic surveys may require additional active acoustic observers working in rotation alongside visual and passive acoustic observers for 24-hour operations. The provision of reliable sonar for mitigation on board seismic vessels would require vessel, likely hull, modifications for equipment installation that may not be applicable from one survey to another.

Like traditional visual surveys, the sonar detection limits and reliability will be affected by weather and water conditions, size of the target, and location and activity of the target; therefore, active acoustic monitoring surveys may not offer distinct advantages under poor visibility conditions. There may be additional potential impacts or unintended consequences to consider with the introduction of another sound source into the water even though the frequency may be outside the functional hearing ranges of many marine mammals. Active acoustics may play a role in some offshore operations (e.g., decommissioning) to search for specific targets. Further assessment of the technology, operating parameters, and associated costs is required before this method could be fully considered as a mitigation measure for the GOM.

2.12.2 Aerial Surveys

Traditional aerial surveys comprise one or more trained observers flying in an aircraft and surveying for marine species in order to supplement visual monitoring conducted from a vessel. Unmanned aerial surveys utilize a remote platform (e.g., drone or kite) with mounted camera equipment and an operator to conduct a smaller scale survey with the images relayed to vessel observers. Aerial surveys offer an advantage to surveying for marine mammals and sea turtles due to an improved coverage area and the ability to spot animals from altitude.

Manned aerial surveys are used for mitigation in operations that present a high probability of lethal impacts to marine mammals or sea turtles within a small area and short timeframe, such as during underwater blasting. However, they do not lend themselves to real-time mitigation for long-term projects such as seismic surveys due to the logistics of offshore flights, weather restrictions, and the functionality of the aerial observer’s field of view compared to the size of the mitigation zone. In addition, manned aerial surveys present a significant risk to personnel and have substantial limitations for offshore waters due to the long transit times.

Unmanned aerial surveys may be useful in real-time monitoring as part of the overall visual monitoring regime. Members of the offshore oil and gas industry, NMFS, BOEM, the U.S. Navy, and others have been investigating the use of unmanned aerial surveys for several reasons, including (1) unmanned surveys address safety concerns of putting human pilots and observers in potentially dangerous offshore areas; (2) unmanned aircraft generally can fly up to 20 hours, which is longer than manned surveys; (3) unmanned surveys can provide video data, even with high-definition video cameras, which can be carefully reviewed post-flight rather than relying on visual observations during the flight; (4) unmanned surveys may provide for more frequent survey effort because securing personnel for flights is not necessary; and (5) aircraft can be launched from and returned to seismic ships. Although the application of unmanned aerial surveys is highly promising, the technology and permitting environment for such systems is not yet fully developed and cannot be assessed as a standard mitigation measure at this time.

As stated earlier, if the technology is further developed and tested, and if permitting issues are streamlined during the 10-year timeframe of this Programmatic EIS, unmanned aerial surveys could be implemented as a mitigation measure for future actions after further evaluation by BOEM prior to imposing as lease stipulations for ancillary activities or COAs on a plan or a G&G permit or authorization.

2.13 COMPARISON OF IMPACTS BY ALTERNATIVE

Alternatives A through G are carried through the detailed environmental impact analysis in **Chapter 4**. **Table 2.13-1** compares the seven alternatives with respect to the impact-level ratings from **Chapter 4**. **Table 2.13-2** provides specific detail on the additional protection afforded to marine mammal species groups from mitigation measures under each of the seven alternatives.

To help frame the comparison of the impact levels included in **Table 2.13-1**, the following describes the process used for the development of impact-level criteria. Broad impact-level criteria were developed for each of the biological and socioeconomic resources present on the Gulf of Mexico OCS based on the results of resource screening and in consideration of recent environmental impact analyses and their respective impact descriptions (**Chapter 4.1.2**). Impact-level criteria 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). The impact-level descriptions developed for this analysis are based on impact-level thresholds employed and impacts determined in earlier EISs (USDOI, BOEM, 2015b). For biological and socioeconomic resources, the impact-level criteria have been broadly defined as follows:

- **Nominal:** Little or no measurable/detectable impact.
- **Minor:** Impacts are detectable, short term, extensive or localized, but less than severe.
- **Moderate:** Impacts are 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.
- **Major:** Impacts are detectable, long term, extensive, and severe.

These broad impact-level categories were tailored as needed to evaluate impacts of relevant IPFs on each resource. The refined impact-level criteria are included in **Chapter 4** for each resource evaluated. Each impact parameter was evaluated on a resource-specific basis to determine the appropriate impact level for each IPF. For biological resources, attributes such as distribution/range, life history, and susceptibility to impact of individuals and populations were considered, among other factors.

The evaluation process to determine impact level considered potential impacts by context (e.g., short versus long term) and intensity (e.g., severity), following NEPA regulations (40 CFR § 1508.27). Context was defined as the extent of the effect (i.e., geographic extent or extent within a species, ecosystem, or region) and any special circumstances (e.g., endangered species or legal status), while intensity of an impact was defined as its magnitude. Moreover, the potential effect was evaluated in terms of duration or frequency (short term, long term, or intermittent). The evaluation process also consisted of evaluating the likelihood (likely or not likely) of an effect to occur (i.e., whether it was plausible or just speculative). During the preparation of the impacts analysis, each application of an impact level was accompanied by a statement explaining how the judgment was reached. Data or information from peer-reviewed journals or other sources used to support each determination are cited, as applicable. Otherwise, the determinations are based on the best available information.

The impact levels are based on numbers of individuals, groups, and local population-level effects to all species within a resource category throughout the entire AOI. The levels also consider specific species, species groups, or stocks and their spatiotemporal distribution, as applicable, to discuss specific protection afforded. The analysis assessed individual species with special circumstances or species group in a given resource category relative to the protection afforded by the mitigation measures included in each alternative, but the impact level is determined for the resource category as a whole.

Table 2.13-1 provides a summary of the impacts as determined in **Chapter 4** for all resources and IPFs across Alternatives A through G. The impact levels for some resources and IPFs include a range. This occurs when an IPF may have acute, short-term, or spatiotemporal impacts that can result in an increase in impacts depending on a specific parameter but overall the IPF warrants a lesser rating under routine activities across all species in a resource category throughout the AOI.

The seasonal restriction in coastal waters for operation of airguns from January 1 to April 30 in Alternative B and from February 1 to May 31 in Alternatives C through F was designed to protect the coastal and estuarine stocks of the common bottlenose dolphin during their peak reproductive activity by reducing active acoustic sound sources from airguns; however, when applying the impact-level criteria for marine mammals (**Chapter 4.2.2.1**), which evaluates population-level impacts for all marine mammals that may occur in the AOI, that protection does not result in an overall reduction of impacts across the alternatives. Although this measure would provide protection to marine mammals that may occur within the restriction area during the seasonal restriction period, it would not benefit individual marine mammals outside of these areas or during other times of year.

The seasonal restriction in coastal waters also would provide protection for loggerhead turtles during a portion of their mating and nesting/inter-nesting season, but when applying the impact-level criteria for sea turtles (**Chapter 4.3.2**), which evaluates population-level impacts for all sea turtles in the entire AOI, this mitigation measure does not result in an overall reduction of the impact level. Other resources, including endangered and coastal fish species, coastal birds, coastal MPAs, *Sargassum*, commercial and recreational fisheries, archaeological resources, and other marine uses would receive the associated protection in that area during the restriction period, but not to an extent that would reduce the overall impact level annually or across the full analysis period.

In accordance with NTL 2016-BOEM-G02, shutdown of airguns was only required for whales (Bryde's whales, beaked whales, sperm whales, or dwarf and pygmy sperm whales). Under Alternatives B through F, the expansion of the PSO Program adds shutdown requirements for manatees, applies to all deep-penetration seismic airgun surveys in the GOM regardless of water depth, provides specific protection to marine mammals although all mitigations are not applied uniformly to all marine mammals, and may afford some protection to sea turtles; however, when applying the impact-level criteria for sea turtles (**Chapter 4.3.2**), which evaluates the impacts at the individual, group and local population levels in the entire AOI, it does not result in an overall change of the impact level. This mitigation does not apply to other resources; therefore, no changes in impact levels are realized. Similarly, the expanded use of PAM applies specifically to marine mammals, and PSOs can monitor for marine mammals, affording some additional protection. However, when applying the impact-level criteria for these resources, this mitigation measure would not reduce the impacts for all marine mammals present in the AOI to the extent that the impact level for either resource would change.

Alternative E specifies a reduction of 10 or 25 percent in deep-seismic, multi-client activities (**Tables 2.7-1 and 2.7-2**), incrementally reducing the extent of seismic survey-related sound sources (i.e., airguns), vessel and equipment noise, vessel traffic, aircraft traffic and noise, and trash and debris within the AOI, and thus, incrementally decreasing impacts from these IPFs to all resources. However, when applying the resource-specific impact-level criteria, the reduction of overall seismic airgun activity under the two sub-alternatives included in Alternative E is not enough to reduce the overall impact determinations from Alternative A.

Four area closures are introduced in Alternative F: the CPA Closure Area, the EPA Closure Area, the Dry Tortugas Closure Area, and the Flower Gardens Closure Area. The selection of these closure areas was based on expert opinion (within NOAA and BOEM) of the relative densities and biological importance of target cetacean species within the AOI, such as the endangered sperm whale, Bryde's whale, and beaked whales (i.e., Blainville's beaked whale, Gervais' beaked whale, and Cuvier's beaked whale), as well as reef and pelagic fishes associated with the FGBNMS. Closure of these areas from airgun surveys would provide refuge to these species (as well as the suite of other deepwater cetacean species in these areas of the GOM) during the 10-year period of this Programmatic EIS. Although non-resident species may be transient in the closure areas, the closure of areas from airgun surveys can provide protection to transient species involved in biologically important activities (e.g., feeding, socialization, and mating) while they are in residence in closure areas. However, except for the Bryde's whale whose distribution largely appears to be limited to the EPA Closure Area, other species regularly move beyond the boundaries of the closure areas. Therefore, the protection afforded to most species by these closure areas would be limited because their presence outside of the closure areas would expose them to potential impacts from seismic airgun survey activities at a concentrated level because, for purposes of this analysis, the same level of activity is anticipated to occur within the reduced survey area (i.e., the AOI minus the closure areas). In addition, other non-airgun G&G activities would still occur throughout the AOI, including in the closure areas although they would be limited. Therefore, the mitigation provided by the closure areas would reduce but not prevent impacts to the resources in the AOI. Overall, the selection of Alternative F with its associated area closures to seismic surveys during biologically important periods would result in a reduced level of exposure to the active acoustic source IPF, particularly for specific regions of the AOI, thus resulting in an overall incrementally reduced impact to the marine mammals within these areas of the AOI from deep-penetration seismic sound sources. Compared with the impact level of Alternative A (**nominal** to **moderate**), the impact level of Alternative F may be incrementally reduced to **nominal** to **minor**.

Alternative G includes no new G&G activities that require permits or authorizations from BOEM. Therefore, no routine or accidental activities would occur as part of the proposed action. However, previously authorized activities would still occur under existing agreements, permits, or authorizations and are evaluated as part of the cumulative analysis. This would include a very limited number of localized survey activities to support ongoing oil and gas exploration and development on existing leases. Alternative G does not meet BOEM's mandates outlined in the OCSLA because orderly development of oil and gas would not occur under this alternative.

Overall, the entire suite of mitigation measures included in Alternatives A through G affords protection to specific species and may reduce impacts for specific species on a spatial or temporal scale. Specific protections are discussed in **Chapter 4**. **Table 2.13-1** provides the impact levels by resource and IPF across Alternatives A through G. **Table 2.13-2** allows for comparison of the additional protection afforded to marine mammal groups under each alternative. A summary of notable impact levels for each resource category and an assessment of changes in impact levels across the alternatives are presented here.

- Impacts to marine mammals from all IPFs associated with deep-penetration seismic airgun surveys may result in extensive (i.e., affecting large numbers of individuals) short-term, but not severe, impacts with possible, albeit limited, physical injury. Possible mortality would only be reasonably foreseeable in the unlikely event of a vessel collision or entanglement. Some of the mitigation measures included in the alternatives provide a level of protection to various target species and afford a reduced level of impacts to those target species and biologically important periods and geographic locations (e.g., seasonal restrictions in coastal waters afford protection to individual members of the bay, sound, and estuary [BSE] stocks during their calving season as well as coastal stocks of common bottlenose dolphins, Atlantic spotted dolphins, and individual manatees that may occur in coastal and inshore waters; the EPA Closure Area provides protection targeted to the Bryde's whale, with protection afforded to other species present in the closure area; and the CPA Closure Area provides targeted protection to the sperm whale, with protection afforded to other species within the closure area). However, when impacts from deep-penetration seismic airgun surveys to all marine mammals within the AOI during the 10-year timeframe of this Programmatic EIS are considered for the impact-level determination, the overall impact level is **moderate**, depending on the stock, for Alternatives A through E, **minor** for Alternative F, and **no impact** for Alternative G due to no new activities. **Minor** impacts are expected for shallow-penetration seismic airgun surveys and non-airgun HRG surveys for Alternatives A through F based on exposure modeling. Impacts from vessel and equipment noise are assessed as **nominal** to **minor** for Alternatives A through F because many marine mammal species produce and perceive low- to mid-frequency sounds; furthermore, the effect of increased ambient noise on marine mammals could mask biologically significant sounds. Vessel collisions with marine mammals are likely to be avoided; however, if a collision did occur, it could result in mortality. Therefore, depending on whether or not a collision did occur, **nominal** to **moderate** impacts are expected for Alternatives A through F. Potential impacts to marine mammals from an accidental fuel spill are expected to range from **nominal** to **minor**, depending on the numbers of individuals coming into contact with the spilled fuel and their exposure time as well as the exposure of federally listed species to the spilled fuel, for all alternatives except Alternative G. Other IPFs affecting marine mammals are assessed as **nominal** for Alternatives A through F and **no impact** under Alternative G. Behavioral impacts anticipated as a result of the proposed action that are analyzed in this Programmatic EIS are short-term disruption of behavioral patterns, abandonment of activities, and/or temporary displacement from discrete areas. Due to the extensive mitigations in the proposed action, no serious injuries are anticipated.

- Impacts to sea turtles are assessed as **minor** for airgun surveys for Alternatives A through D and F because they are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Due to the reduced level of proposed activities under Alternative E, the impact level is expected to be **minor**. Due to no new activity under Alternative G, there would be **no impact** from any IPF. In addition, some protection is afforded to sea turtles in Alternatives B through F to reduce the extent of potential PTS auditory injuries from implementation of the expanded PSO Program, but not significantly enough to change the overall impact level. For Alternatives A through F, **nominal** to **minor** impacts are expected for non-airgun HRG surveys. Impacts to sea turtles from vessel traffic would range from **nominal** to **moderate** (if a collision occurred) for Alternatives A through F because the support vessels associated with G&G activities travel at higher speeds and the potential for collisions increases at night and at times of reduced visibility. Potential impacts to sea turtles from an accidental fuel spill are expected to range from **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick) for all alternatives, except Alternative G (**no impact**). Impacts from entanglement and entrapment would be **nominal** for all alternatives except Alternative G, which would be **no impact**. Other IPFs affecting sea turtles are assessed as **nominal** for Alternatives A through F and **nominal** declining to **no impact** under Alternative G.

- Impacts to fish resources and EFH are assessed as **nominal** to **minor** for airgun surveys as well as vessel and equipment noise under Alternatives A through F based on the potential to disrupt spawning aggregations or schools of important prey species, the mobile and temporary nature of most surveys, the small area of the seafloor affected during surveys, and the possibility of fishes temporarily moving away from noise that is affecting them. Due to no new activity under Alternative G, there would **no impact** to fish and EFH from any IPF. Impacts from an accidental fuel spill range from **nominal** to **minor** for Alternatives A through F based on the location of the event and presence of fish or buoyant eggs and larvae. There would be **no impact** from an accidental fuel spill under Alternative G due to no new activity. Other IPFs affecting fish resources and EFH are assessed as **nominal** for all alternatives with the exception of entanglement for Alternative G, which would be **no impact** as there would be no new activity.

- Impacts to benthic communities are assessed as **nominal** for all applicable IPFs and alternatives, except Alternative G, due to the existing protective measures in place for avoiding known sensitive communities during seafloor-disturbing activities and the prevalence of soft bottom in the AOI. In addition, active acoustic sound sources have not been determined to have impacts to benthic communities. Due to no new activity under Alternative G, there would be **no impact** to benthic communities from any IPF.

- Impacts to marine and coastal birds are assessed as **nominal** to **minor** for active acoustic sound sources, vessel and equipment noise, vessel traffic, and aircraft traffic and noise for Alternatives A through D and F. Due to the reduced level of proposed activities under Alternative E, the impact level for seismic airgun surveys is expected to be **nominal**. Due to no new activity under Alternative G, there would be **no impact** to coastal and marine birds from any IPF. Impacts from an accidental fuel spill are **nominal** under most circumstances, may increase to **minor** based on timing and location, and could increase to **moderate** if a listed species or its prey is directly impacted across all alternatives.

- Impacts to MPAs are assessed based on the impact levels presented across all resources that may occur within the boundaries of MPAs. Therefore, impacts from active acoustic sound sources range from **nominal** to **moderate** for all alternatives except Alternative G. Due to no new activity under Alternative G, there would be **no impact** to MPAs from any IPF. Impacts from accidental fuel spills range from **nominal** to **moderate** for all alternatives, except for Alternative G, which would be reduced to **nominal**, eventually declining to **no impact**.

- Impacts to *Sargassum* and associated communities are assessed as **nominal** for Alternatives A through F based on the widespread patchy distribution of *Sargassum* mats and the propensity of *Sargassum* mats to be undisturbed by physical displacement. Species that utilize *Sargassum* as habitat for all or some of their life cycle (e.g., fish, sea turtles, and invertebrates) would be spatially limited and short term. No serious damage to *Sargassum* and associated fauna is expected to occur for all alternatives. Due to no new activity under Alternative G, there would be **no impact** to *Sargassum* from any IPF.

- Impacts to commercial fisheries are assessed as **minor** for airgun surveys for Alternatives A through F. Impacts from airgun surveys are expected to be intermittent and temporary. Because fishing equipment could be damaged, the potential for impacts are reduced by several measures, and any impacts would be spatially localized and temporary. Impacts from entanglement are assessed as **nominal** to **minor** for all alternatives except Alternative E2, which would be **nominal**, and Alternative G, which would be **no impact**. Impacts from stand-off distance are assessed as **minor** for all alternatives except Alternatives E2 and G. Under Alternative E2 (25% reduction in line miles of deep-penetration seismic airgun surveys), a decrease in impacts from **minor** to **nominal** is expected for stand-off distance impacts because these types of surveys typically have the larger stand-off distance requirements and large arrays. Impacts from seafloor disturbance are assessed as **minor** for all alternatives, except for Alternative G (**no impact**). Impacts from non-airgun HRG sound sources, vessel traffic, and accidental fuel spills impacts are assessed as **nominal** for Alternatives A through F due to the limited and localized activities; however, G&G activities could overlap with productive fishing grounds. Due to no new activity under Alternative G, there would be **no impact** to commercial fisheries from any IPF.

- Impacts to recreational fisheries are assessed as **nominal** for all alternatives for all applicable IPFs due to the short-term and localized interactions between recreational fishing and G&G activities, except for Alternative G. Impacts under Alternative G would be **no impact**.

- Impacts to archaeological resources from seafloor disturbance and entanglement are assessed as **nominal** to **major**, depending on the type of survey and whether site-specific information regarding potential archaeological resources is available, for all alternatives, except Alternative G. Under Alternative G, impacts would be reduced to **no impact**. Impacts from drilling discharges and accidental fuel spills are assessed as **nominal** for all alternatives, except for Alternative G. Due to no new activity under Alternative G, there would be **no impact** to archaeological resources from any IPF.

- Impacts to other space use in multiple-use areas is assessed as **no impact** to **nominal** for all alternatives for all applicable IPFs because many of the components of other marine uses are expected to be conducted in support of or in coordination with G&G activities for all three Program Areas. In addition, activities would be of relatively short duration, with the time and extent dependent upon the type of G&G activity. Due to no new activity under Alternative G, changes in space use in multiple-use areas would range from **no impact** to **nominal**.

- Impacts to land use and coastal infrastructure are expected to be **beneficial** (positive) to **minor** for Alternatives A through F and **minor** to **moderate** for Alternative G. Impacts to environmental justice are expected to be **beneficial** (positive) to **nominal** for Alternatives A through F and **minor** for Alternative G. Impacts to demographics are expected to be **beneficial** (positive) to **nominal** for Alternatives A through D, **minor** for Alternatives E and F, and **minor** to **moderate** for Alternative G. For regional economic factors, the selection of Alternatives A through D or F would support current activity levels in industries that depend on G&G surveying, which would have **beneficial** (positive) economic impacts. However, the alternatives would also entail some negative economic impacts arising from costs, inefficiencies, accidental events, and supply chain impacts. These negative impacts are expected to be **minor** for Alternatives A and C. The negative impacts could become **moderate** for Alternatives B, D, E, and F, depending on the ultimate introduced costs and inefficiencies, as well on how the offshore oil and gas industry adjusts its practices. The negative impacts of Alternative G would be **moderate** to **major** since it would substantially disrupt existing industries, supply chains, and energy consumers.

2.14 Mitigation, Monitoring, and Effectiveness

The proposed mitigation measures for all alternatives consist of a combination of monitoring components and operational procedures designed to minimize the potential for injury or harassment to marine mammal species during G&G surveys. The purpose of this section is to provide an overview of the mitigation measures proposed under all the alternatives. In this overview, the historic state of the mitigation (i.e., prior to the Settlement Agreement) in the GOM is detailed as a basis for comparison with the alternatives. The effectiveness of each mitigation measure is evaluated based on their application under requirements in the GOM as well as research and application in other areas of the G&G industry. The NTL 2016-BOEM-G02 is the framework for most of the proposed mitigation measures because it was developed specifically to minimize noise impacts to protected species within the GOM and includes the conditions identified in Alternative A. The NTL, which originally came about as a result of the Section 7 consultation with NMFS for sperm whales, has been applied in the GOM since 2002; therefore, it provides structure to assess effectiveness through the information collected during implementation of NTL mitigation measures to recommend practical measures for the future. Since the implementation of this NTL and its previous versions, the following have contributed to mitigation recommendations and requirements for future G&G activities in the GOM: (1) BOEM Mitigation Survey Report (Barkaszi et al., 2012) and BOEM/NMFS observer standards Technical Memorandum (Baker et al., 2013); (2) research and workshops on acoustic criteria as well as sound and marine life (Southall et al., 2007; Barton et al., 2008; Hannay et al., 2011; Bingham, 2011; Weilgart, 2013; CSA Ocean Sciences Inc., 2014); and (3) the GOM Amended Settlement Agreement. Modifications to the original NTL framework were based on the lessons learned, recommendations, and regulatory requirements from these sources. The various modifications assisted in the development of the alternatives considered in this Programmatic EIS. The individual mitigation measures considered in the alternatives include the following:

- time and area restrictions;
- separation distances between surveys;
- use of lowest practicable source power output necessary to achieve survey goals;
- establishing an exclusion zone;
- visually and/or acoustically monitoring an exclusion zone;
- clearance period before activating sound source;
- ramp-up, or gradual increase in output energy, of the sound source;
- shutdown or deactivation of sound sources; and
- overall reduction in deep-penetration seismic airgun activities.

The components and procedures are described individually for each alternative and are presented in **Tables 2.2-1 and 2.2-2**.

2.14.1 Time and Area Restrictions and Closures

Time and area restrictions limit G&G activities within certain areas and time periods that have been determined as critical to certain species. These restrictions take a biological approach to mitigation in an effort to focus restrictive or reactive measures to areas likely to receive the greatest benefit from those measures. In the GOM, water depth is a key factor used to help delineate area restrictions and closures for G&G operations.

In Alternatives A and G, mitigation requirements are applied when airgun surveys are operating in water depths of ≥200 m (656 ft) within the CPA and WPA and in all water depths within the EPA. The 200-m (656-ft) isopleth was originally selected as a delineation boundary based on ESA consultation for the protection of sperm whales (Northern GOM stock). Subsequently, other deepwater/deep-diving species such as beaked whales, Bryde's whales, and *Kogia* spp., were afforded the same protections under the NTL as the ESA-listed sperm whale. Other MMPA-protected species (delphinids) and ESA-listed sea turtle species are also included in the conditions of the current NTL and are afforded some, but not all, of the same protections designed for the sperm whale. As a condition of the Amended Settlement Agreement, application of NTL 2016-BOEM-G02 mitigation measures, in the interim, are applied to G&G activities in all water depths within the GOM (Alternative B). The mitigation measures from NTL 2016-BOEM-G02 also apply to Alternatives C through F. Alternative B includes seasonal closures to deep-penetration seismic airgun surveys, which have been in effect since the Settlement Agreement for areas shoreward of the 20-m (66-ft) isobath and a 5-km (3-mi) buffer extending seaward from the 20-m (66-ft) isobath between January 1 and April 30, while Alternatives C through F expand this seasonal closure area to between February 1 and May 31 (**Tables 2.2-1 and 2.2-2**).

Limiting or eliminating G&G activities from an area can be an effective mitigation strategy to reduce direct impacts from an activity within the closed or restricted area. Physical disturbances to species and habitats are eliminated with the removal of the activity from the area either seasonally or year-round. However, introduced noise is still likely to be present, at lower levels, if activities are occurring near the restricted or closed area. The noise levels propagated into the restricted or closed areas will depend on distance, source characteristics, and environmental parameters. There are considerations that need to be addressed prior to establishing such closures; for example, efforts to limit activity during a critical period for a single species may introduce greater potential impacts to other species or a more diverse suite of species during closure and non-closure periods. Distribution of and habitat use by the species of concern can fluctuate over time; therefore, area or seasonal restrictions need to be reviewed periodically and modified to meet the intended biological application, which can make survey planning challenging. All surveys or G&G activities may not cause the same impacts and may be better suited for consideration on an individual basis rather than a full closure for all activities.

2.14.2 Minimum Separation Distances

A minimum separation distance between concurrent G&G surveys using high-energy sources is designed to minimize the sound exposure levels for marine mammals and sea turtles moving through a large region. The separation distance is calculated such that individuals will have the opportunity to move away from sounds exceeding TTS levels without encountering another survey exposing them to the same sound levels. In this case, minimal sound "corridors" are maintained to allow for movement of marine life around and between surveys. In practice, minimum separation distances become highly complex when considered within the context of sound propagation in water. To effectively create low-sound corridors, a thorough understanding of how each source propagates within the existing environmental conditions is necessary. In some cases, higher received levels could occur farther from, rather than nearer to, the sound source depending on absorption, reflection, and refraction of the initial sound and the location of the receiver (i.e., marine mammal). In addition to the complexity of sound propagation, there are no current studies documenting the use of such corridors by marine mammals. The animals' specific activity (e.g., feeding and migration) at the time may be more influential than the availability of a low-sound corridor; therefore, a separation distance may give a false sense of impact minimization and not provide the desired protection levels. Some marine mammals have shown avoidance behavior to certain types of sound sources (Malme et al., 1983, 1984, 1986, 1988; Richardson et al., 1986; Ljungblad et al., 1988; DeRuiter et al., 2013). However, much of the behavioral response has been variable and research is continuing on this matter.

Alternative B includes a minimum separation distance between surveys (not individual vessels within a survey) of 40 km (24 mi) within the Settlement Agreement-defined Areas of Concern (**Figure 2.2-1**) and 30 km (19 mi) outside the Areas of Concern. Documentation that separation distances produce low-sound corridors as well as research confirming the use of these corridors by marine animals is necessary before the measures effectiveness can be evaluated. Assessment of unintended consequences, such as lost fitness, and changes in population structure by using such corridor habitat is also needed to evaluate the effectiveness of this mitigation measure. Marine mammal species in the GOM are not highly migratory and are driven mainly by access to food resources; therefore, it is doubtful that separation distances would provide the necessary benefits to offset potential impacts from sound exposure.

2.14.3 Non-Duplicative Surveys and Lowest Practicable Source

Under Alternative B, two requirements are stipulated that are designed to reduce unnecessary noise in the AOI. While these are not active mitigation measures implemented at the time of the survey, they are considered in this discussion due to their mitigation intention to reduce sound impacts on marine mammals. First is the non-duplicative survey requirement, under which the applicant of a G&G permit must provide, in writing, justification for the survey, confirming that previous, duplicative surveys have not been performed or do not provide the required data. Second is the lowest practicable source requirement, under which the applicant must provide an estimate of the total energy output per impulse with respect to each energy source to be used and confirm, in writing, that the proposed airgun arrays to be used are, to the extent practicable, of the lowest sound intensity level that still achieves the survey's goals.

Overall reduction in sound input may have wide-scale benefits. As noted in **Chapter 1**, under the terms of the Settlement Agreement, BOEM convened two panels (**Appendix L**) to determine the feasibility of including refined standards for the two aforementioned requirements. The final determinations of the panels were that standards to determine whether a newly proposed seismic survey is unnecessarily duplicative of previous surveys are feasible and that this could be accomplished under existing statutes and regulations. The panels' determinations on evaluating the feasibility of creating standards on the lowest practicable sound source is not feasible at this time given the variability involved in using sound sources that best capture data sought without minimizing the quality of that data, which could lead to additional surveying. The panels are discussed in more detail in **Appendix L**. In this Programmatic EIS, BOEM evaluates the potential effects and mitigations from the current requirements of the Settlement Agreement on non-duplicative surveys and lowest practicable sound source. Furthermore, determining the feasibility of developing standards for determining lowest practicable sound sources and non-duplicative sound sources will not have an adverse effect on the impact determinations contained in this Programmatic EIS.

2.14.4 Exclusion Zone

An exclusion zone is a defined area within which occurrence of a marine mammal triggers mitigation action intended to reduce the potential for certain outcomes, e.g., auditory injury and disruption of critical behaviors. The 500-m (1,640-ft) radial distance of the standard exclusion zone is intended to be precautionary in the sense that it would be expected to contain sound exceeding peak pressure injury criteria for all hearing groups other than high-frequency cetaceans, while also providing a consistent, reasonably observable zone within which PSOs would typically be able to conduct effective observational effort. Although greater distances may be observed from an elevated platform under good conditions, BOEM believes that 500 m (1,640 ft) is likely regularly attainable for PSOs using the naked eye during typical conditions.

An appropriate exclusion zone based on cumulative sound exposure level (SEL_{cum}) criteria would be dependent on the animal's applied hearing range (USDOC, NMFS, 2016a) and may be larger in some cases than the zones calculated on the basis of the peak pressure thresholds (and larger than 500 m [1,640 ft]) depending on the species in question and the characteristics of the specific airgun array. In particular, it is likely that exclusion zone radii would be larger for low-frequency cetaceans but that the zones would remain very small for mid-frequency cetaceans, such as dolphins.

However, it is important to note that consideration of exclusion zone distances is inherently an essentially instantaneous proposition – a rule or set of rules that requires mitigation action upon detection of an animal. This indicates that consideration of peak pressure thresholds is most relevant, as compared with SEL_{cum} thresholds, as the latter requires that an animal accumulate some level of sound energy exposure over some period of time (e.g., 24 hours). A PSO aboard a mobile source will typically have no ability to monitor an animal's position relative to the acoustic source over relevant time periods for purposes of understanding whether auditory injury is likely to occur on the basis of cumulative sound exposure and, therefore, whether action should be taken to avoid such potential. Therefore, the definition of an exclusion zone based on SEL_{cum} thresholds is of questionable relevance given relative motion of the source and receiver (i.e., the animal). The SEL_{cum} thresholds are likely more relevant for purposes of modeling the potential for auditory injury than they are for informing real-time mitigation. The importance of the accumulation of sound energy to an understanding of the potential for auditory injury is recognized and it is likely that, at least for low-frequency and high-frequency cetaceans, some potential auditory injury is likely impossible to mitigate.

In summary, the intent in prescribing a standard exclusion zone distance is to (1) encompass zones for most species within which auditory injury could occur on the basis of instantaneous exposure; (2) provide additional protection from the potential for more severe behavioral reactions (e.g., panic and antipredator response) for marine mammals at relatively close range to the acoustic source; (3) provide consistency for PSOs, who need to monitor and implement the exclusion zone; and (4) define a distance within which detection probabilities are reasonably high for most species under typical conditions. The use of 500 m (1,640 ft) as the zone is not based directly on any quantitative understanding of the range at which auditory injury would be entirely precluded or any range specifically related to disruption of behavioral patterns. Rather, it is a reasonable combination of factors. This zone would contain all potential auditory injury for mid-frequency cetaceans, would contain all potential auditory injury for both low- and mid-frequency cetaceans as assessed against peak pressure thresholds (USDOC, NMFS, 2016a), and has been proven as a feasible measure through past implementation by operators in the GOM. A practicable criterion such as this has the advantage of familiarity and simplicity while still providing, in most cases, a zone larger than relevant auditory injury zones, given realistic movement of source and receiver. Increased shutdowns, without a firm idea of the outcome the measure seeks to avoid, simply displace seismic activity in time and increase the total duration of acoustic influence as well as total sound energy in the water (due to additional ramp-up and overlap where data acquisition was interrupted).

Operational downtime typically is equated with loss of production and implies there is a necessary re-acquisition period needed to obtain the "missed" data from that downtime period. Due to the size of the survey array configurations and survey data parameters, re-acquisition requires a substantial operational effort, including having the survey and support vessels working in the prospect for longer periods (sometimes days to weeks) to adequately re-acquire data, which can result in longer periods of sound exposure in the area on a project-wide basis. In addition, frequency components of the propagated sound will reach different distances, and each receiver (i.e., marine mammal) may have individual sensitivity to sound levels and frequency bands.

2.14.5 Exclusion Zone Monitoring

Visual Observations by PSOs

The primary purpose of a visual PSO is to reduce the potential for injury or harassment to protected species by ensuring mitigation and monitoring requirements are followed during G&G survey activities and by monitoring any take of protected species (USDOC, NMFS, 2013a). The visual monitoring conducted by a PSO is intended to maintain clearance of an exclusion zone around the sound source, thereby reducing the potential for sound injury (i.e., hearing damage) or adverse impacts associated with disturbance of a species' normal behavior. A PSO visually monitors the sea surface around the G&G survey vessel for the presence of marine mammals and sea turtles, as required under the permit/authorization conditions. The PSOs must successfully complete an approved training course prior to performing any G&G visual monitoring duties. The PSOs, required in all alternatives, are responsible for visually surveying for protected species, collecting data, informing the vessel captain and crew of actions necessary for compliance with mitigation requirements, and submitting data and reports to BSEE on a biweekly basis.

Under the conditions of NTL 2016-BOEM-G02 and for all alternatives, two PSOs will be on watch during all daylight hours (defined as nautical twilight dawn and nautical twilight dusk, regardless of source operations) for seismic airgun surveys. Non-airgun HRG surveys only require one observer on watch, as proposed in Alternatives C through F, as applicable. For seismic airgun surveys, PSOs work in a three-observer rotational shift with two trained PSOs on active watch at all times and one PSO on break. Individual PSOs may only work 4 consecutive hours then must take a 2-hour break at which time no shipboard duties may be assigned. A PSO may work a total of 12 hours, including all shipboard duties, within any 24-hour period. The same rotational schedule is expected for all alternatives.

Under NTL 2016-BOEM-G02, PSOs survey the exclusion zone and surrounding waters using binoculars and the naked eye for the presence of marine mammals and sea turtles. The PSOs must effectively determine the species and distance of the animal relative to the source in order to initiate any required mitigation actions. In addition, stipulations, terms, and conditions may be used to assign mitigation specifications within the framework of a lease agreement for a plan or permit/authorization.

Visual monitoring and data collection will be continuous during all daylight hours. The PSOs do not conduct monitoring at night or when the exclusion zone cannot be fully monitored (e.g., fog, rough sea conditions, and precipitation). Suitable weather conditions should allow an unhindered view of the entire exclusion zone.

There are numerous factors that can influence the effectiveness of visual monitoring, including PSO experience and training, sea conditions, height of survey platform, visual monitoring equipment, and species behavior (Barlow et al., 2006; Barlow, 2015). Accurate, consistent, and frequent recording of sea-state conditions by a PSO will improve the assessment of visual monitoring effectiveness. Sea conditions that are considered suitable for observation are not defined within the alternatives. However, many standardized surveys are conducted only in sea states under Beaufort 5 (Barlow et al., 2006; Fisheries and Oceans Canada, 2008; Barlow, 2015). Beaufort Sea State 5 has moderate waves, many white caps, spray possible with wind speeds at 19 to 24 miles per hour (mph) (17 to 21 knots [kn]) and wave heights of 2 m (7 ft). The limits of allowable sea conditions in which visual monitoring can be conducted for mitigation may need to be adjusted for specific areas and species as the ability to observe some species is more drastically affected by the sea state than others.

Outside of the required completion of a PSO training course, there are no additional minimum qualification requirements for PSOs under any of the alternatives. The capabilities and experience of the visual observers will have a direct impact on the effectiveness of visual monitoring as a mitigation measure. However, NMFS, with the assistance of BOEM and BSEE, developed national standards for PSOs and data management, which are outlined in the 2013 National Standards for Protected Species Observers Technical Manuscript (Baker et al., 2013). These standards recommend that a PSO has

- a bachelor's degree from an accredited college or university with a major in one of the natural sciences;
- a minimum of 30 semester hours or equivalent in the biological sciences, at least one undergraduate course in math or statistics; and
- experience with data entry on computers; or
- the PSO must have documented comparable experience.

Currently in the GOM, PSOs may be trained crew members or independent (3rd party) PSOs. Most PSOs working under NTL 2016-BOEM-G02 and the Settlement Agreement conditions are third-party contractors who are subcontracted by a quality assurance/quality control service company. It is the responsibility of the service company to select and deploy PSOs. This trend is standard in the industry worldwide and is not expected to change under any of the alternatives in the GOM.

Acoustic Observations by PSOs (PAM Operator)

The primary purpose of a PSO working as a PAM operator is similar to a PSO conducting visual observations; however, the PAM operator acoustically monitors an area around the G&G survey vessel for the presence of vocalizing marine mammals. The PAM systems employed in the GOM for mitigation generally use a traditional towed configuration with the hydrophone array towed behind the source vessel and the PAM operator on the same vessel. The PAM operator listens and visually monitors the exclusion zone via sound analysis software that facilitates acoustic and visual representation of marine mammal vocalizations on a monitor. Recent BOEM permit conditions stipulate that standard practice for the GOM is that all PAM operators be third-party observers (Epperson, official communication, 2015). Similarly, recent permit conditions in the GOM have stipulated that all PAM operators maintain the same rotational watch schedule as described in the visual observation section. Two PAM operators are expected to work during each 12-hour shift; therefore, if PAM is required for 24 hours, four PAM operators would be needed. As technologies develop, new monitoring regimes may be considered that could reduce the number of on-vessel PAM personnel.

Under Alternatives A and G, the use of PAM is optional. If used, PAM would allow ramp-up and the subsequent start of an airgun survey from silence during times of reduced visibility (e.g., darkness, fog, and precipitation) when such ramp-up otherwise would not be permitted using only visual observers (i.e., PSOs). Under Alternative B, the use of PAM is required in all planning areas in water depths >100 m (328 ft) during times of reduced visibility. Proposed for Alternatives C through F, PAM would be required during times of reduced visibility in waters >100 m (328 ft) in all planning areas and would be a mandatory requirement at all times for use in Mississippi Canyon and De Soto Canyon lease block areas.

As a mitigation measure, PAM can be highly effective when implemented properly and when expectations are clearly defined. When visual monitoring is not possible, PAM allows monitoring of the exclusion zone. However, PAM will only detect vocalizing individuals that can be detected by the system under survey conditions. The effectiveness of PAM as a mitigation measure during G&G activities is directly influenced by the ability of the PAM operator and the deployment of appropriate PAM equipment for the monitoring environment. The PAM operators are expected to have training and practical experience with documented proficiency in the detection, classification, and localization of marine mammal vocalizations in high-noise environments. Not all PAM systems are suitable for mitigation due to the localization and real-time action requirements. In other words, a PAM system used on one survey may not be suitable for other surveys. A detailed assessment of each PAM plan for proper implementation will drive the effectiveness of this mitigation measure.

PAM Monitoring Plan

The PAM technologies and system options are continually evolving, and each will have advantages and disadvantages for any particular geophysical survey. As such, there are several technical aspects to consider when evaluating the scope and application of a PAM system for mitigation requirements within cetacean regulations. Under all alternatives using PAM (**Tables 2.2-1 and 2.2-2**), an acoustic monitoring plan is required to be submitted to BSEE prior to the start of the survey. Evaluation of the PAM plan will include four main factors:

- appropriateness of the PAM system and the PAM operators for the project parameters and species assemblages;
- methods of deployment to minimize vessel and flow noise while maintaining safety of equipment and crew;
- assessment of the detection, classification, and localization capabilities in regard to protocols for implementing mitigation actions; and
- methods of assessing the efficacy and performance of the system during the project.

Because noise in a commercial mitigation setting is one of the greatest challenges for acoustic monitoring, moored arrays or arrays deployed from dedicated platforms beyond the influence of vessels and machinery have a distinct advantage of working in a relatively quiet environment. However, most mitigation applications require real-time monitoring, which results in the necessity of a towed array behind the source vessel. Towed PAM systems are often used for real-time mitigation during seismic surveys because they maintain the surveillance area around the moving vessel and airgun sources. As stated previously, as technologies continue to evolve, other hardware configurations can be evaluated through the PAM plan assessment process.

The software tools needed to address signal processing in a high-noise environment have significant bearing on the effectiveness of PAM as a mitigation measure and should be evaluated fully in the PAM plan. The primary purpose of any software package is to process and display visual representations of the signals that are received from the array in a way that allows the operator to detect, identify, and localize (i.e., estimate the location of a vocalizing marine mammal in the volume being monitored) target species. There are several good software packages on the market, some of which are free. Differences in software occur mainly in user-interface capabilities, degree of adjustability in processing and display, automation, and methods of localization. Processing capabilities of the software and computer hardware need to reliably handle the data load. Adequate bandwidth for data transmission is critical to ensure data integrity and allow for proper mitigation implementation.

The PAM localization of animals is critical to the mitigation process. The most common form of localization is target motion analysis (TMA), which requires the following assumptions:

- the target (i.e., sound source) is relatively stationary or moves slowly relative to the survey vessel;
- the source vessel towing the hydrophone array is traveling in a straight line;
- the marine mammal is producing frequent calls (at least every few minutes);
- if multiple animals are calling, they occur in compact groups, or individual callers are able to be clearly differentiated; and
- animals detected close to the vessel are not diving deeper than the horizontal distance to the array's hydrophones.

If most of these assumptions can be met, then TMA works very well. If these assumptions cannot be met (which is the more common scenario), then the accuracy and reliability of localization is reduced and may reduce the ability of the PAM operator to implement mitigation actions. It is important to note that, while current BOEM requirements state that shutdowns for marine animals detected in the exclusion zone should be instantaneous, the reality of the TMA method requirements may substantially delay mitigation action.

Under NTL 2016-BOEM-G02, PAM operators are required to provide an assessment of the usefulness, effectiveness, and problems encountered during monitoring and mitigation. However, there are no matrices or minimum requirements for data archiving to achieve this requirement; therefore, a useful assessment of the PAM system efficacy for a survey is difficult to obtain. Archival requirements stipulated in the PAM plan or under the permit conditions will have a direct correlation to the successful validation of data. While post-processing of full datasets is desirable, software that can sample several hours per day (for example) can reduce time and costs but still provide an unbiased post-processing avenue for efficacy assessment.

Pre-Start Surveys

All action alternatives require a period of clearance, either visually or acoustically, prior to the start of any sound sources. Pre-start clearance surveys are defined as required periods of time in which the exclusion zone around the airguns is acoustically or visually monitored before initiation of the sound source. The time period for clearance prior to the initial ramp-up (airgun survey) or start-up (non-airgun HRG survey) is 30 minutes. The premise behind this mitigation measure is that PSOs monitor for a period of time so that when the source is started, there is reasonable assurance that no marine mammals or sea turtles are within the exclusion zone. If a marine mammal or sea turtle is detected in the exclusion zone, there is a delay in source initiation to allow time for the animal(s) to leave the area.

While the premise of this mitigation measure is well founded, in practice the measure is most effective for stationary exclusion zones, which would be associated with geological surveys or VSPs, rather than traditional seismic airgun and non-airgun HRG geophysical surveys. On a moving vessel, the PSOs are monitoring a continuously changing exclusion zone up to the point of source initiation rather than clearing the actual exclusion zone that would be present at the time the source is initiated. The effectiveness of pre-start surveys as a mitigation measure, therefore, will vary greatly with species and diving behavior. To improve the effectiveness of this measure, monitoring should be focused ahead of the vessel to clear the area where ramp-up is likely to begin. This improvement to the methodology will be more effective for visual monitoring than for acoustic monitoring.

2.14.6 Ramp-Up

Ramp-up of the source is defined as an incremental increase in the sound output over a certain time period. The gradual increase in sound level is designed to minimize the risk of exposing animals near or under the sound source to the maximum output levels. It is suggested that ramp-up serves as a warning to animals in the area, allowing them time to move away from the source. There are few data on the efficacy of ramp-up as a mitigation measure. A study funded by the JIP and BOEM of humpback whale (*Megaptera novaeangliae*) responses to airgun ramp-up is underway, and the results may provide an assessment of ramp-up effectiveness (refer to http://www.uq.edu.au/whale/brahss-10-11 for the most recent information).

All alternatives require ramp-up as a mitigation measure for surveys using airguns. Non-airgun HRG survey equipment is turned on to full-power and begins to output sound sources; therefore, ramp-up is not applicable for these types of geophysical survey equipment.

2.14.7 Shutdowns of Sources for Protected Species

Shutdown of active sources is initiated when a protected species enters (or will soon enter) the exclusion zone. Shutting down the active source when a protected species is detected within the exclusion zone is designed to minimize the potential for animals to be exposed to sound levels that are potentially injurious (as defined by NMFS' acoustic guidelines). While the source cannot be initiated from silence if any marine mammal or sea turtle is sighted within the exclusion zone, the alternatives differ on which species require a shutdown of a source that is operating. In Alternatives A and G, shutdowns would be required for all whales (non-delphinid cetaceans) in accordance with NTL 2016-BOEM-G02, including Bryde's, beaked, sperm, or dwarf and pygmy sperm whales. In Alternatives B, C, E, and F, the shutdown would be expanded to manatees. In these alternatives, there would continue to be no shutdown for sea turtles or dolphins (Family Delphinidae). In Alternative D, a source shutdown would be required for all marine mammals that enter the exclusion zone, with the exception of bow-riding dolphins (i.e., common bottlenose, Fraser's, Clymene's, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso's dolphins) that voluntarily approach the vessel. Shutdown for dolphins would be determined by the PSO and would not apply when individuals are bow-riding or continuing to actively approach G&G operations. Vessel operators must comply immediately with a shutdown call from the PSO. There would be no shutdown for sea turtles under any alternative.

The TTS and PTS isopleths will vary significantly from project to project depending on the source characteristics, environmental parameters, and hearing functions of the potential species. Sound exposures within these isopleths will be minimized if the operational shutdowns are implemented based on an accurate mitigation zone. A marine mammal detected within the exclusion zone potentially has been exposed to PTS or TTS sound levels already based on the fact that they are within the exclusionary isopleths. The shutdown mitigation measure minimizes the time that an animal is exposed to those levels so that impacts are reduced. As discussed in **Appendix D**, the usefulness of mitigation depends on species characteristics and environmental conditions. Mitigation effectiveness, measured as percent reduction in exposures relative to no mitigation, is correlated to detection probability and animal density.

The PSO reports from seismic mitigation surveys in the GOM indicate that shutdowns due to marine mammals can last from 30 minutes to 2 hours (Epperson, official communication, 2015). To resurvey the area missed during the shutdown, additional time from 1 to 12 hours may be required depending on the survey type. Comparable shutdown and reshoot times are expected for surveys working under Alternatives A, B, C, E, and F. Additional shutdowns would be expected for non-bow-riding dolphins in Alternative D.

2.14.8 Reduction in G&G Activity Levels

Alternative E presents options to reduce the overall number of deep-penetration, multi-client seismic airgun surveys by either 10 or 25 percent. This alternative likely would be effective in reducing cumulative sound exposures to protected species because fewer surveys would be performed. This mitigation measure represents a GOM regionwide strategy designed to reduce overall exposures and noise levels; however, these measures do not afford any additional mitigation benefit to surveys already in progress.

2.15 ADAPTIVE MANAGEMENT

Adaptive management is a flexible decisionmaking process that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. “Other events” include additions to the body of knowledge for where and when species use the ocean and how the impacting factors from BOEM’s potentially permitted actions affect them. BOEM’s adaptive management approach begins with the preparation of a “programmatic” EIS as a baseline that broadly covers the likely range of protective measures that may be taken to avoid or minimize impacts. Later, any site-specific NEPA compliance needed can be adjusted for subsequent shifts in how protective measures are fielded as it “tiers” off the initial programmatic EIS. The programmatic evaluation, therefore, needs to ensure that a robust collection of potential protective measures have been treated in the analysis of alternatives.

The outline for how BOEM and BSEE intend to realize adaptive management in the Gulf of Mexico AOI follows the USDOI’s Technical Guide’s philosophy and meets the measures of success defined in it: (1) preparation of this Programmatic EIS is a public process; (2) BOEM’s management goals are to reduce and avoid impacts from OCS activities approved by BOEM while still allowing the goals and intent of the OCSLA for exploration and development of the OCS; (3) results from the monitoring plan required in the upcoming MMPA rulemaking will help inform future mitigation strategies and permitting; (4) reporting requirements (e.g., per NTL 2009-G34) and assessment (BOEM’s Environmental Studies Program) are inputs to adjust and improve management decisions for the protective measure available and assigned as conditions of permit approval; and (5) implementation remains consistent with other applicable laws.

There are many and varied types of new information that BOEM will use to inform its adaptive management process. The monitoring and reporting methods identified in the Monitoring Plan in **Chapter 1.2.3.4**, for example, will allow for an increased knowledge of the species, the level of potential impacts on populations of marine mammals from G&G activities, and the effectiveness of the applied mitigations. The implemented mitigation measures will then be evaluated and, through an adaptive management process, may be altered depending on their effectiveness. The ability to analyze the new information and adjust measures based on this analysis will then be built into the site-specific NEPA and other internal and external environmental review processes. The question then becomes what types of additional measures may be considered. Additional measures would need to be analyzed in terms of effectiveness in mitigating the intended effect as well as practicability in being implemented in the field.

Any changes originating from either a programmatic EIS or a site-specific, NEPA-level analysis for a G&G permit would occur only after BOEM considers the best available information. Further, BOEM emphasizes that any changes to mitigation measures at either a programmatic level or at the site-specific review phase may require coordination under other agency authorities (e.g., with the Terms and Conditions under ESA Section 7 consultations with NMFS). Once a better understanding of the effectiveness of assigned mitigations is achieved, BOEM, as the decisionmaker, will be able to better assess and adjust future management decisions and design more effective mitigations if warranted. BOEM understands and acknowledges that there are many uncertainties regarding ecosystems and that actual and expected results of the mitigation measures associated with the alternatives in this Programmatic EIS can vary greatly. By creating and applying an adaptive management process, however, aspects of mitigation and management that are not working can be isolated and adjustments can be made to allow for improved management of the activity and the resource.

CHAPTER 3

G&G ACTIVITIES
AND
PROPOSED ACTION SCENARIO

3 G&G ACTIVITIES AND PROPOSED ACTION SCENARIO

3.1 INTRODUCTION

A variety of G&G techniques are used to characterize the shallow and deep structure of the shelf, slope, and deepwater ocean environments. The G&G activities and project activity levels evaluated as part of this Programmatic EIS are described in this chapter and their applicability to BOEM's three Program Areas (i.e., Oil and Gas, Renewable Energy, and Marine Minerals) is summarized in **Table 3.1-1**. Detailed descriptions of all G&G survey equipment are provided in **Appendix F**. In general, the activities include the following:

- types of deep-penetration seismic airgun surveys used almost exclusively for oil and gas exploration and development (**Appendix F, Section 1.1**);
- other types of surveys and sampling activities used only in support of oil and gas exploration and development, including electromagnetic surveys, deep stratigraphic and shallow test drilling, and various remote-sensing methods (**Appendix F, Section 1.4.4**);
- airgun HRG surveys used in the Oil and Gas and Renewable Energy Programs to investigate the shallow subsurface for geohazards and are used for initial site evaluation, drilling rig emplacement, platform or pipeline design and emplacement, and renewable energy structure emplacement (**Appendix F, Section 1.2**);
- non-airgun HRG surveys used in all three Program Areas to detect and monitor geohazards, archaeological resources, and certain types of benthic communities, and to assess potential offshore sand resources for coastal restoration projects (**Appendix F, Section 1.3**); and
- geological and geotechnical seafloor 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 sand for beach nourishment and coastal restoration projects (**Appendix F, Section 2**).

3.2 PROPOSED ACTION SCENARIO BY PROGRAM AREA

This chapter provides a basic discussion of the types of G&G activities that BOEM is proposing to authorize under the proposed action within BOEM's three broad Program Areas (Oil and Gas, Renewable Energy, and Marine Minerals). The projected activity levels for each Program Area are discussed and broken down by year and planning area in **Tables 3.2-1 and 3.2-2** for oil and gas **Table 3.2-3** for renewable energy, and **Tables 3.2-4 and 3.2-5** for marine minerals. Refer to **Tables 2.7-1 and 2.7-2** for the oil and gas scenarios for Alternative E broken down by year and planning area. **Table 3.2-6** provides additional details to describe the activity types for all Program Areas. A summary of all projected levels of activity for all Program Areas is provided in **Table 3.2-7**.

This EIS analyzes projected scenarios for activity levels that are expected to occur over the next 10 years. While BOEM acknowledges the reduced level of exploration G&G activity and the corresponding decrease in permit applications in the 2016 calendar year, BOEM assumes that future levels will return to previous levels within the next 10 years. Therefore, BOEM must be prudent and conservatively consider the full range of potential impacts. For this reason, the scenarios contain projections based on analysis of past activity levels and trends made by BOEM's subject-matter experts who also considered industry-projected activity levels in their estimates.

3.2.1 Oil and Gas Program G&G Surveys

Certain G&G activities are prerequisite steps needed to determine if there is industry interest for oil and gas leasing in the AOI. The scope of this Programmatic EIS includes a NEPA analysis of specific types of G&G activities that can take place before or after leasing (**Table 1.1-2**). It includes the G&G activities needed for operators to make business decisions about acquiring leases, and the G&G activities that can take place on and near a lease once it has been acquired by an operator.

In addition to the needs of private industry, G&G surveys provide important information for governmental decisions. 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 OCS lease blocks that have received bids in OCS lease sales. They also use G&G data to help them make potential estimates of existing resources and to evaluate both worst-case discharge for potential oil-spill analysis and sites for potential hazards prior to drilling.

The G&G activities for oil and gas exploration may include proposed activities that occur either before leasing takes place (pre lease) or after authorization of an existing lease (post lease). The scenario evaluated in this Programmatic EIS includes G&G activities for all existing leases, as well as future leases. The NEPA action for the various types of activities is shown in **Table 1.1-2**.

A NEPA evaluation is part of the approval process for OCS plans for exploration, development, or production under the OCS Oil and Gas Program. The evaluation includes a proposed action at a specific location with specific types of tools and intensity of G&G activity, and it may include an EA. The consultations required under environmental law for protected species typically are carried out at the time of the NEPA evaluation associated with a proposed lease sale. All actions consequent to a lease sale are examined in an EIS.

Many post-lease activities are guided by NTLs, which are posted to BOEM's website, and those applicable to G&G activities are described in **Appendix B**. Ancillary activities are post-lease operations by lease owners in furtherance of developing oil and gas resources. Ancillary activities are defined in 30 CFR § 550.105 and regulated in 30 CFR §§ 550.207 through 550.210. A discussion of ancillary activities and NTL 2009-G34 ("Ancillary Activities") is provided in **Appendix B, Section 1.2.2.3**.

3.2.1.1 Proposed Action Scenario

Typical pre-lease activities include deep-penetration seismic airgun surveys to explore and evaluate deep geologic formations. The 2D seismic surveys usually are designed to cover thousands of square miles or entire geologic basins as a means to geologically screen large areas for potential hydrocarbons. The 3D surveys can cover several hundred OCS lease blocks and provide much better resolution to evaluate hydrocarbon potential in smaller areas or specific prospects. Other pre-lease surveys include largely passive data gathering methods such as electromagnetic, gravity, and magnetic surveys, as well as remote-sensing surveys from aircraft and satellites.

Post-lease activities conducted by operators can include additional seismic surveys, non-airgun HRG seismic surveys, and seafloor sampling, including via stratigraphic wells, shallow test wells, and geotechnical sampling. Examples of post-lease seismic surveys include VSPs with geophone receivers placed in a wellbore and four-dimensional (4D; time-lapse) surveys to monitor reservoirs during production. Non-airgun HRG surveys are conducted in leases and along pipeline routes to evaluate the potential for geohazards, archaeological resources, and certain types of benthic communities. Geotechnical sampling is conducted to assess seafloor conditions with respect to siting facilities such as platforms and pipelines.

The major categories of G&G activities conducted for oil and gas exploration are summarized in **Table 3.1-1** and are described by specific activity in **Appendix F**. Projected activity levels are described in **Chapter 3.2.1.2** below. The major categories are as follows:

- seismic airgun surveys (**Appendix F, Sections 1.1 and 1.2**);
- non-airgun HRG surveys (**Appendix F, Section 1.3**);
- non-acoustic marine geophysical surveys (**Appendix F, Section 1.4**); and
- geological and geotechnical surveys (**Appendix F, Section 2**).

3.2.1.2 Projected Activity Levels

To construct a scenario for G&G surveys in support of oil and gas exploration, BOEM has evaluated recent trends in permit applications as well as industry estimates of future seismic survey activity. BOEM also has taken into account the restrictions under the Gulf of Mexico Energy Security Act (GOMESA), which precludes leasing, pre-leasing, or any related activity in the GOM east of the Military Mission Line (86°41' W. longitude), and the area within the CPA that is within 125 mi (201 km) of Florida. The GOMESA restrictions place most of the EPA and a portion of the CPA under restriction from oil and gas leasing until 2022, which is within the time period covered by this Programmatic EIS (**Chapter 4.12.1.6**). However, geophysical surveys are not restricted by GOMESA.

A range of projected activity levels for geophysical surveys related to oil and gas exploration over the 10-year time period analyzed in this Programmatic EIS are shown in **Table 3.2-1**. This range of projected activity level includes an upper bound of activity level range based on industry capacity in the GOM and a lower bound of activity levels that accounts for a number of things that could affect these activities (e.g., marketplace changes and adjustment of schedules for closures). BOEM analyzed the upper bound of projected activity level across all resources in **Chapter 4**. The G&G surveys for the Oil and Gas Program could occur anywhere in Federal waters of the AOI; however, as shown in **Table 3.2-1**, a higher activity level is expected in deeper waters. Additionally, more surveys are expected to occur in the CPA than in the WPA or EPA.

While the primary focus of the analysis in this Programmatic EIS is seismic airgun and non-airgun HRG surveys, there are many other types of oil and gas surveys that do not depend on sounds for actual data collection (**Appendix F, Sections 1.4 and 1.5**); nonetheless, such surveys can contribute operational and equipment noise while they are being conducted. These include controlled source electromagnetic (CSEM), magnetometer, magnetotelluric (MT), gravity, magnetic, full sensor gravity (gradiometry), and aeromagnetic surveys; continental offshore strategic test (COST) wells; shallow test drilling; geologic coring; cone penetrometer tests (CPTs); and seafloor sampling. Non-acoustic and geological activities that have an estimated level of activity broken down by year and planning area are included in **Table 3.2-2**. BOEM anticipates that up to one aeromagnetic survey may be conducted in the AOI during the time period covered by this Programmatic EIS (**Table 3.2-6**).

Although gravity, magnetic, and electromagnetic surveys are conducted in the GOM, they are usually complementary to airgun and non-airgun HRG seismic surveys. The principal seismic acquisition method is 3D, using towed hydrophones (streamers) or seafloor cables and nodes (geophones) as acoustic receivers. Time-lapse (4D) surveys are 3D surveys that are repeated one or more times after the original survey to monitor reservoirs. Seismic airgun surveys, using a hydrophone and three orthogonal geophones, are also conducted more frequently to obtain four-component data, which consists of seismic pressure, vertical motion, and two horizontal motions of the seafloor.

A summary of the projected levels of activity for all Program Areas over the 10-year project period is provided in **Table 3.2-7**. Specific to the Oil and Gas Program, the total projected line miles (line mi) or geological tests over the 10-year time period for each major activity category are as follows:

- seismic airgun surveys (i.e., sum of VSP, seismic while drilling (SWD), 2D, 3D, WAZ, and 4D surveys) totaling 2,485,992 line mi (4,000,816 line kilometers [line km]) (**Table 3.2-1**);
- non-airgun HRG surveys totaling 103,025 line mi (186,803 line km) (**Table 3.2-1**);
- non-acoustic marine geophysical surveys totaling 8,120 line mi (13,068 line km) (**Table 3.2-2**); and

- geological and geotechnical surveys (e.g., seafloor sampling) totaling 899 tests/cores/grabs/probes/wells (**Table 3.2-6**).

3.2.2 Renewable Energy Program G&G Surveys

BOEM is responsible for offshore renewable energy development in Federal waters and anticipates that any potential renewable energy projects would need to be supported by G&G surveys in the GOM. While there are no projects planned, potential future projects may focus on generating wind energy or hydrokinetic power, or on sequestering carbon.

Under the Renewable Energy Program (30 CFR part 585), lessees are granted the right to use leased areas to develop their plans for renewable energy projects, which must be approved by BOEM. Specifically, the regulations require that a lessee provide the results of G&G surveys within a SAP, COP, or GAP. The G&G surveys conducted in support of SAPs, COPs, and GAPs can include the following:

- shallow hazards surveys (30 CFR §§ 585.610(b)(2), 585.626(a)(1), and 585.645(a)(2));
- geological surveys (30 CFR §§ 585.610(b)(4), 585.616(a)(2), and 585.645(a)(4));
- geotechnical surveys (30 CFR §§ 585.610(b)(1), 585.626(a)(4), and 585.645(a)(1));
- biological surveys (30 CFR §§ 585.610(b)(5), 585.626(a)(3), and 585.645(a)(5)); and
- archaeological resource surveys (30 CFR §§ 585.610(b)(3), 585.626(a)(5), and 585.645(a)(3)).

BOEM refers to these surveys as “site characterization” activities. The G&G surveys are conducted in support of the planning requirements to develop a lease. Although BOEM does not issue permits or approvals for these site characterization activities, it will not consider approving a lessee’s SAP, COP, or GAP if the required survey information is not included. If the lessee is required to obtain an authorization pursuant to Section 101(a)(5) of the MMPA prior to conducting survey activities, the lessee must provide to the lessor a copy of such authorization prior to commencing survey activities, pursuant to 30 CFR 585.801(b).

BOEM’s Office of Renewable Energy Programs (OREP) has developed guidance documents for various surveys, including G&G surveys, to support SAP, COP, and GAP submissions, including those for work in the GOM (USDOI, BOEM, 2015c). The guidance includes acceptable instrumentation and survey design parameters, and specifies the report outputs that will allow BOEM to make decisions.

3.2.2.1 Proposed Action Scenario

To estimate the survey activity that could reasonably result from renewable energy lease issuance and approval of site characterization activities in the GOM associated with wind, marine hydrokinetic power, and alternate use of existing platforms, BOEM's Gulf of Mexico OCS Region developed an activity scenario incorporating information gathered from various sources. These sources include the Gulf Coast States' Coastal Management Programs; interviews with industry that have shown interest in developing renewable energy projects in the GOM; information from the U.S. Department of Energy (USDOE), National Renewable Energy Laboratory (NREL); and information gathered from the *Atlantic OCS Proposed Geological and Geophysical Activities; Mid-Atlantic and South Atlantic Planning Areas; Final Programmatic Environmental Impact Statement* (USDOI, BOEM, 2014b).

Wind

The NREL produced maps indicating the offshore 90-m (295-ft) wind resource potential (USDOE, NREL, 2010). As indicated by the NREL (USDOE, NREL, 2010), wind resource potential in the GOM is limited to the WPA, with the southeast Texas coast having the highest potential for wind resources.

Based on information provided by the State Coastal Management Programs, the NREL, and Schellstede and Associates, Inc., BOEM assumes that up to one new wind energy lease could be issued for the Gulf of Mexico OCS over the 10-year time period of this Programmatic EIS. The current target size of an offshore wind facility is approximately 500 megawatts (MW) (USDOE, NREL, 2012a and 2012b); however, projects between 350 and >500 MW are possible. Using current technology and spacing requirements for offshore wind turbines, this equates to a minimum lease area of approximately 150 km^2 (58 mi^2; 37,000 acres [ac]) or approximately six OCS lease blocks.

The G&G activities for renewable energy could occur anywhere within the AOI. However, the potential geographic scope is likely to be limited for several reasons. Wind energy facilities currently are the only type of renewable energy facility considered for the GOM. Although offshore wind foundation designs are rapidly changing, the distance from shore for a wind facility generally is defined as the outward limit of its economic viability, which currently is approximately 46 km (25 nmi; 27 mi) from shore or within 40-m (131-ft) water depth. As a result, renewable energy projects are likely to occur only in a narrow band along the Texas coast having sufficient wind resources.

While an offshore wind energy lease for six or more OCS lease blocks is possible off the coast of Galveston, Texas in the next 10 years, it is unlikely due to the low cost of natural gas, which thereby reduces the economic incentive for wind energy development. Nonetheless, if an offshore wind energy lease is issued, it is assumed that the Port of Galveston would be utilized as the shore base to conduct site characterization activities due to current activity taking place within Texas State waters. Based on the duration of time per G&G event related to wind energy, up to one support vessel is projected to be utilized because the distance to shore is minimal and the survey vessels will likely return to the shore base daily (USDOI, BOEM, 2014b).

Alternate Use of Existing Platforms

Alternate use of existing platforms on the OCS could be done for the following activities: research; education; recreation; support for offshore operations and facilities; telecommunication facilities; renewable energy; and offshore aquaculture. At this time, alternate use is not foreseeable within the 10-year time period. If alternate use of existing facilities is proposed, G&G events related to the specific use would be determined at that time, but likely will rely on historical G&G data for any site-specific location.

For renewable energy-related G&G activities in the GOM, the shore bases and ports likely to be utilized are Galveston, Texas, and Amelia, Louisiana, with Fourchon, Louisiana, as an alternate because they currently are utilized for projects within close proximity to proposed activities.

3.2.2.2 Projected Activity Levels

Table 3.2-3 summarizes the projected activity levels for G&G activities associated with renewable energy development over the 10-year time period; as stated above, BOEM assumes that up to one new wind energy lease could be issued for the Gulf of Mexico OCS over that 10-year period. To estimate non-airgun HRG activity levels, BOEM assumed that geophysical surveys for shallow hazards and archaeological resources would be conducted at the same time using the finer line spacing required for archaeological resource assessment (30 m [98 ft]). Tie-lines would run perpendicular to the track lines at a line spacing of 150 m (492 ft), which would result in 925 km (575 mi) of non-airgun HRG surveys per OCS lease block. It would take approximately 150 hours to survey one OCS lease block. In addition, a 16-km (9.9-mi) cable route to shore was assumed for each State with a 300-m (984-ft) wide survey corridor, which would include approximately 8 km (5 mi) or 1 hour of survey per mile of cable. In order to survey an entire renewable energy area and potential cable route, non-airgun HRG surveys would have to be conducted by multiple vessels, or over multiple years and along multiple potential cable routes.

The number of seafloor sampling/testing locations for geotechnical surveys was estimated by assuming that a sample would be collected at every potential turbine location. Spacing between wind turbines typically is determined on a case-by-case basis and is based on several project-specific factors to minimize wake effect, including turbine size and rotor diameter (for 3 MW to 8 MW turbines, the rotor diameters range from approximately 100 to 164 m [328 to 538 ft]). Offshore Denmark, a spacing of seven rotor diameters between units has been used. In the U.S., the Cape Wind Project proposed a spacing of 6 to 9 rotor diameters. In some land-based settings, turbines are separated from each other by 10 rotor diameters. Based on this range in spacing for a 3.6-MW (110-m [361-ft] rotor diameter) turbine and a 5-MW (130-m [427-ft] rotor diameter) turbine, it would be possible to place 14 to 45 turbines in one OCS lease block. The sampling numbers in **Table 3.2-3** are based on the assumption that a seafloor sample would be collected at every potential turbine location in a wind energy area, at a density of 14 to 45 turbines per OCS lease block. It is also projected that up to two bottom-founded monitoring buoys would be placed to collect metocean and meteorological data.

3.2.3 Marine Minerals Program G&G Surveys

Under Section 11 of the OCSLA, BOEM may authorize G&G exploration for non-energy marine minerals. Commercial G&G prospecting for marine minerals is regulated under 30 CFR part 580 and requires authorizations from BOEM. State and local government-sponsored, noncommercial G&G prospecting for marine minerals for use in coastal restoration and public works projects require BOEM's authorization. The G&G prospecting conducted by a Federal agency or their contractor does not require BOEM's authorization.

Under Section 8(k) of the OCSLA, BOEM may authorize use of non-energy, marine minerals from the OCS. Authorizations for use of OCS marine minerals are by (1) a noncompetitive negotiated agreement, which can only be used for obtaining sand and gravel (or other sediment) for beach nourishment, coastal restoration, and public works projects partially or entirely funded by a Federal, State, or local government (implemented through program guidelines); or (2) a competitive lease sale in which any qualified person may submit a bid (30 CFR parts 581 and 582). BOEM's Marine Minerals Program historically has implemented the combined authorizations through the following four primary functions:

- authorizing G&G prospecting for OCS sand resources for Federal, State, and local government-sponsored public works projects;
- preparing noncompetitive leases and MOAs authorizing the use of OCS sand resources for beach nourishment and coastal restoration projects;
- managing and coordinating cooperative agreements, task forces, and working groups with local, State, and Federal partners; and
- sponsoring, funding, and partnering with stakeholders to conduct environmental evaluations and resource studies to support permitting, leasing, and stewardship of OCS sand resources.

Although there has been occasional interest, no competitive leasing for marine minerals has occurred, and BOEM does not anticipate any commercial prospecting for marine minerals in the GOM during the time period of this Programmatic EIS. In general, most of the OCS marine minerals used in the GOM are associated with sand resources for coastal ecosystem restoration projects sponsored and funded by State and Federal agencies.

Until 2011, BOEM managed cooperative agreements with all five Gulf States. Currently, BOEM only has agreements with Louisiana, Mississippi, and Texas. Between 2005 and 2015, BOEM issued eight negotiated agreements along the Gulf Coast authorizing the use of OCS sand resources from borrow areas offshore Louisiana and Florida for barrier island restoration, hurricane damage protection, infrastructure protection, ecosystem restoration, and beach nourishment projects. Much of the OCS sand used in these projects was identified through the cooperative agreement program between BOEM and the Gulf Coast States. Over the 10-year project period, BOEM anticipates that G&G actions will be largely associated with prospecting and noncompetitive leases for OCS marine minerals with Federal, State, and local governments.

In all cases, the OCS sand will be utilized for projects in State waters or on State lands. These projects generally will be under the jurisdiction of the USACE, through civil works mandates or Section 10/404 regulatory authority. BOEM will not be the lead Federal agency but likely will serve as a cooperating agency in collaboration with the lead agency to ensure effective implementation of NEPA requirements and associated consultations. In these cases, BOEM will adopt the NEPA documentation prepared by the project proponent for the Federal action of the lease issuance.

3.2.3.1 Proposed Action Scenario

The suite of survey and tool types deployed for the Renewable Energy and Marine Minerals Programs are very similar. The G&G surveys supporting the Marine Minerals Program historically have occurred:

- under cooperative agreements where State researchers and other Federal agencies, funded by BOEM, identified and assessed potential offshore sand resources for use in public works projects (USDOI, MMS, 1999 and 2004);
- under prospecting permits or authorizations; and
- in support of noncompetitive leasing before and after dredging operations.

The general area where G&G prospecting, pre-lease site assessment, and on-lease bathymetric surveys in the GOM likely will occur over the 10-year time period is a relatively discrete area of the OCS inner shelf in water depths of <25 m (82 ft) offshore Texas, Louisiana, Mississippi, Alabama, and the west coast of Florida where sand resources are present and within an economically feasible transport distance to shoreline restoration sites. The total area within which Marine Minerals Program activities occur represents approximately 1.11 percent of the AOI covered by this Programmatic EIS. Though dredging by the U.S. fleet is generally limited to <30 m (98 ft) based on current hopper and cutterhead dredge configurations, technologies are available to dredge deeper. However, these have not been used on U.S.-flagged vessels and may require costly retrofits. Moreover, the cost for transporting sand located in offshore sand shoals and banks to shoreline project areas where it is placed for beach nourishment or coastal restoration projects is relatively expensive, causing coastal planners to use resources in areas closest to shore first.

The G&G surveys may occur during the following three distinct phases of a project, in order of occurrence: (1) initial reconnaissance level sand search; (2) pre-authorization or pre-leasing environmental review; and (3) monitoring of the borrow area (i.e., the location of the sand source that is being dredged) before, during, and after dredging and construction.

Reconnaissance level sand search data often exist from previous projects, regional resource evaluation studies, or scientific research studies; therefore, new projects often begin at the design-level phase. Additional geophysical surveys may be conducted at the borrow area prior to and at regular intervals after dredging. These surveys are performed as conditions of BOEM's authorization to use the OCS sediment resource. Previous environmental reviews would have considered, analyzed, and established the need for such monitoring surveys to monitor seafloor change in the vicinity of the borrow area. Typical surveys include pre- and post-construction bathymetric surveys in the borrow area and are used to document seafloor changes, determine volumes used, and validate environmental analyses.

Sand Search, Borrow Design, Site Characterization, and Site Clearance Geophysical Surveys

Site characterization and sand search, or prospecting, geophysical surveys are undertaken to identify OCS sand resources and any environmental resources, cultural resources, and shallow hazards such as pipelines that may exist in potential borrow areas. Marine minerals prospecting surveys usually deploy the same suite of geophysical instruments that are used for archaeological surveys; therefore, a single survey effort often satisfies the needs for sand prospecting, identification of cultural resources and sensitive seafloor habitat, and identification of shallow hazards.

Typical survey deployments may involve 24- to 400-kHz single-beam echosounders (SBESs) or 50- to 400-kHz multi-beam echosounders (MBESs); usually 16- to 1,500-kHz side-scan sonar; marine magnetometers; and sediment profilers, including 0.5- to 24-kHz CHIRP subbottom profilers. On rare occasions, boomer subbottom profilers (300 to 3,000 hertz [Hz]) may be deployed. However, newer CHIRP systems are able to penetrate to comparable levels as the boomer with improved resolution, essentially eliminating the utility of boomers for marine minerals applications in the context discussed here (USDOI, GS, 2014). In addition, the SBESs usually employed are above 200 kHz, and the lower frequency (12 to 240 kHz) instruments are only used in muddy environments where fluid mud layers develop within dredge areas, typical of <5 percent of all survey areas. Operating frequencies listed above are further described in **Chapter 3.3.1.1 and Table 3.3-2**. **Table 3.1-1** shows the types of G&G activities associated with the Marine Minerals Program, and further descriptions of the surveys and equipment are included in **Appendix F**.

If preexisting regional scale sand resources data are not available, an early phase of regional reconnaissance sand search is conducted to define and map sediment bodies and to characterize the surficial geology of potential sand resources. The initial surveys are used to ascertain if sediment resources are of a certain quantity and quality (i.e., texture, mineralogy, percent sand, color) to warrant further exploration. The surveys may be conducted with line spacing between 120 and 600 m (394 and 1,968 ft). During the reconnaissance phase, limited geological sampling by vibracores or surface grab samples may occur along seismic lines and are used to validate geophysical data interpretations.

Geophysical survey equipment usually is deployed from a single, relatively small (8 to 30 m [26 to 98 ft]), slow-moving vessel having a survey speed <5 kn (6 mph). Because design level survey areas are small (3 to 10 km^2 [1.2 to 3.9 mi^2]) relative to oil and gas and renewable energy site characterization surveys, they are generally completed in 1 to 3 days (which rarely, if ever, include work in the dark).

Design-level surveys often are performed using the same instrumentation suite discussed previously once a relatively smaller area is identified as a promising target borrow area based on reconnaissance level or other preexisting sand resource data. Design-level surveys provide information on seafloor and sub-seafloor conditions, shallow hazards, infrastructure condition and location, archaeological resources, and sensitive benthic habitats. The data are often used to prepare a dredging plan to efficiently and economically obtain the needed sand volumes while minimizing adverse environmental impacts and avoiding existing infrastructure. Depending on the quality of the initial reconnaissance geophysical data, the data may also be used to refine the borrow area or determine horizontal and vertical continuity of sedimentary units (in which case, the survey may be subject to BOEM authorization).

Design-level surveys do not have a required line spacing for the full suite of instruments; however, because archaeological guidelines call for a 30-m (98-ft) line spacing for marine magnetometer surveys, the full suite usually is towed at this spacing. The surveys conducted for marine minerals site clearance employ marine magnetometers (in addition to the suite of tools discussed previously) to identify infrastructure and seafloor debris hazards within approximately 10 m (33 ft) of the seafloor and should not be confused with shallow hazards surveys. Shallow hazards surveys are conducted in support of oil and gas development, as defined by NTL 2008-G05, that requires operators to employ geophysical tools with usable frequency content across the 20- to 300-Hz band and are capable of penetrating the subsurface to at least 750 m (2,461 ft) below the seafloor to identify potential geological hazards such as faults and gas deposits.

Pre- and Post-Dredging Bathymetric Surveys

Bathymetric surveys that use SBESs (12 to 240 kHz) or MBESs (50 to 400 kHz) typically are performed at the borrow area, or within a subarea of the borrow area, before and at specified intervals after dredging. BOEM uses the surveys to monitor the location and volumes of sand dredging, ensure observance of stand-off distances, and monitor the morphologic evolution of sand bodies and borrow pits. If submerged cultural resources or sensitive benthic habitat and communities are in the immediate vicinity of dredging, side-scan sonar (16 to 1,500 kHz) may be deployed. Because survey areas are relatively small, bathymetric surveys generally are completed within 1 to 2 days. Operating frequencies listed above are further described in **Chapter 3.3.1.1 and Table 3.3-2**. **Table 3.1-1** shows the types of G&G activities associated with the Marine Minerals Program.

Prospecting and Geological (Geotechnical) Sampling

Geological sampling is typically conducted by means of pneumatic vibracoring, jet probes, or grab sampling, and is used to characterize the volume (footprint times thickness) and quality of a prospective sand body. Geotechnical sampling is most frequently done in connection with reconnaissance geophysical surveying but may occur at the design level as well. Of these techniques, vibracoring is the most common technique used to define the thickness and lateral extent of OCS sand bodies and to provide samples for borrow area sand compatibility and beach performance analysis. **Table 3.1-1** shows the types of G&G activities associated with the Marine Minerals Program, and further descriptions of the sampling equipment is included in **Appendix F, Section 2**.

Vibracoring generally uses a 7-centimeter (cm) (2.8-inch [in]) diameter core barrel mounted on a 1- to 4-m (3- to 13-ft) square platform or support assembly, and is deployed to penetrate sediment in the upper 3 to 13 m (10 to 43 ft) of the seafloor. A typical vibracore survey will obtain 10 to 25 cores (each approximately 6 m [20 ft] in length) within the AOI. Vibracoring may occur with diver and/or jet hose assistance.

Grab sampling penetrates <1 m (3.3 ft) below the seafloor and typically involves 30 to 40 grabs within the AOI. Nearly all geotechnical sampling occurs from relatively small (7 to 30 m [23 to 98 ft]) vessels, small work barges towed into place, or self-propelled lift boats.

Operators performing the range of geological sampling activity in support of the Marine Minerals Program have among their array of work boats those that are dynamically positioned (DP) (vessels that can automatically maintain position using propellers, rudders, and thrusters). Consequently, not all geological sampling includes bottom disturbance by anchoring. Approximately 25 percent of deployments for this sampling work could involve a boat having DP capability. The majority of operational platforms, however, do require anchoring for short periods using relatively small anchors or, offshore Louisiana, spuds on small lift boats.

Because geophysical exploration surveys for marine minerals employ the same suite of tools as those used during cultural resource surveys and because data collected are used for evaluations of cultural resources, sites for geological sampling are cleared prior to any seafloor-disturbing activities. In some cases, when geophysical surveying and geological sampling are done under a single mobilization, a project archaeologist clears potential sample locations in real time.

3.2.3.2 Projected Activity Levels

The Marine Minerals Program identified beach nourishment and coastal restoration projects likely to require use of OCS sand resources over the next 10 years, and employ some or all of the G&G techniques described in **Chapter 3.2.3.1**. Because this G&G activity is embedded in coastal restoration projects, projected marine minerals leasing activity serves as a good proxy for estimating levels of G&G activity. Therefore, this proposed activity scenario is based on an examination of past trends in OCS geological and geophysical activity and leasing activity and anticipated OCS leasing requests. The activity scenario is spatially and temporally explicit; however, because activity beyond the next 2 to 3 years is difficult to predict accurately, this scenario is not intended to limit G&G activity related to marine minerals to the exact list of restoration projects used for scenario development. **Tables 3.2-4 and 3.2-5** summarize the projected activity levels for G&G activities associated with the Marine Minerals Program over the 10-year period.

For each project listed, borrow area sand volumes are used as a proxy for calculating potential G&G activity levels; however, this analysis does not cover any activity associated with sand extraction except for sand search, design and clearance surveys, and dredging compliance bathymetry surveys. Note that G&G prospecting and design surveys have been completed for many of the Louisiana and Mississippi projects; therefore, only pre- and post-dredging surveys are considered for projects under this scenario.

Geophysical and Bathymetric Surveys

The activity level for geophysical activity in support of marine minerals is based on the following assumptions for two different survey types:

(1) sand search, borrow design, site characterization, and site clearance geophysical surveys (including those directed at hazards and biological and cultural resources) consist of a 0.5- to 24-kHz CHIRP subbottom profiler, marine magnetometer, >200-kHz swath or SBES, and 100- to 500-kHz side-scan sonar, and assume a 30-m (98-ft) line spacing; and

(2) pre- and post-dredging bathymetric surveys assume a line spacing of approximately twice the water depth (line spacing is determined by swath width, which increases with depth).

The number and size of borrow areas across known projects vary substantially. In some cases, specific borrow areas have yet to be identified. Nourishment volumes and frequency are comparatively well-defined for the relevant timeframe, except for potential use in critically eroding segments along the central west coast of Florida. Given a projected fill volume and assuming a typical cut depth (2.5 m [8 ft] for this case, with the exception of Florida where shallow limestone bedrock limits cut depth to approximately 2 m [7 ft]), the borrow area footprint can be estimated to calculate kilometers of survey line for each project. For these calculations, a borrow area footprint is assumed to be 0.3 km^2 (0.12 mi^2) per 1 million cubic yards (yd^3) of sand for each project. Based on instrument-dictated maximum survey speeds (<5 kn; 5.8 mph), a survey duration can be calculated from the estimated length of survey line for each project. Projections were verified by comparing historical prospecting, pre-dredging, and post-dredging survey kilometers of line with what would have been estimated strictly from anticipated volumes.

In some cases, sand search surveys are designed to cover areas containing up to twice the volume of sand required for the associated restoration project so that areas identified for dredging avoidance due to sensitive habitat, archaeological buffers, or slight variations in sand quality will not result in the need to deploy a subsequent survey effort to meet target sand volumes. To account for this practice, this scenario employs a multiplier of two, applied to each of the anticipated projects, effectively doubling the spatial and temporal G&G survey footprint for each project. Furthermore, because sand volumes in the borrow area often far exceed those that are actually excavated for the associated project, the remaining sand is often used for later projects where no new sand search or design-level surveys are required; however, this scenario anticipates a new survey for each project, further reinforcing the conservative nature of this scenario.

The geophysical surveying scenario for marine minerals in the GOM includes approximately 675 km (419 mi) of prospecting/design surveys over a cumulative duration of approximately 81 hours for the entire 10-year period of analysis and approximately 2,860 km (1,777 mi) of pre- and post-dredging bathymetric surveys with a cumulative duration of approximately 345 hours for the entire period of analysis (**Table 3.2-5**). Assuming 8-hour survey days, approximately 10 survey days of prospecting/design surveys would occur over the project period (or 1 survey day per year) and 43 days of bathymetry surveys would occur over the project period (or 4.3 survey days per year). However, all surveys are limited to daylight hours, and most surveys are 1 to 3 days in duration; therefore, there will be years in which no prospecting/design surveys occur. This scenario does not include similar activities that may occur in State waters or prospecting conducted by other Federal agencies or their contractors on the OCS. Similarly, G&G surveys associated with connected actions such as monitoring of nearshore environmental resources or beach fill performance are not included.

Geological or Geotechnical Surveys

Approximately 10 events for 392 pneumatic vibracores, 5 events for 50 jet probes, and 2 events for 90 grab samples are expected to occur in the AOI over the 10-year time period. The spatial distribution and timing are expected to be similar to that described for geophysical survey activity. It is assumed that approximately 8 to 10 vibracores per 1,000,000 yd^3 target volume will be sampled for each project with the exception of such projects on Florida's OCS, which require approximately 15 vibracores per 1,000,000 yd^3 target volume due to State color matching and quality requirements. Based on historical efforts, approximately 12 vibracores are sampled per day. Effects from marine minerals geophysical explorations are short-term and minor. Total seafloor disturbance from all combined geophysical activities for 532 samples with an average disturbance of 0.018 square meters (m^2),(0.194 square feet [ft^2]) per sample would be under 10 m^2 (107 ft^2) total.

3.3 IMPACT-PRODUCING FACTORS FROM THE PROPOSED ACTION

Table 3.2-6 summarizes the characteristics of G&G scenario activities for the three Program Areas (Oil and Gas, Renewable Energy, and Marine Minerals) and **Table 3.2-7** provides the sum of all proposed survey activities for all Program Areas. Based on the scenario, the following IPFs have been identified for routine activities undertaken during the proposed action:

(1) active acoustic sound sources;
(2) vessel and equipment noise;
(3) vessel traffic;
(4) aircraft traffic and noise;
(5) stand-off distance;
(6) vessel discharges;
(7) trash and debris;
(8) seafloor disturbance;
(9) drilling discharges; and
(10) entanglement.

The only IPF identified for accidental events is fuel spills. **Table 3.3-1** summarizes the IPFs with respect to the associated survey types and Program Areas.

3.3.1 Impact-Producing Factors for Routine Activities

3.3.1.1 Active Acoustic Sound Sources

Active acoustic sound sources included in the proposed action include airguns, boomers, sparkers, and CHIRP subbottom profilers; side-scan sonars; and MBESs. **Table 3.3-2** summarizes the characteristics of these sources. **Appendix F, Sections 1.1 through 1.3** provides detailed descriptions of the different survey types that use active acoustic sound sources. Detailed acoustic characteristics and assumptions for representative sources are discussed in **Appendix D, Section 3**. Representative active acoustic sound sources were modeled to provide estimates of acoustic propagation of these sources and marine mammal exposures for the proposed level of activity during the 10-year time period of this Programmatic EIS (**Appendix D, Section 5**).

As part of the development of this Programmatic EIS, BOEM's senior staff recognized a need to identify, quantify, and analyze all active acoustic source operations that might occur during G&G activities. The ultimate goal was for this process to indicate which sources and activities, based on their potential to affect the environment, required thorough analysis in this Programmatic EIS, and which sources and activities did not. BOEM created a Screening Out Team (ScOT) to examine the issue and make recommendations; the ScOT's results and recommendations are provided in **Appendix G**.

3.3.1.1.1 Airguns

Airguns would be used as seismic sources during deep-penetration seismic surveys for oil and gas exploration, and individual airguns would be used for some post-lease HRG surveys of oil and gas leases. BOEM predicts that no survey using airguns would be used for renewable energy site assessment activities (**Table 3.2-3**) or for assessment of marine minerals sites (**Table 3.2-5**).

An airgun is a stainless steel cylinder filled with high-pressure air. An acoustic signal is generated when the air is released nearly instantaneously into the surrounding water. During seismic surveys, seismic pulses are emitted at intervals of 5 to 30 seconds, and occasionally at shorter or longer intervals.

The acoustic characteristics of the representative airguns selected for modeling are discussed in **Appendix D, Sections 1.3 and 5**. Modeling was conducted to calculate incidental exposure levels for marine mammals from active acoustic sound sources associated with the proposed action (**Appendix D**). Although airguns have a frequency range from approximately 10 to 2,000 Hz, most of the acoustic energy is radiated at frequencies below 500 Hz. The amplitude of the acoustic impulse emitted from the source is equal in all directions, but airgun arrays do possess some directionality due to variable phase delays between airguns in different positions within an array.

Individual airguns are available in a wide range of chamber volumes, from <5 in^3 to more than 2,000 in^3, depending on survey requirements. Airgun sources can range from a single airgun (for some HRG surveys) to a large array of airguns (for deep-penetration seismic surveys). The volume of airgun arrays used for seismic surveys can vary from approximately 45 to 8,460 in^3. For this Programmatic EIS, the following two airgun configurations and sizes were modeled (**Appendix D, Section 1.3**), based on current usage in the GOM, and are considered representative of potential future G&G seismic surveys in the GOM:

- Large airgun array (8,000 in^3) – This array is used to represent sound sources for deep-penetration seismic surveys, including 2D, 3D narrow azimuth (NAZ), 3D WAZ, and other variations.
- Small single airgun (90 in^3) – This array is used to represent sound sources for HRG surveys using ariguns.

The modeling methods and justifications are described in **Appendix D, Section 5**. The large airgun array has dimensions of 48 by 15 m (157 by 49 ft) and consists of 6 subarrays, each with 12 airguns for a total of 72 airguns, and a separation distance of 9 m (30 ft) between subarrays. The volume of individual airguns ranges from 40 to 250 in^3. The depth below the sea surface for the array was set at 8 m (26 ft) for the large array. The small 90-in^3 airgun had a tow depth of 4 m (13 ft).

Broadband source levels are 248 and 228 decibels (dB) re 1 µPa at 1 m for the large and small airgun arrays, respectively (**Table 3.3-2**). The two airgun configurations differ in source level and frequency spectrum; large arrays generate sound with more energy at low frequencies due to the presence of large volume airguns. Different survey scenarios to represent the various survey types performed in the GOM were analyzed as well (**Appendix D, Section 5**). **Appendix F, Sections 1.1 and 1.2** provide detailed descriptions of the survey types using airguns.

3.3.1.1.2 Non-Airgun (Electromechanical) HRG Sources

In non-airgun HRG surveys, a high-resolution boomer, sparker, or CHIRP subbottom profiler is used to delineate near-surface geologic strata and features. Typical survey deployments also include SBESs or MBESs and side-scan sonars, which often are towed on an autonomous underwater vehicle. These electromechanical sources may operate simultaneously with airguns during deep-penetration seismic surveys. Boomer use in shallow water is rare for the Marine Minerals Program because it provides an approximately 0.5- to 1-m (1.6- to 3.3-ft) resolution, and it is typically replaced with subbottom profiling systems that have sufficient depth penetration and higher resolution (note that it was kept in the analysis because it may be used to examine ancient, sediment-filled, river channels in the future) and that, in Renewable Energy Program surveys, it is more commonly used.

Boomers generate short, broadband acoustic pulses that are useful for high-resolution, shallow penetration sediment profiling. Boomers are commonly mounted on a sled and towed off the stern or alongside a ship. The reflected signal is received by a towed hydrophone streamer. Sparkers provide seafloor profiles, but boomers were selected as a representative source for this Programmatic EIS because the acoustic impulses produced by both sources are similar. The CHIRP systems are used for high-resolution mapping of relatively shallow deposits and have less penetration than boomers; however, newer CHIRP systems are able to penetrate to levels comparable to boomers yet yield extraordinary resolution of the substrate (NSF and USDOI, GS, 2011). The MBESs emit brief impulses of medium- or high-frequency sound in a fan-shaped beam extending downward and to the sides of the ship, allowing bathymetric mapping of swaths of the seafloor. The SBESs may be used for seafloor mapping, but the boomer was selected as a representative source for this Programmatic EIS and is conservative from the standpoint of acoustic impacts. Further details regarding non-airgun HRG acoustic sound sources are provided in **Appendix F, Section 1.3**.

The acoustic characteristics of the modeled electromechanical sources are discussed in **Appendix D, Section 5** and included a boomer as well as a suite of MBESs, side-scan sonars, and subbottom profilers. Electromechanical sources are considered mid- or high-frequency sources. They usually have one or two (sometimes three) main operating frequencies (**Table 3.3-2**). The frequency ranges for the representative sources used for modeling are 100 Hz to 10 kHz for boomers, 100 to 410 kHz for side-scan sonars, 0.5 to 24 kHz for CHIRP subbottom profilers, and 200 kHz for MBESs. For these sources, the acoustic energy emitted outside the main operating frequency band is minute; therefore, these can be considered narrow-band sources. High-frequency electromechanical sources can be highly directive, with beam widths as narrow as a few degrees or less. Broadband source levels for the representative electromechanical sources analyzed in this Programmatic EIS range from 200 to 213 dB re 1 μPa at 1 m sound pressure level (SPL) (**Table 3.3-2**).

A BOEM-funded field verification study of electromechanical sound sources was conducted in 2012 and examined sound emissions from a subbottom profiler (Zykov and MacDonnell, 2013). The study measured sound emissions of a subbottom profiler in a shallow-water and a deepwater location and compared the field results with results of the modeling conducted specifically for the preparation of the “Atlantic OCS Proposed Geological and Geophysical Activities: Mid-Atlantic and South Atlantic Planning Areas; Final Programmatic EIS” (USDOI, BOEM, 2014b). Zykov and MacDonnell (2013) demonstrated for the locations where the field verification was conducted that the received levels and threshold radii were much lower than previously thought. For 180 and 160 dB re 1 µPa, the threshold radii were measured at 2 and 29 m (7 and 95 ft), respectively.

3.3.1.2 Vessel and Equipment Noise

3.3.1.2.1 Vessel Noise

Nearly all G&G activities in the proposed action scenario would be conducted from ships. The exception would be remote-sensing methods from aircraft and satellites, and some VSP surveys. The most extensive vessel activities are 2D and 3D seismic surveys for oil and gas, which could occur anywhere in the AOI. Vessels conducting G&G surveys or sampling for renewable energy would be operating at specific sites (consisting of one or more OCS lease blocks), in water depths <40 m (131 ft), and along potential cable routes to shore. Vessels conducting G&G surveys or sampling for marine minerals would be operating at specific borrow sites in water depths <30 m (98 ft). Nearly all marine minerals geotechnical sampling occurs from relatively small (7 to 30 m [23 to 98 ft]) vessels, small work barges towed into place, or self-propelled lift boats.

Vessel noise is one of the main contributors to overall noise in the sea (NRC, 2003a). The G&G survey vessels would contribute to overall noise by transmitting noise through air and water. Vessel noise is a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995). Tones typically dominate up to approximately 50 Hz. The majority of broadband sound energy is restricted to frequencies below 100 to 200 Hz, but broadband sounds may include sound energy at frequencies as high as 100 kHz.

The primary sources of vessel noise are the propeller and machinery. Ship-generated noise at frequencies <50 Hz is dominated by sound produced by propeller cavitation, which results from high thrust loading and non-uniform inflow of water into a propeller (Wright, 2008). Some propellers may produce a high-pitched noise, often referred to as propeller singing. This sound usually is a clear harmonic tone within the practical frequency range of approximately 10 to 1,200 Hz, although the audible range of singing can be as high as 12,000 Hz (HydroComp, Inc., 2003).

Primary sources of machinery noise include diesel-powered propulsion engines and ship service engines (Wright, 2008). Other sources of noise include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation usually is the dominant noise source. The intensity of noise from support vessels is approximately 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 unladen vessels. For a given vessel, relative noise tends to increase with speed. Ship noise radiates asymmetrically, with stern aspect noise levels higher than bow aspect levels by 5 to 10 dB (McKenna et al., 2012). Broadband source levels for most small ships (a category that would include seismic survey vessels and support vessels used when drilling COST wells or shallow test wells) are anticipated to be in the range of 170 to 180 dB re 1 µPa at 1 m (Richardson et al., 1995). Broadband source levels for smaller boats (a category that includes survey vessels for renewable energy and marine minerals sites) are in the range of 150 to 170 dB re 1 μPa at 1 m (Richardson et al., 1995).

Noise levels from project-related survey and survey support vessel traffic would be spatially restricted to discrete survey areas or OCS lease blocks and of relatively short-term duration. It is predicted that additional vessel traffic will contribute to elevated local ambient noise levels during surveys; however, it is expected that these levels would dissipate quickly with distance from the source.

3.3.1.2.2 Equipment Noise Including Drilling Noise

Drilling of COST and shallow test wells would introduce additional underwater noise into the AOI from engines, generators, and other drilling rig equipment. The oil and gas scenario assumes that up to one COST well and up to two shallow test wells would be drilled in the planning areas during the 10-year time period of this Programmatic EIS. Neither the well locations nor the types of drilling rig are known at this programmatic stage. Jack-up rigs typically are used in water depths <100 m (328 ft) (USDOI, BOEM, 2017a). Semisubmersibles are floating rigs that are used in water depths ranging from 100 to 3,000 m (328 to 9,842 ft); these can be moored or DP. Drillships are used in water depths greater than approximately 600 m (1,968 ft) and can also be moored or, more commonly, DP.

Noise from drilling operations includes strong tonal components at low frequencies (<500 Hz), including infrasonic frequencies in at least some cases (Richardson et al., 1995). Machinery noise can be continuous or transient and can vary in intensity. Noise levels vary with the type of drilling rig and water depth. Drillships produce the highest levels of underwater noise because the hull containing the rig generators and drilling machinery is well coupled to the water. In addition, DP drillships use thrusters to maintain position and are constantly emitting engine and propeller noise. The noise levels produced by DP vessels largely depend on the level of thruster activity required to keep position, and therefore will vary based on environmental site conditions and operational requirements. Representative source levels for DP vessels range from 184 to 190 dB re 1 μPa, with a primary amplitude frequency below 600 Hz (Kyhn et al., 2011; Blackwell and Greene, 2003; McKenna et al., 2012). Jack-up rigs are at the other end of the spectrum because they are supported by metal legs with only a small surface area in contact with the water, the drilling machinery is located on decks well above the water, and there is no propulsion noise. Semisubmersibles are intermediate in noise level because the machinery is located well above the water, but the pontoons supporting the structure have a large surface area in contact with the water. Richardson et al. (1995) noted that broadband source levels for semisubmersible rigs have been reported to be approximately 154 dB re 1 μPa. Drilling operations would be supported by crew boats, supply vessels, and helicopters traveling between the drilling rig and the shore base. Support vessels usually make a few round trips per week, and helicopters typically make one round trip per day (**Table 3.3-3**).

3.3.1.3 Vessel Traffic

The G&G activities in all three Program Areas involve vessel traffic. All of the vessels involved in G&G activities would operate from shore bases. Ports and shore bases serve as launching points for the structures, equipment, supplies, and crew that serve the offshore G&G industry. In addition to providing berthing space, fuel, and supplies, shore bases may provide products and services such as engine repair, electric generators, chains, gears, tools, pumps, compressors, and a variety of other tools and equipment.

Vessels conducting 2D, 3D, 4D, and WAZ seismic airgun surveys are the largest vessels and would account for most of the vessel line miles estimated for the proposed action. Estimated line miles for these four survey types total 2,469,030 line nmi (2,841,309 mi; 4,572,644 km) (**Table 3.2-6**). These surveys could occur anywhere within the planning areas; however, approximately 64 percent of the surveys are expected to take place in the CPA, 27 percent in the WPA, and the remaining 9 percent in the EPA (**Table 3.2-1**).

Vessels conducting G&G surveys for oil and gas exploration would operate predominantly in water depths of ≥40 m (131 ft) on large survey prospect areas and for extended periods of time. Vessels conducting G&G surveys or sampling for renewable energy would be smaller and would operate at specific sites consisting of one or more OCS lease blocks in water depths <40 m (131 ft) and along potential cable routes to shore. Similarly, vessels conducting G&G surveys or sampling for marine minerals would be operating at specific borrow sites in water depths <30 m (98 ft). Survey vessels for renewable energy and marine minerals projects are expected to make daily round trips to their shore bases, whereas the larger seismic vessels can remain offshore for weeks or months. Additionally, combined marine mineral-associated vessel traffic would be approximately 53 days total, i.e., 10 survey days for prospecting/design surveys, and 43 days for bathymetric surveys.

3.3.1.3.1 Surveys for Oil and Gas Exploration

Seismic survey vessels used for deep-penetration seismic airgun surveys typically are 60 to 90 m (197 to 295 ft) long for 2D surveys and 80 to 90 m (262 to 295 ft) long for 3D, 4D, and WAZ surveys. The 3D, 4D, and WAZ surveys usually require larger vessels because there is more equipment to be towed. Survey vessels for 2D, 3D, 4D, and WAZ surveys are likely to remain offshore for most, if not all, of the survey duration. The larger ships used for seismic surveys typically are foreign-flagged vessels that may mobilize from ports outside the AOI, but they may periodically travel to a shore base in the AOI for service. Typical towing speed during a survey is 4.5 kn (5.2 mph). These surveys could occur anywhere within the planning areas, with 24-hour operations that may continue for weeks or months, depending on the size of the survey. Seismic survey vessels may transit into the GOM and stay within the survey area for the duration of the survey with no port calls. Therefore, while these survey vessels contribute a large percentage of the total vessel line miles over the 10-year time period, the majority of the line miles are at slow vessel speeds and likely represent only a small portion of vessel transits between offshore and shore bases (**Table 3.3-3**). As such, most supply runs, crew transfers, and refueling must be done with smaller, faster support vessels and helicopters. The smaller vessels are classified as support vessels in the IPF analysis and include supply ships, crew boats, fuel boats, USCG boats, and guard vessels. Deep-penetration seismic airgun surveys conducted in association with a platform or drill ship (e.g., VSP and SWD) are shorter in duration, and while they may use typical 2D or 3D vessels, more commonly a supply vessel or similar platform approximately 30 to 60 m (98 to 197 ft) in length is used for drilling-based surveys (**Table 3.2-6**). These surveys typically do not require any support vessels due to their shorter durations and associations with a drilling platform.

The proposed action scenario for oil and gas (**Table 3.2-7**) includes 103,025 line mi (174,924 line km) of HRG surveys; 149,800 line mi (241,080 line km) of 2D streamer surveys; 16,962 line mi (27,298 line km) of VSP surveys; 2,319,230 mi (3,732,439 line km) of 3D, 4D, and WAZ streamer surveys; and 8,120 line mi (13,068 line km) of CSEM surveys, for a total of 2,597,137 line mi (4,179,687 line km). Assuming a vessel speed of 4.5 kn (5.2 mph), these surveys would represent approximately 499,450 hours (20,811 days) of active seismic data acquisition. This estimate does not include transit times; non-acquisition periods (e.g., mobilization, testing, turns, ramp-ups); downtime for weather, mitigation, and mechanical and regular services; data re-acquisition time; or multiple vessel components of a survey. Therefore, to take into account the full vessel activity required to assess vessel traffic as an IPF, the non-active and active seismic acquisition time is considered a survey "event." A survey event takes into account all vessel and aircraft activities necessary to complete a seismic survey from beginning to end. Seafloor sampling for oil and gas exploration includes up to 100 CPTs, 795 corings, 1 grab sample, 2 drill test wells, and up to 1 COST well. Like the seismic surveys, the vessels and time required to complete sampling activities are considered as a whole for each event.

These surveys and sampling events may be undertaken with support vessels operating from ports along the Gulf Coast, but support vessel use is not a requirement. For this analysis, seven potential deepwater shore bases were identified: Houston, Texas; Corpus Christi, Texas; Beaumont, Texas; Galveston, Texas; New Orleans, Louisiana; Mobile, Alabama; and Tampa, Florida. These ports were selected based on their geographic proximity to the AOI, the locations named in permit applications for G&G activities, and the availability of adequate support facilities that could be used by G&G survey and support vessels.

It is impossible to characterize a typical seismic survey (Hannay et al., 2011) due to the variability in survey design, implementation, and operating conditions. However, based on information from operators in the GOM and from lease sale EISs (e.g., USDOI, BOEM, 2013c, 2013d, and 2017a), some generalities were applied to develop vessel traffic statistics (**Tables 3.2-6 and 3.2-7**) as part of this IPF assessment. Assumptions for each oil and gas survey type are as follows:

- average duration for a survey vessel at sea without accessing a port for 2D, 3D, 4D, and WAZ survey vessels is 10.5 months;

- average duration for a survey vessel at sea without accessing a port for all other surveys and sampling is <1 month;
- average duration of a support vessel at sea without accessing a port is 14 days;
- number of crew changes is based on a 5-week rotational schedule with change out of personnel every 2.5 weeks to achieve 50 percent crew overlap; and
- 90 percent of crew changes on all deep-penetration seismic airgun surveys are done via helicopter while 10 percent are done with vessels.

Based on these assumptions and the projected level of survey activity (**Table 3.2-6**), an estimated 993 transits to or from shore will be made by the survey vessels and 19,689 transits will be made by service and support vessels for oil and gas surveys (**Table 3.3-3**). An estimated 7,497 helicopter trips will be required to support crew changes on active seismic surveys.

3.3.1.3.2 Renewable Energy Surveys

Vessels conducting G&G surveys or sampling for renewable energy development would operate mainly at specific sites consisting of one or more OCS lease blocks in water depths generally <40 m (131 ft) and along potential cable routes to shore. As discussed in **Chapter 3.2.2**, development of renewable energy is likely only offshore southeast Texas. While it is recognized that 24-hour surveys occur for renewable energy surveys in the Atlantic Ocean, typically in the GOM, the vessel would return to its shore base daily. Therefore, for the purposes of this assessment, the following is assumed:

- all surveys work an 8- to 12-hour offshore shift requiring 1 daily transit between the port and the survey site;
- the average number of days required to complete a survey is used in calculating the number of transits; and
- survey vessels on site operate at slow speeds but may increase speed during transit.

In nearshore waters, non-airgun HRG surveys would be conducted by a single small (<23 to 30 m [75 to 98 ft]) vessel moving at <5 kn (6 mph). Geotechnical surveys for renewable energy sites are expected to be conducted from a small barge or ship of similar size.

While there are no renewable energy projects planned in OCS waters of the GOM, for the purposes of this analysis, the renewable energy scenario includes 5,587 km (3,472 mi) and 667 hours (assuming 4.5 kn [5.2 mph]) of non-airgun HRG surveys (**Table 3.2-7**). Assuming that non-airgun HRG survey vessels would operate on 8-hour work days, the scenario would require 83 active survey days. Five survey vessel transits are estimated (**Table 3.2-6**). However, survey vessels may return to port daily, depending on site location and vessel type.

Included in the renewable energy scenario are a maximum of 810 geotechnical sampling locations where cone penetrometer testing, geologic coring, and grab sampling would be conducted. There are nine projected survey events necessary to complete this sampling scenario.

Two projected bottom-founded monitoring buoy placements are included in this scenario. Based on the average duration of these activities and the presumed daily transits, there are an additional 34 round-trip vessel transits anticipated for the renewable energy geological and buoy placement surveys. Vessel trips associated with renewable energy areas would use existing ports in southeast Texas.

3.3.1.3.3 Marine Minerals Surveys

For non-airgun HRG surveys of sand source areas, geophysical survey equipment typically is deployed from a single vessel <20 to 30 m (66 to 98 ft) long, moving at approximately 4.5 kn (5.2 mph). Surveys are likely to focus on prospective borrow sites (3 to 10 km^2 [1.2 to 3.9 mi^2]) or reconnaissance areas (1 to 3 OCS lease blocks), and each survey is assumed to require 3 to 7 operational days for completion. Vessels are assumed to operate on site for 8 hours per day and return to the shore base at the end of each day.

The marine minerals scenario includes approximately 673 km (418 mi) of non-airgun HRG prospecting surveys, 1,155 km (718 mi) of non-airgun HRG pre-lease/design surveys, and 1,706 km (1,060 mi) of on-lease HRG surveys (**Table 3.2-5**). Across all geophysical survey activities, the maximum activity level is estimated at 3,534 km (2,196 mi); this is the equivalent of approximately 425 hours of surveying across 8-hour operational survey days (**Table 3.2-5**). Given the projected number of surveys, the scenario would require 53 to 126 vessel round-trips.

Nearly all geotechnical sampling occurs from relatively small vessels (approximately 20 m [66 ft] in length) or from work barges towed into place. A typical survey would last 3 to 5 days (**Table 3.2-6**). The marine minerals scenario includes a maximum of 90 grab samples, 50 jet probes, and 392 pneumatic vibracoring deployments (**Table 3.2-4**). Seventeen geotechnical sampling surveys are projected for the period (**Table 3.2-6**), and given the average duration of the specific survey types, an estimated 64 round-trip vessel transits would be associated with these surveys. Vessel trips associated with marine minerals activities would be divided among several existing ports in Texas, Louisiana, Alabama, and Florida. Depending on the location of the marine mineral area, the surveys could operate from one of the larger ports analyzed in this Programmatic EIS (i.e., Houston, Corpus Christi, Galveston, Beaumont, New Orleans, Mobile, or Tampa) or any number of smaller ports along the coast, depending on what is convenient.

3.3.1.4 Aircraft Traffic and Noise

BOEM anticipates that only one aeromagnetic survey would be conducted in the AOI during the time period covered by this Programmatic EIS. The survey would be conducted by fixed-wing aircraft flying at speeds of approximately 135 kn (155 mph) (Reeves, 2005). Based on aeromagnetic datasets posted by Fugro Gravity and Magnetic Services (2012) for the northern GOM, most offshore aeromagnetic surveys are flown at altitudes between 61 and 152 m (200 and 499 ft) and collect 9,321 to 37,284 line mi (15,000 to 60,000 line km) of data. Line spacing varies depending on the objectives, but typical grids are 0.5 × 1.0 mi or 1.0 × 1.0 mi (0.8 × 1.6 km or 1.6 × 1.6 km). A broad-scale survey would be flown at higher altitudes (e.g., 305 m [1,001 ft]) and use wider line spacing (e.g., 4 × 12 mi or 8 × 24 mi [6 × 19 km or 13 × 39 km]). A fixed-wing aircraft typically acquires 12,428 line mi (20,000 line km) of useful data per month (Reeves, 2005). Therefore, it is expected that a typical aeromagnetic survey would require 1 to 3 months to complete. Based on the scale of aeromagnetic surveys that have been conducted in the northern GOM, an individual survey probably would cover <10 percent of the AOI.

Helicopters are used extensively in the offshore industry throughout the GOM. Helicopters are a potential source of aircraft noise during all G&G activities in the GOM and are most heavily used for personnel transport during vessel- and platform-based seismic surveys that stay on site for extended periods. 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). These helicopters also follow Federal Aviation Administration (FAA) Minimum Altitudes over "coastal game reserves" (bird strike issues), cruising altitudes for easterly and westerly headings, altitude restrictions over certain offshore fields, and the operators' contractual guidelines. These helicopters follow these recommendations and restrictions as applicable and with weather permitting. For this analysis, survey crew changes are assumed to be on a 5-week rotational schedule with a minimum 50 percent overlap required for transferring personnel (i.e., a minimum of 1 flight every 2.5 weeks to change personnel). Based on the projected number of seismic surveys for oil and gas operations, a minimum of 7,497 helicopter transits associated with the active G&G surveys is estimated for the 10-year period (**Table 3.3-3**). The oil and gas scenario assumes that up to one COST well and up to two shallow test wells would be drilled in the planning areas during the time period of this Programmatic EIS. It is expected that drilling activities would be supported by a helicopter making one round trip daily between the drilling rig and shore base. Neither the well locations nor the location of potential helicopter shore bases are known at this programmatic stage.

Helicopters and fixed-wing aircraft generate noise from their engines, airframe, and propellers. The dominant tones for both types of aircraft generally are below 500 Hz (Richardson et al., 1995). Richardson et al. (1995) reported that received SPLs (in water) from aircraft flying at altitudes of 152 m (499 ft) were 109 dB re 1 μPa for a Bell 212 helicopter and 101 dB re 1 μPa for a small fixed-wing aircraft such as a BN Islander aircraft. Helicopters are approximately 10 dB louder than fixed-wing aircraft of similar size (Richardson et al., 1995). Penetration of aircraft noise into the water is greatest directly below the aircraft; at angles >13° from the vertical, much of the sound is reflected and does not penetrate into the water (Richardson et al., 1995). The duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 152 m (499 ft) that is audible in air for 4 minutes may be detectable underwater for only 38 seconds at 3-m (10-ft) depth and for 11 seconds at 18-m (59-ft) depth (Richardson et al., 1995).

3.3.1.5 Stand-Off Distance

The proposed action includes extensive 2D and 3D surveys involving towed-streamer arrays. The scenario includes 149,800 line mi (241,080 line km) of 2D streamer surveys; 2,319,230 line mi (3,732,439 line km) of 3D streamer, 4D, and WAZ surveys; and 8,120 line mi (13,068 line km) of CSEM surveys (**Table 3.2-7**). These surveys could occur anywhere within the planning areas.

Vessels towing streamers during 2D, 3D, 4D, and WAZ seismic surveys follow pre-plotted track lines and have limited maneuverability during data acquisition. Accordingly, seismic vessels typically are accompanied by an escort vessel, which is used to scout the route ahead, identify hazards such as adverse currents, vessel traffic, or fishing equipment, and to ensure that other vessels do not cross over or interfere with the equipment being towed.

For safety and security reasons, survey operators attempt to keep an area around the source vessel and its towed-streamer arrays clear of other vessel traffic and marine hazards that could result in a space-use conflict or interaction with other vessels. For the proposed action, this is defined as the “stand-off distance.” Depending on the survey and region, other names for this area include separation distance, fisheries exclusion zone, vessel clearance zone, or safety zone. The size of the stand-off distance that would be maintained around a source vessel and its towed-streamer arrays varies depending on the array configuration. A typical stand-off distance would be approximately 8.5 km (4.6 nmi; 5.3 mi) long and 1.2 km (0.6 nmi; 0.7 mi) wide, covering a total of 1,021 ha (2,523 ac) of the sea surface. With the source vessel moving at speeds of approximately 4.5 kn (5.2 mph), the length of time that any particular point would be within the stand-off distance would be approximately 1 hour.

The stand-off distance is an area monitored by a seismic survey operator and has no formal status or designation by the USCG. Prior to conducting a seismic survey, operators would submit information to the local USCG office and the local Harbormaster for issuance of a Local Notice to Mariners. The Local Notice to Mariners would specify the survey dates and locations as well as the recommended avoidance requirements. The wording of these notices is general (e.g., “a wide berth is urged”). All vessels operating with restricted maneuverability are required to carry the lights and signals described in Rule 27 of International Regulations for Preventing Collisions at Sea (COLREGS). Towed streamers are marked with an orange buoy equipped with a flashing light and radar reflector.

3.3.1.6 Vessel Discharges

Operational waste generated from vessels associated with the proposed action includes bilge and ballast waters, trash and debris, and sanitary and domestic wastes. Bilge water is water that collects in the lower part of a ship; it may be contaminated by oil that leaks from the machinery within the vessel. The discharge of any oil or oily mixtures of >15 parts per million (ppm) is prohibited under 33 CFR § 151.10. Ballast water is used to maintain the stability of the vessel. Generally, ballast water is pumped into and out of separate compartments and is not contaminated with oil. In March 2012, the USCG issued Ballast Water Discharge Standards enumerating the requirements for the management of ballast (33 CFR part 151 subpart D); additionally, USCG regulations specify certain technologies be applied on vessels for treatment of ballast water prior to discharge. The U.S. Environmental Protection Agency (USEPA) provides National Pollutant Discharge Elimination System (NPDES) permit coverage for ballast water from commercial vessels of all sizes through the Final 2013 Vessel General Permit, which only covers NPDES permits for incidental discharges from commercial vessels >79 ft (24 m) in length. The changes are included in the USEPA's Final 2013 Vessel General Permit and the Final 2014 Small Vessel General Permit, which provides NPDES permit coverage for discharges incidental to the normal operation of nonmilitary, nonrecreational vessels <79 ft (24 m) (i.e., "small vessels") operating as a means of transportation.

3.3.1.7 Trash and Debris

Marine debris (here termed trash and debris) is defined as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally disposed of, or abandoned into the marine environment (USDOC, NOAA, 2015a). Survey operations generate trash made of paper, plastic, wood, glass, and metal that are managed as a part of routine operations but which accidentally could be lost overboard. Most trash is associated with galley and offshore food service operations. Occasionally, some personal items such as hardhats and personal flotation devices are lost overboard accidentally. Discarded trash and debris is a major form of marine pollution.

The most common materials that compose trash and debris are plastics, glass, metal, paper, cloth, rubber, and wood. Like plastics, glass, metal, and rubber are used for a wide range of products, and while they can be worn away or broken down into smaller fragments, they generally do not biodegrade entirely.

The types of objects most commonly encountered in offshore waters are plastic bags, wrappers, bottles, and cups; raw plastic pellets; synthetic rope; glass bottles; metal cans; lumber; and cigarette butts (Laist, 1996 and 1997; Barnes et al., 2009; Gregory, 2009). Factors that account for recent increases in trash and debris include unlawful disposal practices, proliferation of synthetic materials that are resistant to degradation in the marine environment, and increasing numbers of people using and disposing of more synthetic items (USDOC, NOAA, 2015a).

The discharge of trash and debris is prohibited unless it is passed through a comminutor (a machine that breaks up solids) and can pass through a 25-millimeter (mm) (1-in) mesh screen (33 CFR §§ 151.51 through 151.77). Discharge of plastic is prohibited regardless of size. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste.

The USCG and USEPA's regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. In addition, over the last several years, companies operating offshore have developed and implemented trash and debris reduction, and have improved handling practices to reduce the amount of offshore trash that could be lost into the marine environment. Trash management practices include replacing Styrofoam cups and dishes with those made of paper and ceramic, recycling offshore trash, and transporting and storing supplies and materials in bulk containers when feasible. These practices have resulted in a reduction of accidental loss of trash and debris.

Under the proposed action, all authorizations for shipboard surveys would include guidance for trash and debris awareness as described in NTL 2015-BSEE-G03 ("Marine Trash and Debris Awareness and Elimination"). All vessel operators, employees, and contractors actively engaged in G&G surveys must be briefed on trash and debris awareness and elimination as described in the NTL. An applicant would be required to ensure that its employees and contractors are made aware of the environmental and socioeconomic impacts associated with trash and debris disposal, as well as their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment.

3.3.1.8 Seafloor Disturbance

Sources of seafloor disturbance in the proposed action include the following:

- seafloor sampling activities in all three Program Areas;
- placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor for various activities in the Oil and Gas Program;
- COST well and shallow test drilling in the Oil and Gas Program; and
- placement of bottom-founded monitoring buoys in the Renewable Energy Program.

BOEM will require site-specific information regarding potential archaeological resources and sensitive benthic communities (including hard/live bottom areas, deepwater coral communities, and chemosynthetic communities) prior to approving any G&G activities involving seafloor-disturbing activities or placement of bottom-founded equipment or structures in the planning areas. BOEM will use this information to ensure that physical impacts to archaeological resources or sensitive benthic communities are avoided.

BOEM has designated specific benthic locations for avoidance in the planning areas, including high-density deepwater benthic communities and biologically sensitive topographic features. These areas for benthic disturbance avoidance include known hard/live bottom areas; chemosynthetic communities; known deepwater coral locations, including *Lophelia* and *Oculina* coral sites and deepwater coral HAPCs; deepwater MPAs; pinnacle trend features (Shelf Edge Banks such as the Flower Gardens); and archaeological sites. These benthic features and MPAs are discussed in **Chapters 4.5.1 and 4.7.1**. All authorizations for G&G surveys proposed within or near these areas would be subject to review to facilitate avoidance. BOEM has developed specific buffer zones for sensitive benthic communities in the GOM.

For the Renewable Energy Program, BOEM has issued "Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585." The July 2015 revised guidelines specify that a site characterization survey must reliably cover any portion of the site that would be affected by seafloor-disturbing activities. The guidelines recommend avoidance as a primary mitigation strategy for objects of historical or archaeological significance. An applicant has the option to demonstrate through additional investigations that an archaeological resource either does not exist or would not be adversely affected by the seafloor-disturbing activities. While site characterization activities covered by these guidelines could identify other resource types (e.g., benthic communities), recommendations for conducting and reporting the results of other (e.g., biological) baseline collection studies would be provided by BOEM in separate guidelines, e.g., Guidelines for Providing Benthic Habitat Survey Information for Renewable Energy Development.

3.3.1.8.1 Seafloor or Bottom Sampling Activities

The proposed action scenario includes seafloor sampling activities in all three Program Areas, including the following:

- up to 896 CPTs, coring, or grab samples in the Oil and Gas Program;
- up to 810 CPTs, coring, or grab samples in the Renewable Energy Program; and
- up to 90 grab samples, 50 jet probes, and 392 vibracores in the Marine Minerals Program.

Collection of each sample is estimated to disturb an area of approximately 10 m^2 (108 ft^2), although the actual area of the core or grab extracted may be much smaller. If all of the samples (total of 2,238) in the proposed action scenario were collected, the total area of seafloor disturbed by bottom sampling is expected to be approximately 22,380 m^2 (240,896 ft^2) (**Table 3.2-7**), which represents an extremely small percentage of the planning areas.

Sampling for oil and gas exploration would be conducted at specific OCS lease blocks where structures such as drilling rigs, platforms, or pipelines might be installed. The OCS lease blocks could be anywhere within the planning areas and cannot be specified as there are many active oil and gas leases in the GOM.

Sampling for renewable energy projects would occur at specific sites consisting of one or more OCS lease blocks in water depths <40 m (131 ft) and along potential cable routes to shore. As discussed in **Chapter 3.2.2.1**, southeast Texas in the WPA has the highest potential for wind resources. These offshore areas would likely be where sampling would occur. No areas currently are being considered for hydrokinetic power.

Sampling activities for marine minerals would be conducted at specific sand resource areas in water depths <25 m (82 ft). As discussed in **Chapter 3.2.3.1**, much of the marine minerals activity is expected to occur within existing borrow sites offshore Texas, Louisiana, Alabama, and the west coast of Florida. By design, the sampling locations are expected to be almost exclusively sand bottom.

3.3.1.8.2 Placement of Anchors, Nodes, Cables, and Sensors

Certain surveys in oil and gas exploration require placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor. Ocean bottom seismic surveys include ocean-bottom cable (OBC) and ocean-bottom node (OBN) surveys, vertical cable surveys, CSEM surveys, and MT surveys involve placement of sensors and anchors on the seafloor (**Appendix F, Section 1.1.3**). Each of these activities would temporarily affect a small area of seafloor. After a survey is completed, the sensors are removed; anchors are removed or, if biodegradable, left in place. The OCS lease blocks where these surveys would be conducted could be anywhere within the planning areas and cannot be predicted as there are many active oil and gas leases in the GOM. The total area of disturbed seafloor for future placement of anchors, nodes, cables, and other such equipment has not been calculated.

3.3.1.8.3 COST Wells and Shallow Test Drilling

The oil and gas scenario assumes that up to one COST well and up to two shallow test wells would be drilled in the planning areas during the time period of this Programmatic EIS. Locations for COST wells and shallow test wells are unknown.

The COST wells and shallow test wells would be drilled using conventional rotary drilling techniques. Seafloor disturbance would result from anchoring (if a moored drilling rig was used), placing a well template on the seafloor, and jetting the well. The area of seafloor disturbance varies with the type of rig chosen to drill a well, which depends primarily on water depth (USDOI, BOEM, 2012, and 2017a). Jack-up rigs are used in shallow water and disturb approximately 1 hectare (ha) (2.5 ac) at each location. Semisubmersibles can be operated in a wide range of water depths and disturb approximately 2 to 3 ha (5 to 7 ac), depending on their mooring configurations. In water depths >600 m (1,968 ft), DP drillships could be used; these drillships disturb only a very small area where the seafloor template and wellbore are located, approximately 0.25 ha (0.62 ac).

For this impact analysis, the area of seafloor disturbance is assumed to average approximately 2 ha (5 ac) per well. If the COST well and both shallow test wells in the proposed action scenario were drilled, the total seafloor disturbance would be approximately 6 ha (15 ac), or approximately 0.00001 percent of the AOI.

3.3.1.8.4 Bottom-Founded Monitoring Buoys

As part of the Renewable Energy Program, lessees may install bottom-founded monitoring buoys. This Programmatic EIS assumes that lessees would choose to install buoys instead of meteorological towers. The buoys would be anchored at fixed locations and regularly collect observations from many different atmospheric and oceanographic sensors.

Monitoring buoys typically would be towed or carried on board a vessel to the installation location. Once at the location site, the buoy would be lowered to the sea surface from the deck of the transport vessel or placed over the final location and then the mooring anchor dropped. A boat shaped buoy in shallower waters of the planning areas may be moored with an all-chain mooring, while a larger discus type buoy would use a combination of chain, nylon, and buoyant polypropylene materials (USDOC, NOAA, 2012a). After installation, the transport vessel would remain in the area for several hours while technicians configure proper operation of all systems. Buoys typically take 1 day to install. Transport and installation vessel anchoring for 1 day is anticipated for these types of buoys. Decommissioning of buoys is essentially the reverse of the installation process.

The proposed action scenario includes two buoys that may be installed within the AOI during the time period of this Programmatic EIS. Anchors for boat- and discus-shaped buoys would have a footprint of approximately 0.56 m^2 (6 ft^2) and an anchor sweep of approximately 3.4 ha (8.5 ac) (USDOI, BOEM, 2012). The larger anchor sweep area is used to estimate seafloor disturbance. If both of the monitoring buoys in the proposed action scenario were installed, the total seafloor disturbance would be approximately 6.8 ha (17 ac), or approximately 0.00001 percent of the seafloor area of the planning areas.

3.3.1.9 Drilling Discharges

The oil and gas exploration scenario assumes that up to one COST well and up to two shallow test wells would be drilled in the planning areas during the time period of this Programmatic EIS. The COST wells are drilled using conventional rotary drilling techniques, which are the same as those routinely used for drilling oil and gas exploration and development wells. During the process, drilling fluid and cuttings are discharged, disperse in the water column, and accumulate on the seafloor (NRC, 1983; Neff, 1987; Neff et al., 2000). Shallow test wells will result in drilling fluid and cuttings discharges.

During the initial stage of drilling, a large-diameter surface hole is jetted a few hundred meters into the seafloor. An NPDES permit must be obtained from the USEPA in order to discharge drilling fluids and cuttings as well as any other possible produced waters (e.g., bilge, ballast, fire, cooling water; sanitary and domestic waste; and deck drainage) that may be associated with COST well drilling. At this stage, the cuttings and seawater used as drilling fluid are discharged onto the seafloor. A continuous steel pipe known as a surface casing is lowered into the hole and cemented in place. A blowout preventer is installed to prevent water and hydrocarbons from escaping into the environment. Once the blowout preventer is fully pressure tested, the next section of the well is drilled.

The marine riser is a pipe with special fittings that establishes a seal between the top of the wellbore and the drilling rig. After it is set, all drilling fluid and cuttings are returned to the drilling rig and passed through a solids control system designed to remove cuttings and silt so that the drilling fluids may be recirculated downhole. The drill cuttings, typically sand or gravel sized with any residual drilling mud attached, are passed through a cuttings dryer to decrease the retained drilling fluid on cuttings, and then discharged via the shale chute.

The typical drilling fluids in widespread use on the OCS are water-based fluids (WBFs) or synthetic-based fluids (SBFs). During well intervals when WBF systems are used, cuttings and adsorbed WBF solids are discharged to the ocean at a rate of 0.2 to 2.0 m^3/hr (Neff, 1987). Overboard discharge of WBF results in increased turbidity in the water column, alteration of sediment characteristics following the introduction of coarse material in cuttings, and elevated concentrations of some trace metals (NRC, 1983; Neff, 1987). In shallow environments, WBFs disperse rapidly in the water column immediately after discharge and quickly descend to the seafloor; in deeper water, however, fluids discharged at the sea surface are dispersed over a wider area (Neff, 1987).

The average exploration well in the GOM is approximately 3,674 m (12,054 ft) below mudline (USDOI, MMS, 2007a). Each well discharges approximately 7,000 to 9,700 bbl of WBF and 1,500 to 2,500 bbl of cuttings (USEPA, 1993, 2000). Assuming an average of 2,000 bbl of cuttings and 8,350 bbl of drilling fluid discharged per well, the total volumes for one COST well and two test wells would range from 2,000 to 6,000 bbl of cuttings and from 8,350 to 25,050 bbl of drilling fluid.

3.3.1.10 Entanglement

Lines, cables, and buoys deployed in the water present entanglement risks to marine wildlife, archaeological resources that stand proud of the bottom, and benthic communities. Specific to G&G activities in the GOM, acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines pose an entanglement risk to marine mammals, sea turtles, and other marine life, and could impact archaeological resources through direct contact or by being dragged through an archaeological site. Although rare, entanglement has occurred in association with OBC and OBN surveys where rope or cable connections are used between nodes, and with associated equipment (e.g., anchors and buoys). The deployment of OBCs and OBNs is accomplished by a Remotely Operated Vehicle (ROV), by dropping nodes on a tether, or by laying cables off the back of a layout boat. The assemblage remains on the seafloor during the seismic survey and is retrieved at the completion of the survey. Not all surveys will have tethered nodes; however, a typical tethered survey can lay out more than 500 km (310 mi) of line for nodal surveys. According to BOEM (USDOI, BOEM, 2013e), risks of entanglement for pelagic organisms can be minimized further by implementing the following measures: (1) shortening acoustic buoy and tethered acoustic pinger lines to the shortest length practical; and (2) replacing tether rope lines <0.25 in (0.64 cm) in diameter with a thicker, more rigid tether line or modifying the line to increase the diameter and rigidity. BOEM also requires that if, upon retrieval, a cable becomes snagged, the operator must verify what is causing the snag, which could possibly minimize further damage to archaeological resources or benthic communities.

3.3.2 Impact-Producing Factors for Accidental Fuel Spills

Vessel fuel capacities generally depend on vessel size, which varies according to the nature of the survey (e.g., 3D surveys use larger vessels than 2D surveys). A large seismic survey vessel may carry between 6,447 and 12,108 bbl of fuel, including diesel and fuel oil (Polarcus, 2015). Smaller coastal vessels may carry several thousand gallons.

Vessels involved in G&G activities in the GOM could be involved in collisions or other accidents that result in a fuel spill. Spill size would depend on the type of vessel, the severity of the event, and whether the fuel storage is compartmentalized.

All G&G vessels are required to comply with USCG requirements relating to prevention and control of oil spills. Nevertheless, for the purposes of this analysis, a spill scenario was evaluated – a release of 1.2 to 7.1 bbl of diesel fuel caused by a vessel collision or an accident during fuel transfer. The volume is based on spill statistics from 2000 to 2009 developed by the Coast Guard (USDHS, CG, 2011b). During this period, there were 1,521 to 5,220 spills per year from vessels other than tankers and tank barges. Total annual spill volumes from these vessels ranged from 2,200 to 10,807 bbl, resulting in average spill sizes ranging between 1.2 and 7.1 bbl. There were 137 reported vessel collisions in the GOM from 2007 to 2014 (USDOI, BSEE, 2015). Additionally, from 1964 to 2013, there were 1,823 reportable spills of 1 to 4 bbl, for a total spill volume of 4,253 bbl, related to oil and gas activities on the OCS (USDOI, BSEE, 2014a).

The likelihood of a fuel spill during seismic surveys or other G&G activities is expected to be remote. For example, in their programmatic analysis of impacts associated with seismic research, the NSF and USDOI, GS (2011) noted that there has never been a recorded oil/fuel spill during more than 100,000 km (54,000 nmi; 62,137 mi) of previous NSF-funded seismic surveys.

The potential for impacts from a 1.2- to 7.1-bbl diesel fuel spill would depend on the location of the spill, meteorological conditions at the time, and the speed with which cleanup plans and equipment could be employed. Diesel fuel is a refined petroleum product that is less dense than water. It may float on the sea surface or be dispersed into the water column by waves. It is assumed that spilled fuel would rapidly spread to a layer of varying thickness and break into narrow bands, or windrows, parallel to the wind direction. Diesel is a distillate of crude oil and does not contain the heavier components that contribute to crude oil's longer persistence in the environment. Small diesel spills (500 to 5,000 gallons) usually evaporate and disperse within a day or less, even in cold water (USDOC, NOAA, 2015b); thus, there seldom is any oil on the surface for responders to recover. However, what is commonly referred to as "marine diesel" is often a heavier intermediate fuel oil that will persist longer when spilled. When spilled on water, diesel oil quickly spreads to a thin film of rainbow and silver sheens, except for marine diesel, which may form a thicker film of dull or dark colors (USDOC, NOAA, 2015b). A small proportion of the heavier fuel components may adhere to particulate matter in the upper portion of the water column and sink. Particulate matter contaminated with diesel fuel could reach the benthos within or outside the AOI, depending on spill location, water depth, ambient currents, and sinking rate.

3.4 CUMULATIVE ACTIVITIES SCENARIO

Cumulative effects (40 CFR § 1508.7) refers to impacts on the environment that result from the incremental increase in impact from the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. The cumulative effects assessment incorporates individually minor but collectively important actions taking place over a period of time.

Previous environmental analyses were reviewed to identify and characterize the nature of ongoing or proposed non-G&G activities as a basis for development of a cumulative activities scenario, focusing exclusively on activities with similar impacts and IPFs to the proposed action and alternatives (e.g., USDOI, BOEM, 2012, 2013c, and 2013d; U.S. Department of the Navy, 2013). The identification of the cumulative activities that have similar IPFs, as defined in **Chapter 3.3.1**, were presented in a matrix to correlate the proposed action IPFs to the potential cumulative effect of past, present, and reasonably foreseeable actions (**Table 3.4-1**).

The resultant screening analysis identified potentially important cumulative effects associated with the proposed action and defined the assessment goals as well as the resultant cumulative scenario, including activities classified under three major areas or components:

- OCS Program
  - Oil and Gas Exploration and Development
  - Decommissioning
  - Renewable Energy Development
  - Marine Minerals Use
- Oil and Gas Activities in State Waters
  - Oil and Gas Exploration and Development
  - Decommissioning
- Other Major Factors Influencing the AOI
  - Deepwater Ports
  - Commercial and Recreational Fishing
  - Shipping and Marine Transportation
  - Dredged Material Disposal
  - Existing, Planned, and New Cable Infrastructure
  - Military Activities
  - Scientific Research

- Dredging and Federal Channels
- Coastal Restoration Programs
- Mississippi River Hydromodification, Subsidence, and Drainage
- Extreme Climatic Events
- Climate Change and Sea-Level Rise
- Natural Oil Seeps
- Treasure Hunting/Looting
- Sport Diving

As outlined in **Chapter 3.3.1**, IPFs have been identified in association with proposed G&G activities. Key G&G-related, IPFs that could affect marine resources in the AOI include the following: (1) active acoustic sound sources; (2) vessel and equipment noise; (3) vessel traffic; (4) aircraft traffic and noise; (5) stand-off distance; (6) vessel discharges; (7) trash and debris; (8) seafloor disturbance; (9) drilling discharges; (10) entanglement; and (11) accidental fuel spills. These IPFs have been compared to the IPFs from each of the cumulative scenario components on the activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The cumulative effect (additive or synergistic) can then be assessed for each resource to determine the incremental increase attributed to the proposed action (refer to **Chapter 4**).

This cumulative scenario establishes the geographic boundaries for the cumulative analysis by considering geographic areas occupied by migratory resources and affected institutional jurisdictions, and focusing on the distance over which an impact may extend, as recommended by the CEQ (1997). The AOI includes all three of BOEM's Gulf of Mexico OCS planning areas (i.e., WPA, CPA, EPA) and the State waters of Texas, Louisiana, Mississippi, Alabama, and Florida extending from the coastline (outside of estuaries) to the seaward extent of the planning areas (*Federal Register*, 2013a). The inclusion of State waters considers that impacts from G&G surveys could affect resources in State waters. Because the AOI includes all Federal and State waters of the GOM and not just those within BOEM's jurisdiction, coupled with the understanding that G&G activities will not be occurring homogenously throughout the AOI, the geographic bounds for the cumulative analysis are reasonable. **Figure 3.4-1** depicts, in a predictive manner, the projected spatial distribution of various cumulative scenario activity components based on existing activity and the assumption that spatial distribution trends would continue in similar locations.

The G&G activities have been ongoing in the GOM for at least the past 30 years, and it is reasonable to assume they will continue into the future; however, for the purpose of this Programmatic EIS, the cumulative analysis assesses a 10-year time period to coincide with the proposed action because it is not expected that G&G activities will have lasting effects or extend beyond the 10-year time period of this Programmatic EIS.

3.4.1 OCS Program

The IPFs associated with OCS Program activities that coincide with the proposed action include vessel and equipment noise (including explosives use [decommissioning]), support vessel traffic, aircraft traffic and noise, stand-off distance, vessel discharges, trash and debris, seafloor disturbance, drilling discharges, and accidental fuel spills (**Table 3.4-1**). All G&G survey activities associated with the OCS Program are included in the proposed action; therefore, G&G activities are not included in the cumulative analysis but instead are addressed in the proposed action impact analysis.

3.4.1.1 OCS Oil and Gas Exploration and Development

Oil and gas activities in the GOM began in the 1950s, and the levels of activity have undergone cyclical swings (Adams et al., 2009). Most activities and resultant infrastructure development, such as oil and gas platforms and pipelines, are located within the CPA (**Figure 3.4-1, Panel A**). The G&G survey activities, such as seismic surveys, have occurred throughout the WPA and CPA from the seaward boundary of State waters to the boundary of the U.S. Exclusive Economic Zone (Schlumberger, 2015). Vessel traffic associated with oil and gas activities originated from several ports within the WPA and CPA. Due to recent growth of oil and gas development in deepwater areas of the GOM, oil and gas service activities for OCS operations have been centralized at Port Fourchon, Louisiana (Keithly, 2001). Currently, Port Fourchon services approximately 90 percent of all deepwater rigs and platforms in the GOM (USDOC, NOAA, 2012b). Consequently, a large percentage of supply, service, and construction vessel traffic associated with OCS activities is concentrated in waters offshore of this port. Within the northern GOM, oil and gas exploration and development activities were largely spatially limited to waters of the continental shelf; however, as OCS exploration and development technologies advanced, activities transitioned into shelf edge and deepwater environments. Within the southern GOM, beyond the U.S. Exclusive Economic Zone (and beyond the boundaries of the AOI), Mexico stands ninth in the worldwide ranking of conventional oil reserves, with several fields offshore Campeche, Tabasco, and Tampico (Index Mundi, 2015). In December 2013, the U.S. Congress approved the U.S.-Mexico Transboundary Hydrocarbons Agreement (P.L. 113-67, the Bipartisan Budget Act of 2013), which aims to facilitate joint development of oil and natural gas in part of the GOM.

BOEM developed a cumulative activities scenario for oil and gas exploration and development in the three planning areas, estimating activity levels over a 40-year period (2012 to 2051) (USDOI, BOEM, 2015d and 2016a). Given the 10-year time period for the cumulative analysis in this Programmatic EIS, estimates developed for the 40-year period have been decreased by 75 percent. While this approach provides an approximation of activity levels for the period of interest, many factors may affect oil and gas exploration and development. Oil and gas activities are influenced, in the short term, by the economic environment, crude oil and natural gas prices, leasing activity, and vessel and drilling rig availability, among other factors. Consequently, the 10-year projections outlined in **Table 3.4-2** represent approximations based on the 40-year projections; actual activity levels may vary from estimated levels. The majority of projected oil and gas activities would occur within the CPA (**Table 3.4-2**), followed by a reduced level of projected activities occurring in the WPA. The projected level of activities in the EPA is very small, representing all anticipated production from lands currently under lease in the EPA plus all anticipated production from future lease sales (**Table 3.4-2**). Detailed descriptions of deepwater (>305 m [1,000 ft]) production activities are included in a prior assessment of the physical impacts of installation and operation for various types of systems (USDOI, MMS, 2000). Typical effects from exploration (e.g., delineation wells and non-seismic activities) and development that coincide with the IPFs from G&G activities can include noise from support vessels and aircraft (helicopters), drilling equipment, and pipeline and infrastructure placement (e.g., trenching). Underwater marine sounds associated with drilling operations are not particularly intense and include strong tonal components at low frequencies with infrasonic frequencies in at least some cases (Richardson et al., 1995; USDOI, MMS, 2000; Wyatt, 2008). Other sources of drilling-related sounds include riser rotation, DP thrusters, and ROV operations. Production wells are drilled using mobile offshore drilling units. The type of production platform installed depends on water depth and other factors, and may be fixed or floating; production also may be realized through the use of subsea completions and associated pipelines, but only in deep water.

Vessel traffic and associated discharges associated with oil and gas activities could occur, along with potential for accidental loss of trash and debris. Seafloor infrastructure associated with production would disturb the seafloor during installation and, to a lesser extent, from operation (e.g., as a consequence of drilling discharges). The area surrounding oil and gas activities would be precluded for use by other ocean users during certain activities. All activities could result in an accidental spill of diesel fuel. **Table 3.4-1** outlines the IPFs that coincide between G&G activities and oil and gas exploration and development activities.

3.4.1.2 Decommissioning

When an OCS lease expires or development and production operations cease, companies are obligated to decommission and remove their facilities (30 CFR § 250.1725(a)) and clear the seafloor of all obstructions (30 CFR § 250.1740). While production structures are removed, it is anticipated that multiple appurtenances or types of equipment (e.g., subsea systems, pipelines, umbilical lines, etc.) would not be removed from the seafloor if placed in waters exceeding 800 m (2,625 ft), as allowed under certain conditions in 30 CFR § 250. As of January 30, 2017, there were more than 2,110 active production platforms in the GOM (USDOI, BSEE, 2017). Offshore facility decommissioning, including platform and caisson removal, typically uses one of two primary methods to sever structures attached to the seafloor: mechanical severance or explosive severance. Explosive severance utilizes specially designed bulk or shaped charges with specific properties to produce enough stress upon detonation to completely sever the bottom-founded components of a platform. Explosive charges generally are placed inside the platform legs or conductors 4.6 to 7.6 m (15 to 25 ft) below the seafloor. Current regulations do not mandate which method is to be used during decommissioning. BOEM is currently preparing a programmatic NEPA document for decommissioning activities in the GOM to update the 2005 programmatic NEPA document (USDOI, MMS, 2005) analyzing impacts from decommissioning operations.

Approximately 85 percent of decommissioned offshore structures in the GOM were destined for shore-based scrap processing, while the remaining structures were reused or converted to artificial reefs. Structure-removal permit applications for the GOM between 2002 and 2013 are summarized in **Tables 3.4-3 and 3.4-4**.

Mechanical methods are used for structure removal in approximately 35 percent of decommissioning operations (USDOC, NMFS, 2012). Based on 10-year projections, **Table 3.4-2** provides the estimated number of structures to be removed.

The IPFs associated with decommissioning that coincide with the IPFs from G&G activities include noise from vessels and use of explosives to decommission equipment (i.e., platforms), vessel traffic and discharges, trash and debris, stand-off distance, and seafloor disturbance. Noise would be generated during explosive and nonexplosive structure removal. Vessel and helicopter traffic would occur in the vicinity of the platform undergoing decommissioning. The area surrounding decommissioning activities would be precluded for use by other ocean users, requiring a stand-off distance. Seafloor disturbances would occur as a result of the requirement to remove components below the mudline. Decommissioning activities have the potential for accidental fuel spills associated with support vessels. **Table 3.4-1** outlines the IPFs that coincide between G&G activities and decommissioning activities.

3.4.1.3 Renewable Energy Development

The two primary categories of renewable energy that have potential for development in the coastal and OCS waters of the U.S. are wind turbines and marine hydrokinetic systems. No wind farm developments have been proposed in OCS waters of the GOM; however, one facility in Texas State waters is in the initial stages of development. Wind Energy Systems Technology/Coastal Point Energy received State consent to build Galveston Offshore Wind Phase I, a 150-megawatt project proposed approximately 8 km (5 mi) off the Galveston coast. Neither the company nor the State have any intentions at this time of proposing activities in Federal waters. Additional information regarding this site is provided in **Appendix E, Section 12.4**. **Figure 3.4-1, Panel A** shows a proposed renewable energy site in the GOM.

The IPFs associated with renewable energy that could coincide with the IPFs from G&G activities include noise from vessels and from installation and operation of the equipment (e.g., pile driving, vibratory hammering, operational vibration), vessel traffic, space-use conflicts, vessel discharges, trash and debris, seafloor disturbance, and accidental fuel spills. **Table 3.4-1** outlines the IPFs that coincide between G&G activities and renewable energy development.

3.4.1.4 Marine Minerals Use

Coastal restoration, beach nourishment, and levee reconstruction are crucial to mitigate future coastal erosion, land loss, flooding, and storm damage in the GOM. The success of these long-term efforts depends on locating and securing significant quantities of OCS sediment resources that are compatible with the target environments being restored. Human activities over the past century have contributed to erosion and coastal alteration, leading to the need for restoration and stabilization of coastal barrier islands and wetlands utilizing OCS marine minerals. Beginning in the late 1920s, flood control of the Mississippi River and subsequent construction of jetties and other structures began altering natural sediment availability and land-building processes. As the oil and gas, shipping, commerce, and other maritime industries expanded in the GOM, navigation channels were constructed, altering coastal habitats. Continued coastal development, coupled with severe hurricanes, has resulted in increased demand for coastal restoration projects, and these are critical to protect human and natural communities, as well as important coastal infrastructure.

Projected volumes from OCS sand borrow areas over the 10-year project period are 9,700,000 yd^3 from the EPA; 53,400,000 yd^3 from the CPA; and 5,000,000 yd^3 from the WPA, all from water depths no deeper than 20 m (66 ft) (**Table 3.2-5**). Offshore sand resources are considered extremely scarce, particularly in close proximity to where they are most needed. In addition, many of these offshore sand resources are not extractable because of the presence of oil and gas infrastructure, archaeologically sensitive areas, and biologically sensitive areas that require setbacks for dredging operations. Additional information regarding sand and gravel mining activities is provided in **Appendix E, Section 12.3**.

The OCS protraction areas in the GOM with significant sediment resources that could be used in coastal restoration, beach nourishment, and levee reconstruction include the following (**Figure 3.4-1, Panel A**):

- Breton Sound Area;
- Chandeleur Area;
- Main Pass Area;
- Main Pass Area, South and East Addition;
- High Island Area;
- Sabine Pass Area;
- West Cameron Area;
- West Cameron West Area;
- Vermilion Area;
- South Marsh Island Area, North Addition;
- Eugene Island Area;
- Ship Shoal Area;
- South Pelto Area;
- West Delta Area; and
- Mobile Area.

The IPFs associated with the Marine Minerals Program that coincide with the IPFs from G&G activities could include noise from vessels and dredging equipment noise, vessel traffic and discharges, stand-off distance, trash and debris, seafloor disturbance, and accidental fuel spills. **Table 3.4-1** outlines the coinciding IPFs that originate from G&G activities and extraction of marine minerals.

3.4.1.5 Geological and Geophysical Activity Related to the Oil and Gas Program

Since the passage of the OCSLA in 1953, BOEM (BOEMRE/MMS/USGS) has issued over 12,000 permits for conventional 2D and 3D seismic survey acquisition, as well as for multi-component, high-resolution, wide-azimuth and other advanced types of seismic surveys as well as over 400 geological coring permits in Gulf of Mexico OCS waters. Historically, a large percentage of the geophysical data in BOEM's inventory was 2D common depth point seismic information. The 2D seismic data were the basis of evaluation for many of BOEM's historic lease sales until the early 1990s. Since then, 3D surveys have become the main source of information in Gulf of Mexico block evaluations, although variations of 3D acquisition have recently evolved, specifically for imaging below salt after special processing of that data.

By regulation, BOEM has the right to acquire any data or reprocessed data collected under an OCS permit. Industry, overall, has acquired more data in the OCS than BOEM, but BOEM has purchased a substantial portion of the data used for post-lease sale block evaluation, hydrocarbon reserves calculations, and resource estimates made to Congress.

3.4.2 Oil and Gas Activities in State Waters

The types of activities described for the OCS Program (**Chapter 3.4.1**) are the same as oil and gas activities in State waters and would have the same IPFs. Oil and gas activities in State waters also include the G&G surveys permitted by other agencies. Therefore, IPFs that coincide with G&G activities include: active acoustic sound sources, vessel and equipment noise, (support) vessel traffic, aircraft traffic and noise, stand-off distance, trash and debris, seafloor disturbance, drilling discharges, entanglement, and accidental fuel spills.

State waters typically extend from the mean lower low water line to 3 nmi (3.5 mi; 5.6 km) offshore, with the exception of Texas and the Gulf Coast of Florida, where State waters extend 9 nmi (10.6 mi; 16.7 km) offshore. All five Gulf Coast States have had some level of historical oil and gas exploration activity. Texas, Louisiana, and Alabama currently produce oil and gas in State waters (USDOI, BOEM, 2013c and 2013d). The USDOI, BOEM (2013c and 2013d) assembled a list of various Oil and Gas Program websites for each Gulf Coast State. The websites provide information about State oil and gas activities as well as production data for select states. Among the Gulf States, Louisiana and Texas currently have the highest oil and gas production from State waters (**Table 3.4-5**). In addition, there is infrastructure that supports oil and gas activities in State waters, including wells; facilities that produce and treat raw product; and pipelines that transport the product to refineries, gas plants, storage, and market (USDOI, BOEM, 2012).

3.4.3 Other Major Factors Affecting Offshore Environments

3.4.3.1 Deepwater Ports

Deepwater ports are designed to provide access for tankers and liquefied natural gas (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, then transported to shore via pipeline, while LNG is regasified and pumped to shore. While the U.S. Department of Transportation's Maritime Administration (MARAD) received numerous deepwater port applications between 2000 and 2010, economic conditions for LNG production have declined since 2010. BOEM expected interest in LNG offshore terminal projects to diminish over the next decade, with potential and subsequent stabilization in the LNG market (USDOI, BOEM, 2013c and 2013d). It is possible that LNG facilities in the GOM, 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. A summary of LNG terminal applications, application review determinations, and operational status for the GOM offshore LNG facilities is provided in **Table 3.4-6**. Additional discussion of deepwater ports is provided in **Appendix E, Section 12.6**.

Only one offshore deepwater port currently handles the offloading of petroleum products, the Louisiana Offshore Oil Port (LOOP), which offloads crude oil and transports it to shore via pipeline. Operational since 1981, LOOP receives and temporarily stores crude oil supplies from three sources: (1) tankers carrying foreign and domestic crude oil; (2) domestic crude oil produced in the GOM; and (3) movement of domestic crude oil via the Houston to Houma Pipeline. The LOOP is the only port in the U.S. capable of offloading deep-draft tankers (i.e., ultra-large crude carriers and very large crude carriers); LOOP also offloads smaller crude oil tankers. In 2012, LOOP received 304 tanker calls (**Table 3.4-7**).

The LOOP has a fleet of support vessels that patrol the port, support marine operations, and maintain stand-off distances for other vessels within the restricted safety zone. No major spills at LOOP have occurred in the more than three decades of operation, and maintenance inspections are expected to ensure that none will occur in the future. The operation of deepwater ports includes the following IPFs coincident with G&G activities: vessel and equipment noise, vessel traffic, stand-off distance, vessel discharges, trash and debris, and accidental fuel spills.

3.4.3.2 Commercial and Recreational Fishing

Commercial Fishing

The commercial fishing industry is an important contributor to the GOM economy and has been since the mid-1800s. In 2014, the seafood industry in the five coastal states adjacent to the AOI supported over 191,000 jobs and generated $24.3 billion in sales (**Appendix E, Section 9.1**). Florida generated the highest employment, income, and value added impacts, generating nearly 93,000 jobs, $3.4 billion, and $6.1 billion, respectively. Louisiana and Texas had the highest landings revenue in 2014, $451 million and $278 million, respectively (USDOC, NMFS, 2016c).

Fishers in the GOM region landed roughly 1.2 billion pounds (lb) of finfish and shellfish in 2014 (USDOC, NMFS, 2016c). The main commercial fishing gears used within the AOI and along the GOM coast are bottom trawls, purse seines, gill nets, pots/traps, and longlines (bottom and pelagic), all of which can cause seafloor disturbance and pose a risk of entanglement with marine resources. **Appendix E, Section 9.1** provides information on past landings for key species in the GOM from 2003 to 2014. **Figure 3.4-1, Panel B** shows dominant areas of commercial fishing in the GOM.

Summary data provided by the USEPA (2010) indicate that commercial fishing vessel activity in the GOM, based on a subset of operational U.S.-flagged commercial fishing vessels for which the

Marine Information for Safety and Law Enforcement provides a hailing port, varies substantially by State as follows:

State	Number of Commercial Fishing Vessels
Texas	>2,000 to 3,000
Louisiana	>3,000
Alabama	>500 to 1,000
Mississippi	>500 to 1,000
Florida	>3,000

Commercial fishing vessels utilize various types of active acoustic sound sources (e.g., sonar, echosounders, and acoustic instruments) to locate fish and identify seafloor contour and composition in order to target desired species effectively. Instrumentation is also used on gear (e.g., nets and trawls) to send acoustic signals to the vessel to determine the net's location in the water or along the seafloor.

Recreational Fishing

Recreational fishing activity has influenced the GOM economy in a variety of ways since the 1950s. Following World War II, increased tourism along the Gulf Coast, coupled with the mass production of fiberglass boats and improvements in motor technology and navigational equipment, led to increases in recreational fishing (Walter, 2006). Direct economic inputs include spending on fishing related goods and services such as expenditures on trips and durable equipment. Trip expenditures include transportation costs, boat fees, and bait expenses. Durable equipment expenditures include the purchase of fishing equipment and fishing boats. **Appendix E, Section 10.1** provides information on economic contributions of recreational fishing, along with the locations, catch characteristics, and tournaments.

Recreational fishing is a year-round activity throughout the AOI and can be classified as a nearshore (<4.8 km [3.0 mi]) or offshore (>4.8 km [3.0 mi]) effort, depending on the size of the vessel and its fishing location. Nearshore recreational fishing consists of anglers fishing from private vessels and along beaches, marshes, or man-made structures (e.g., jetties, docks, and piers), whereas offshore fishing consists of anglers fishing from larger vessels farther from shore (i.e., private, rental, charter, or party).

Commercial and recreational fisheries include the following coinciding IPFs with G&G activities: active acoustic sound sources; vessel and equipment noise; vessel traffic; stand-off distance; vessel discharges; trash and debris; seafloor disturbance; entanglement; and accidental fuel spills.

3.4.3.3 Shipping and Marine Transportation

The U.S. economy relies heavily on GOM ports for the import and export of foreign and domestic goods. The GOM supports many ports that rank high among U.S. ports in total commerce

(USDOC, NOAA, 2012b). Shipping and marine transportation into GOM ports is summarized in **Table 3.4-7**, in terms of individual port calls and total port calls for the most recent year that data are available (2012). **Figure 3.4-1, Panel B** depicts the shipping fairways and lanes, and major ports in the GOM. Total vessel activity in the GOM can be accessed via the Automated Identification System (AIS), based on data acquired and stored by the USCG. The AIS is required on

- ships of 300 gross tons (GT) or more;
- passenger ships and tankers of 150 GT or more;
- all self-propelled commercial vessels (excluding fishing and passenger vessels with ≤150 passengers) 65 ft (20 m) or more in length; and
- towing vessels longer than 26 ft (8 m).

The AIS data do not include recreational boats and other small vessels owned, leased, or operated by the military or other U.S. Government entities. The AIS-based vessel trips in the GOM in 2012 are summarized in **Table 3.4-8**. Of the 308,664 total vessel trips documented in 2012, approximately 13 percent (39,111) were vessels measuring 60 to 170 m (197 to 558 ft) in length, the vessel size range that includes seismic survey vessels; vessel totals for which no vessel length data are available (67,344) are likely to include vessels in the 60- to 170-m (197- to 558-ft) size range. There were 59,334 cargo ship and 28,112 tanker trips in 2012.

Cruise ship activity in the GOM is limited to four ports: Galveston; Mobile; New Orleans; and Tampa. **Table 3.4-9** outlines cruise ship departures from GOM ports on an annual basis between 2008 and 2011. The AIS-based vessel trips in the GOM in 2012 are summarized in **Table 3.4-8**, documenting 14,486 passenger ship (including cruise ship) trips in 2012.

Shipping and marine transportation include the following coinciding IPFs with G&G activities: vessel and equipment noise; vessel traffic; vessel discharges; trash and debris; and accidental fuel spills.

3.4.3.4 Dredged Material Disposal

Materials from maintenance dredging are disposed of offshore primarily at existing dredged material disposal banks and ocean dredged material disposal sites (ODMDSs), which are regulated by USEPA. Additional dredged material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by the USACE and relevant State agencies prior to construction.

The USACE currently identifies 40 ODMDSs in the GOM that were in use between 1973 and 2013. As of early 2015, there were 30 active ODMDSs in the GOM (USACE, Engineer Research and Development Center, 2015) (**Figure 3.4-1, Panel D**). Additional information regarding ODMDSs is provided in **Appendix E, Section 12.5**.

BOEM (USDOI, BOEM, 2013c and 2013d) anticipates that, over the next 40 years, the amount of dredged material disposed at ODMDSs will fluctuate within the trends established by the Galveston and New Orleans USACE Districts. 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 was about one-quarter of that quantity, or 4.6 million yd^3 (3.5 million m^3) of dredged material. Galveston averaged 6.8 million yd^3 (5.2 million m^3) of dredged material (USDOI, BOEM, 2017a). Future quantities may decrease slightly as more beneficial uses of dredged material onshore are identified.

The 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention), to which the U.S. is a signatory, requires annual reporting of the amount of materials disposed at sea. The USACE prepares the dredged material disposed portion of the report to the International Maritime Organization, the yearly reports for which are posted on the USACE's Ocean Disposal Database. Disposal produces increased water column turbidity as material is deposited on the seafloor.

Disposal at ODMDSs typically include use of dredges to excavate and deposit the material at the sites, and use support vessels and barges to monitor operations. The IPFs coincident with G&G activities include vessel and equipment noise, vessel traffic, stand-off distances, vessel discharges, seafloor disturbance, trash and debris, and accidental fuel spills.

3.4.3.5 Existing, Planned, and New Cable Infrastructure

The only in-service submarine cable system that currently traverses the WPA and CPA is the BP Fiber Optic Network, which comes ashore in Freeport, Texas, and Pascagoula, Mississippi (North American Submarine Cable Association, 2014). The system is buried to a target depth of 1 m (3 ft) in water depths up to 800 m (2,625 ft) and is surface laid in water depths exceeding 800 m (2,625 ft). The 1,216-km (756-mi) long system is composed of a backbone and spurs. Additional information regarding the BP Fiber Optic Network is provided in **Appendix E, Section 12.6.3**. **Figure 3.4-1, Panel B** shows all submarine cables in the GOM.

No new cable development projects in the GOM have been publicly reported; however, if future installations occur, a survey utilizing HRG equipment would be conducted along the proposed route to identify seafloor characteristics, identify hazards, and determine burial methods. Cable systems typically are installed from a large cable vessel supported by smaller vessels and can be buried via plow, jetting, or trenching. The IPFs coinciding with G&G activities include active acoustic sound sources, vessel and equipment noise, vessel traffic, stand-off distances, vessel discharges, trash and debris, seafloor disturbance, and accidental fuel spills.

3.4.3.6 Military Activities

The Gulf of Mexico (GOMEX) Range Complex contains four separate U.S. Navy Operating Areas (OPAREAs): Panama City and Pensacola, Florida; New Orleans, Louisiana; and Corpus Christi, Texas. The OPAREAs within the GOMEX Range Complex are not contiguous but scattered throughout the GOM. The GOMEX Range Complex includes special-use airspace with associated warning areas, and restricted airspace, as well as surface and subsurface sea space of the OPAREAs where underwater detonation testing and training may occur.

Twelve military warning areas and six Eglin Water Test Areas (EWTA) are located within the GOM (**Figure 3.4-1, Panel C**). These are multiple-use areas where military operations and oil and gas development coexist without conflict. 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. The airspace over the WPA is used by the U.S. Department of Defense (USDOD) for conducting various air-to-air and air-to-surface operations. Naval Mine Warfare Command Operational Area D contains 17 OCS lease blocks in the WPA and is used by the U.S. Navy for mine warfare testing and training. In addition to Naval Mine Warfare Command Operational Area D, the WPA has four military warning areas that are used for military operations. The areas total approximately 8.6 million ha (21.3 million ac) or 75 percent of the total acreage of the WPA. To eliminate potential impacts from multiple-use conflicts on the aforementioned area, particularly those in OCS lease blocks that the U.S. Navy has identified as needed for testing equipment and for training mine warfare personnel, a standard Military Areas Stipulation is applied routinely to all GOM leases in the WPA and CPA.

Within the CPA, wholly or partially, are six designated military warning areas and three EWTAs used for military operations (**Figure 3.4-1, Panel C**). The military warning areas within the CPA total approximately 5.4 million ha (13.3 million ac) or 23 percent of the total acreage of the CPA. The EWTAs within the CPA total approximately 2.8 million ha (7 million ac) or 12 percent of the total acreage of the CPA. In addition to the previously noted standard Military Areas Stipulation, the EWTAs require special stipulations, including an Evacuation Stipulation and a Coordination Stipulation. Additional information regarding military warning areas and other military uses is provided in **Appendix E, Section 12.2**.

Within the EPA, the EWTAs encompass nearly all of the planning area and their primary function is to support research, development, test, and evaluation of conventional weapons and electronic systems. The secondary function is to support training of operational units (Air Force Air Armament Center, 2002). In addition, the Panama City and Key West OPAREAs are located in the EPA and have been identified by the USDOD (2010) as areas incompatible with oil and gas development.

It is anticipated that the military use areas currently designated in the GOM will remain the same and that none will be released for non-military use. With 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.

Military activities include the following IPFs coinciding with G&G activities: active acoustic sound sources; vessel and equipment noise; vessel traffic; aircraft traffic and noise; stand-off distance; vessel discharges; trash and debris; seafloor disturbance; and accidental fuel spills.

3.4.3.7 Scientific Research

Scientific research in the GOM, including BOEM-funded research, has been ongoing for several decades. Most of the recent oceanographic research in the GOM has centered on assessing the impacts of the *Deepwater Horizon* explosion, oil spill, and response. A few examples include the Gulf of Mexico Research Initiative's selection of 12 research consortia to conduct scientific studies of the impacts of oil, dispersed oil, and dispersant on the GOM ecosystem and public health in 2014, and the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act's (RESTORE Act) funding of seven projects that focus on assessing ecosystem modeling, evaluating indicators for ecosystem conditions, and assessing and developing recommendations for monitoring and observing in the GOM.

Other scientific research in the GOM includes ship and aerial surveys for marine mammal population assessment. Ship surveys are used to assess the abundance and distribution of cetaceans by conducting visual line-transect surveys during the day, and utilizing towed hydrophone arrays and sonobuoys at night. Surveys also include biopsy sampling and oceanographic data collection. Sea turtle population assessments typically are conducted in-water by visual observers from small vessels, but they also can be conducted via aerial surveys. Other methods to obtain sea turtle data include nest assessments, stranding data, bycatch, trawling, and satellite tracking. Fisheries stock assessments are complex, but methods include the use of acoustic techniques, aerial surveys, sampling (e.g., trawling), and visual surveys from autonomous underwater vehicles.

Research activities include the following IPFs coinciding with G&G activities: active acoustic sound sources; vessel and equipment noise; vessel traffic; aircraft traffic and noise; vessel discharges; trash and debris; seafloor disturbance; and accidental fuel spills.

3.4.3.8 Maintenance Dredging of Federal Channels

Navigation channels undergo maintenance dredging that is necessary for sustaining proper water depths and for allowing ships to move safely through the waterways to ports, shore bases, and terminal facilities. BOEM anticipates that there will be maintenance dredging of navigation channels and an increase in activity at shore bases as a result of future lease sales in the WPA and CPA, although the extent of this dredging has not been quantified (USDOI, BOEM, 2013c and 2013d).

Maintenance dredging activities include the following IPFs coinciding with G&G activities: vessel and equipment noise; vessel traffic; stand-off distance; vessel discharges; trash and debris; seafloor disturbance; and accidental fuel spills.

3.4.3.9 Coastal Restoration Programs

Coastal erosion results in a loss of sand from beaches, dunes, and barrier islands, and has become a serious problem. Beach nourishment and other coastal restoration projects are authorized by BOEM to address this problem when offshore OCS sand resources are used. The P.L. 109-234, enacted in June 2006, appropriates funds to support coastal restoration efforts in the Gulf Coast States of Alabama, Mississippi, Louisiana, and Texas to assist in restoring the coastal areas damaged by Hurricanes Katrina and Rita in 2005. Sand resources needed to repair the damaged coastlines and barrier islands of the four states are estimated to be 191 to 229 million m^3 (250 to 300 million yd^3) or more; in Louisiana alone, more than 518 km^2 (200 mi^2) of coastal land was lost due to the hurricanes (USDOI, BOEM, 2015e). **Chapter 3.4.1.4 and Appendix E, Section 12.3** provide details for recent projects, source sand volumes mined, and miles of restored shoreline (USDOI, BOEM, 2015e), as well as additional detail on various marine minerals projects in the GOM. **Figure 3.4-1, Panels A and D** show the marine mineral borrow areas and the barrier islands where restoration projects likely will occur.

Coastal restoration program activities, in general, and sand source/beach restoration project operations, in particular, include the following IPFs coinciding with G&G activities: vessel and equipment noise; stand-off distance; vessel discharges; trash and debris; seafloor disturbance; and accidental fuel spills.

3.4.3.10 Mississippi River Hydromodification and Subsidence

Hydromodification generally refers to a disruption or alteration of the natural flow of a water channel or drainage system that results in altered water quality. Hydromodification processes have transpired over time frames ranging from millennia to lesser increments (e.g., decades, years, and months). Nonpoint-source pollution impacts generally are the result of anthropogenic land-use activities (e.g., straightening, dredging, and relocation). Hydromodification interventions include the construction of (1) levees along river and distributary channel systems, (2) upstream dams and flood control structures that impound sediment and meter the river flow rate, (3) culverts for freshwater diversion, and (4) channelized channels with earthen or armored banks. Once the natural processes that act to add sediment to the delta plain to keep it emergent are shut down, subsidence begins to outpace deposition of sediment (USDOI, BOEM, 2012).

The USDOI, BOEM (2012) anticipates that over the next 40 years there may be minor sediment additions resulting from new and continuing freshwater diversion projects managed by the USACE. Of the more than 200 projects currently listed in the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA, 2015) Program by the State of Louisiana, the majority involve introduction of sediment or reestablishment of natural water and sediment flow regimes to allow the delta plain to replenish and build up. Remaining programs represent freshwater diversion, outfall management, sediment diversion, and marsh creation projects.

Hydromodification activities include the following IPFs coinciding with G&G activities: vessel and equipment noise; vessel traffic; vessel discharges; trash and debris; and accidental fuel spills.

3.4.3.11 Natural Processes

Several discussion areas described below are considered in the cumulative scenario and impact analysis, although they are not considered in the same context (e.g., in terms of activity levels or spatial and temporal attributes) as are previously described cumulative scenario activities. These ancillary considerations, including extreme climatic events, global climate change, and natural oil seeps, may function in a predictable or unpredictable fashion to influence coastal and offshore environments.

Extreme Climatic Events

Between 1995 and 2015, 18 hurricanes made landfall in the GOM. Half of these hurricanes reached a maximum strength of Category 1 or 2; the other half were powerful hurricanes reaching maximum strengths of Category 4 or 5. In 2008, Hurricanes Gustav and Ike damaged energy infrastructure, and there were supply disruptions for the oil and gas industry similar to, but not as severe as, those caused by Hurricanes Katrina, Rita, and Wilma in 2005 (USDOE, 2009). Hurricane Isaac in 2012 was only a Category 1 storm, and fewer damages were reported; 2013, 2014, and 2015 did not have any hurricane landfalls in the GOM.

Climate Change and Sea-Level Rise

Warming of Earth's climate system is occurring, and most of the observed increases in global average temperatures since the mid-20th century are very likely due to the observed increase in anthropogenic greenhouse gas concentrations (Intergovernmental Panel on Climate Change, 2014; U.S. Global Change Research Program, 2009). Globally, many environmental effects have been documented, including widespread changes in snow melt and ice extent; spatial changes in precipitation patterns; changes in the frequency of extreme weather events; changes in stream flow and runoff patterns in snow fed rivers; warming of lakes and rivers, with effects on thermal structure and water quality; changes in the timing of spring events such as bird migration and egg laying; poleward shifts in ranges of plant and animal species; and acidification of marine environments (Orr et al., 2005; Intergovernmental Panel on Climate Change, 2007; Nye et al., 2009).

Over the next century, the Intergovernmental Panel on Climate Change (2014) projects that global temperature increases will cause significant global environmental changes, including a rise in sea level. The rate of climate change is forecast to have strong potential for continuation and acceleration, although many note that consequences will be unevenly felt across ecosystems (Doney et al., 2014). Cascading effects on resources of concern and the services they provide manifest in numerous ways that vary both spatially and temporally. Secondary impacts of increasing atmospheric concentrations of carbon dioxide and other greenhouse gases include several key physicochemical drivers: relative sea-level rise; ocean acidification; the intensity, return interval, duration, and extent of storm events; and changes in ocean heat content, albedo (reflectivity), distribution and abundance of precipitation, and coastal erosion. These have been described in numerous reports (e.g., Boesch et al., 2000; Titus et al., 2009; NRC, 2010; Blunden et al., 2011; Blunden and Arndt, 2015).

Tertiary effects of climate change on natural resource services arising from these key drivers include the distribution and abundance of both habitats and species. Associated with these climate change impacts are effects on critical habitats including sea ice loss (both a driver and a habitat), declining coral reef conditions, and loss of critical habitats (e.g., estuaries, wetlands, barrier islands, and mangroves). Interestingly, not all habitats are projected to experience an overall decline as a result of climate change. For example, Dixon et al. (2015) characterize the genetic response of coral to heating, and Koch et al. (2013) discuss projected increases in seagrass habitat associated with climate change.

According to BOEM (USDOI, BOEM, 2013c and 2013d) in its cumulative impact analysis, the relative sea-level rise rates calculated by Penland and Ramsey (1990) are considered representative of the GOM. The 2017-2022 GOM Multisale EIS's (USDOI, BOEM, 2017a) cumulative assessment indicates that 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) (USDOI, BOEM, 2017a).

Natural Oil Seeps

Naturally occurring deepwater hydrocarbon seeps have been estimated to release between 1 to 1.4 million bbl/yr into the GOM (Kvenvolden and Cooper, 2003; NRC, 2003b). Natural seeps are extensive throughout the GOM continental slope and are the highest contributor of petroleum hydrocarbons to the marine environment. Pelagic tar is a common form of hydrocarbon contamination present in the GOM offshore environment (Van Vleet et al., 1983a and 1983b; Farrington, 1987). Higher tar concentrations were closely correlated with proximity to the Loop Current (Van Vleet, 1983b; Farrington, 1987). Van Vleet (1983a) estimated that approximately 7,112,328 kilograms (7,000 tons) of pelagic tar are discharged annually from the GOM into the North Atlantic and that approximately half of the oil may be brought into the GOM from the Caribbean Sea via the Loop Current, while the remainder appears to originate in the GOM. Chemosynthetic communities with aerobic bacterial components typically are associated with natural oil seeps.

3.4.3.12 Recreational Activities

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. 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 a ROV pipeline inspection (Ford et al., 2008).

Sport Diving

Sport diving includes private or commercial recreational diving on archaeological sites for pleasure and education. 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, however, may have an impact to archaeological sites by monitoring sites, encouraging fellow divers to protect sites, and reporting any observed adverse impacts to the appropriate State or Federal agency.

CHAPTER 4

DESCRIPTION OF THE AFFECTED RESOURCES AND IMPACT ANALYSIS

4 DESCRIPTION OF THE AFFECTED RESOURCES AND IMPACT ANALYSIS

4.1 INTRODUCTION

On the Gulf of Mexico OCS, various types of G&G activities are ongoing in support of offshore energy and minerals development under BOEM's jurisdiction. A detailed summary of G&G activities and associated sound sources is provided in **Appendix F**. The projected activity levels for each of the three offshore Program Areas (i.e., Oil and Gas, Renewable Energy, and Marine Minerals) are presented in **Chapter 3**. A brief summary of the Program Areas and associated survey types is as follows:

Oil and Gas: Exploratory G&G surveys are conducted to locate and evaluate potential oil and gas resources, primarily by conducting broad-scale 2D and 3D seismic surveys (deep-penetration surveys). Similar seismic sources are used in bore-hole surveys (VSPs) with downhole receivers and external sources. In addition, shallow-penetration HRG site surveys of individual OCS lease blocks are conducted to detect geohazards, shipwrecks and other archaeological resources, and certain types of benthic communities. Once development of oil and gas resources has begun, periodic surveys of the producing field (e.g., VSPs and 4D surveys) may be conducted. Geological surveys include seafloor sampling such as cone penetrometer tests (CPTs), cores, grabs, and test well drilling (**Chapter 3.2.1, Table 3.2-9**).

Renewable Energy: The G&G surveys in support of renewable energy development could include airgun surveys; however, surveys are most likely to include non-airgun HRG and geological surveys for three primary purposes: (1) assessment and characterization of potential wind facility locations; (2) cable routes to shore; and (3) detection of geohazards, shipwrecks and other archaeological resources, and certain types of benthic communities (**Chapter 3.2.2, Table 3.2-9**).

Marine Minerals: The G&G surveys locate, characterize, and evaluate marine mineral deposits, including sand for beach nourishment and coastal restoration projects. Site characterization and sand search (prospecting) geophysical surveys are undertaken to identify OCS sand resources and any environmental resources, cultural resources, and shallow hazards such as pipelines that may exist in potential borrow areas. The G&G surveys are also conducted to monitor dredging activities. Typical geophysical survey deployments may involve single-beam echosounders (SBESs) or multi-beam echosounders (MBESs), side-scan sonar, marine magnetometers, and sediment profilers (e.g., CHIRP subbottom profiler). Geological sampling is typically conducted by means of vibracoring, jet probing, or grab sampling (**Chapter 3.2.3, Table 3.2-9**).

This Programmatic EIS analyzes projected scenarios for activity levels that are expected to occur over the next 10 years. While BOEM acknowledges that 2016 experienced a reduced level of oil and gas exploration, G&G activity, and the corresponding decrease in permit applications, BOEM assumes that future levels will return to previous historic levels within the next 10 years. Therefore, BOEM must be prudent and conservatively consider the full range of potential impacts. The scenarios contain projections based on the analysis of recent historic activity levels and trends made by BOEM's subject-matter experts who also considered industry-projected activity levels in their estimates.

4.1.1 Preliminary Screening of Activities and Affected Resources

Earlier environmental analyses were reviewed to determine the physical, chemical, biological, and socioeconomic resources that should be considered and incorporated by reference in the current programmatic baseline characterization and impact analysis covering Gulf of Mexico G&G activities. Previous EAs include the Programmatic EA for G&G activities in the GOM (USDOI, MMS, 2004) and a series of recent applicable EISs covering oil and gas activities in the GOM (e.g., USDOI, BOEM, 2012a, 2013c, 2013d). In addition, the Final Programmatic EIS for Atlantic G&G activities (USDOI, BOEM, 2014b) was reviewed and considered during identification of activities and affected resources relevant to the GOM and proposed action.

The initial step in preliminary screening was to briefly identify and characterize G&G activities expected to occur on the Gulf of Mexico OCS (i.e., activities expected under the Oil and Gas, Renewable Energy, and Marine Minerals Programs), focusing on activity- and equipment-specific IPFs. The IPFs identified in this analysis were (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars); (2) vessel and equipment noise; (3) vessel traffic (i.e., physical disturbance to and risk of collisions); (4) aircraft traffic and noise (e.g., helicopters and fixed-wing aircraft); (5) stand-off distance (i.e., area around the survey vessel cleared of other vessels); (6) vessel discharges; (7) trash and debris; (8) seafloor disturbance; (9) drilling discharges; and (10) entanglement (**Chapter 3.3**). Potential accidents were integrated into the preliminary screening in the form of a diesel fuel spill resulting from a vessel collision. **Chapter 4.1.1.1** discusses the activity screening process.

Preliminary screening was conducted to identify the resources at risk of impact from the suite of proposed and anticipated G&G activities. Screening allows for completion of a focused impact analysis by eliminating (from detailed analysis) resources with no potential for adverse or significant impact. This approach focuses the analysis on the resources at greatest impact risk. A total of 20 resources were reviewed initially. **Chapter 4.1.1.2** discusses the resource screening process.

The G&G activity types and IPFs were formulated into a matrix (**Table 4.1-1**), which provides information on the activity types associated with each G&G activity included in all three Program Areas. A second matrix was developed to identify resources that could be affected by each type of G&G activity to identify the IPFs for which impacts must be analyzed (**Table 4.1-2**). In this analysis, the level of impact associated with each interaction was categorized as "potential impact for analysis" (i.e., a measurable impact to a resource is predicted) or "no impact expected" (i.e., no measurable impact to a resource is evident).

4.1.1.1 Activity Screening

Based on the preliminary screening of G&G activities and identifiable IPFs, radar imaging using satellites was eliminated because it is not a geological or geophysical survey and does not require BOEM permit review and issuance. In addition, the onshore support activities IPF was determined to result in "no impact expected" because G&G surveys have been ongoing in the AOI and because onshore support facilities exist for this type of activity, so no additional onshore infrastructure is reasonably expected as a result of the proposed action or alternatives; therefore, it was not carried forward to the impact analysis. The IPFs from all G&G activities were evaluated for each Gulf of Mexico OCS resource to determine the resource-specific IPFs based on the activities. The results of this screening determined that >60 percent of the possible IPFs were determined to have "no impact expected" across the OCS resources (**Table 4.1-2**).

4.1.1.2 Resource Screening

Several resource areas were identified as having no expected potentially significant impacts from G&G activities. Resources eliminated from detailed analysis (**Table 4.1-2**) are described in **Appendix E**. The rationale for excluding these resources from further analysis is based on the following:

> **Recreational Resources and Tourism:** The G&G activities in the GOM would have a nominal impact on recreational resources and tourism along the Gulf Coast. Many recreational resources and tourist attractions associated with the GOM are located on the coast or in coastal waters. As BOEM-regulated G&G activities would occur in Federal waters at least 3 nmi (3.5 mi; 5.6 km) away from all Gulf Coast States except Florida and Texas, where activities would occur at least 9 nmi (10.4 mi; 16.7 km) away from the coast, few, if any, negative impacts would occur to recreational amenities. Water quality, air quality, and aesthetics near the recreational resources would not be affected; therefore, there would be no change in the quality of the recreational experience. As a result of the unchanged recreational amenities, tourist visitation rates and expenditures are expected to remain constant.
>
> **Air Quality:** Potential impacts from emissions on air quality are expected to be nominal. Survey vessels, aircraft, machinery, and equipment involved in G&G activities would emit a variety of air pollutants, including nitrogen oxides (NO_x), sulfur oxides (SO_x), particulate matter (PM), volatile organic compounds (VOCs), and carbon monoxide (CO), as well as greenhouse gases (e.g., carbon dioxide [CO_2]) primarily from the combustion of fossil fuels for propulsion and power generation. The amount of air pollutants and greenhouse gases generated during G&G activities will depend primarily on the number, design, and size of the vessels; the size of

engines and generators on the vessels; the distance traversed under power; and overall duration of the survey activities. Due to the limited extent and duration of most G&G activities, the amount of air pollutants generated would be small. Also, emissions will be distributed over a broad area of the OCS due to the generally non-stationary nature of G&G activities and likely would not result in any elevated pollutant concentrations exceeding air quality standards.

Water Quality: Potential impacts from vessel discharges on water quality are expected to be nominal. Survey vessels undertaking G&G activities would discharge treated sanitary and domestic wastes from USCG-approved marine sanitation devices along with miscellaneous discharges (e.g., deck drainage, bilge water, machinery space drainage). The volume of treated discharges generated during G&G activities will depend primarily on the number, design, and size of the vessels, which would determine the onboard crew complement; the distance traversed; and overall duration of the G&G activities. All vessels in U.S. and international waters are required to adhere to MARPOL, limiting discharges (e.g., treatment of sanitary wastes and maceration of food wastes), avoiding releases of oily water, and prohibiting disposal of solid wastes. Treated sanitary and domestic wastes discharged into OCS waters will contain organic matter, particulates, nutrients, and residual chlorine that could affect water quality parameters. Due to the limited extent and duration of most G&G activities, the volume of liquid wastes generated would be small. Also, discharges would be distributed over a broad area of the OCS due to the generally non-stationary nature of G&G activities and likely would not result in any elevated concentrations of discharges or pronounced conditions affecting water quality.

Geography and Geology: The G&G activities that could affect sediments include deep stratigraphic and shallow test drilling, CSEM and magnetotelluric (MT) anchors, ocean-bottom seismometer (OBS) receivers, and seafloor sampling. Because of the nature of these sampling activities, only very minor impacts to ambient sediments are expected as a result of well drilling, coring, grab sampling, anchor deployment for CSEM and MT surveys, OBN or OBC deployment, and penetrometer tests, including the creation of small areas of surficial sediment disturbance, localized sediment resuspension and redeposition, and minor surficial discontinuities (i.e., a change in the physical or chemical characteristics in a soil or rock mass). Furthermore, deep stratigraphic and shallow test drilling, as well as seafloor sampling, would have no effect on local or regional geology.

Physical Oceanography: Physical oceanographic resources would not be affected by G&G activities and associated discharges; impacts to physical oceanography are expected to be nominal and temporary. The G&G activities conducted from a survey vessel or floating platform would account for local and regional physical oceanographic conditions. Ocean current characteristics, water column density stratification, and vertical current structure, among other factors, would be considered during planning, operation, and data post-processing of G&G survey or sampling efforts.

Coastal Barrier Island Beaches, Seagrass, and Wetlands: The G&G activities in the GOM would have a direct impact on coastal barrier island beaches, seagrass, and wetlands along the Gulf Coast from G&G vessel traffic; however, this impact would be nominal because G&G vessels represent such a small portion of overall vessel traffic in the GOM. However, sand sources found from G&G activities in Federal waters for beach nourishment would have a positive indirect impact on coastal barrier island beaches. The majority of these resources are located on the coast or in coastal waters. As the proposed G&G activities would occur in Federal waters at least 3 or 9 nmi (3.5 or 10.4 mi; 5.6 or 16.7 km) (depending on the state) away from the coast, few, if any, negative impacts would occur to these resources.

Twelve resource categories were carried forward for detailed baseline environment characterization and impact analysis in **Chapters 4.2 through 4.13**:

- marine mammals;
- sea turtles;
- fisheries resources and EFH;
- benthic communities;
- marine and coastal birds;
- MPAs;
- *Sargassum* and associated communities;
- commercial fisheries;
- recreational fisheries;
- archaeological resources;
- other marine uses; and
- human resources, land use, and economics.

4.1.2 Impact-Level Definitions

Broad impact-level criteria were developed for each of the biological and socioeconomic resources present on the Gulf of Mexico OCS based on the results of the resource screening and in consideration of recent environmental impact analyses and their respective impact descriptions. Criteria 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 or long term); spatial extent (i.e., localized or extensive); and severity (i.e., severe or less than severe).

The impact descriptions developed for this analysis are based on impact thresholds employed and impacts determined in earlier EISs, including recent applicable EISs covering oil and gas activities in the GOM (e.g., USDOI, BOEM, 2012a, 2013c, 2013d), the Final Programmatic EIS for Atlantic G&G activities (USDOI, BOEM, 2014b), and other impact analyses (e.g., Alternative Energy Programmatic EIS [USDOI, MMS, 2007b], the NSF-USGS Marine Seismic Research Programmatic EIS/Overseas EIS [NSF and USDOI, GS, 2011]). For biological and socioeconomic resources, the impact-level criteria have been broadly defined as follows:

- **Nominal:** little or no measurable/detectable impact;
- **Minor**: impacts are detectable, short term, extensive or localized, but less than severe;
- **Moderate**: impacts are detectable, short term, extensive, and severe; or impacts are detectable, short term or long lasting, localized, and severe; or impacts are detectable, long lasting, extensive or localized, but less than severe; and
- **Major**: impacts are detectable, long lasting, extensive, and severe.

Each impact parameter was evaluated on a resource-specific basis to determine the appropriate impact level for each IPF. For biological resources, attributes such as distribution/range, life history, and susceptibility to impact of individual and populations were considered, among other factors. For socioeconomic resources, attributes such as archaeological significance, socioeconomic characteristics, and susceptibility to impact were evaluated, among other factors.

The evaluation process to determine impact level considered the potential impacts by context (e.g., short term versus long term) and intensity (e.g., severity), following NEPA regulations as guidance (40 CFR § 1508.27). Context was defined as the extent of the effect (geographic extent or extent within a species, ecosystem, or region) and any special circumstances (e.g., endangered species or legal status), while intensity of an impact was defined as its magnitude and duration. Moreover, the potential effect was evaluated in terms of duration or frequency (short term, long term, and intermittent). The evaluation process also consisted of evaluating the likelihood (likely or not likely) of an effect to occur (i.e., whether it was plausible or just speculative). During the preparation of the analysis of impacts, each application of an impact level was accompanied by a statement or statements explaining how the impact level was reached. Data or information from refereed journals used to support each determination are cited, as applicable. Otherwise, the determinations are based on the best available information.

Overall, impact ratings used in this Programmatic EIS were designed to address impact probability, severity, and duration to local populations rather than to individual animals. The definitions of each impact level were purposely broad to avoid exceptions to single impact ratings due to the complexities of program-related IPFs to resources that occur within the AOI and over the 10-year period of this Programmatic EIS. Potential impacts to species listed as endangered or threatened by the ESA and marine mammal stocks listed as strategic by NMFS were given greater "weight" than impacts to non-listed species and non-strategic marine mammal stocks.

4.1.3 Impact-Producing Factors

Chapter 3.3 describes the specific details of each IPF, and **Table 3.4-1** outlines the IPFs identified in association with G&G activities. During screening of IPFs, it was recognized that there was a need to identify, quantify, and analyze all of the potential active acoustic sources that might occur during G&G activities. The primary function of equipment and activity screening was to identify sources and survey types that could affect environmental resources and to dismiss those that did not rise to this level of potential impact. To accomplish this screening, BOEM created a Screening Out Team (ScOT), which first convened in April 2014, to examine the source identification issue and make recommendations. The results of the screening indicated that acoustic sources operating at frequencies >200 kHz do not require detailed analyses because this frequency is outside the hearing range of marine mammals; instead, the focus should be on the impact analysis for specific equipment types that have operational frequencies <200 kHz, as well as airguns. The results of this screening are presented in the ScOT report (**Appendix G**).

Overall, the impact analyses consider direct, indirect, and cumulative effects. Direct effects are defined as effects that may be caused by the proposed action and occur at the identical location and time of the action (40 CFR § 1508.8). Indirect effects are defined as effects that may be caused by the proposed action at a later time or farther from the location of the action but are still reasonably foreseeable to occur (40 CFR § 1508.8). Cumulative effects are defined as additive, interactive, countervailing, or synergistic effects that would result from the incremental impact of the proposed action compared with or added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions (40 CFR § 1508.7; CEQ, 1997). Cumulative impacts, or the accumulation of effects, can result from one or more processes. These processes, as outlined by the NRC (2003c), can include the following:

- frequent and repeated impacts on a single environmental resource (i.e., time crowding);
- high-density impacts on a single environmental resource (i.e., space crowding);
- synergistic impacts attributable to multiple sources on a single environmental resource (i.e., compounding impacts);
- impacts that become qualitatively different once a resource-specific threshold of disturbance has been reached or surpassed (i.e., thresholds); and
- the progressive loss of habitat resulting from a sequence of activities, each of which has relatively innocuous consequences, but the environmental consequences accumulate (i.e., “nibbling”).

Cumulative impacts characterized in the following analysis consider the incremental increase of each IPF associated with G&G activities, as well as the additive, interactive, countervailing, or synergistic effects that might result.

4.1.4 Other Considerations

4.1.4.1 Analysis and Incomplete or Unavailable Information

The analyses of potential effects on the wide variety of physical, biological, and socioeconomic resources in the vast area of the GOM and adjacent coastal areas are very complex. Specialized education, experience, and technical knowledge, as well as familiarity with the numerous IPFs associated with G&G activities at sea that can cause cumulative impacts in the area, are required. Knowledge and practical working experience with major environmental laws and regulations such as NEPA, CWA, CAA, CZMA, ESA, MMPA, MSFCMA, and others is also required.

Due to the complexity of the GOM and the wide range of resources found therein, it is unlikely that complete information will ever be available for all resources evaluated in this Programmatic EIS. However, NEPA guidance allows decisions to be made if certain conditions are met. When an agency is evaluating reasonably foreseeable, significant adverse effects on the environment in an EIS and there is incomplete or unavailable information, NEPA requires the agency to report what relevant information is incomplete or unavailable and why, whether it is essential to a reasoned choice among the alternatives, and whether the cost or time limitations would be exorbitant to obtain the information or if a means to acquire it is not known (40 CFR § 1502.22). The action agency must provide a statement to this effect in addition to an evaluation of impacts based on existing credible scientific evidence applied using theoretical approaches or methods generally accepted in the scientific community (40 CFR § 1502.22).

For example, there is incomplete or unavailable information for marine mammal species found in the GOM related to (1) seasonal abundance, (2) stock or population size, and (3) stock or population trends. For marine mammals, in general, there is incomplete or unavailable information regarding hearing ranges and the basic biology of specific species and their physiology for underwater hearing. For marine mammals and sea turtles, there is incomplete or unavailable information about how these species are impacted by anthropogenic sounds, including chronic and sublethal impacts. Because many environmental factors affect sound propagation in the sea, investigations are underway to improve the understanding of sound propagation.

This chapter thoroughly examines the existing credible scientific evidence relevant to evaluating the reasonably foreseeable, significant adverse impacts of G&G activities on the environment. A diligent search for pertinent new information was conducted, and BOEM's evaluation of such impacts is based on theoretical approaches or research methods generally accepted in the scientific community. BOEM's subject-matter experts acquired and used newly available, scientifically credible information and determined that other additional information was not available or could only be obtained at exorbitant costs or could not be obtained in a timely manner; regardless of cost. The subject-matter experts determined where gaps remained, exercised best professional judgment to extrapolate baseline conditions, and determined impacts using accepted methodologies based on credible information, including information in the appendices. All reasonably foreseeable impacts have been considered, and the characterization of impact magnitude and duration is supported by credible scientific evidence. BOEM's assessment of impacts is not based on conjecture, media reports, or public perception; rather, it is based on theoretical approaches, research methods, and modeling applications generally accepted in the scientific community. BOEM has analyzed the results of an extensive modeling effort (**Appendix D**), which estimates marine mammal exposures to the proposed G&G activities included in the proposed action.

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 is essential, whether it can be obtained, whether the cost of obtaining the information is exorbitant, and whether 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. Nonetheless, BOEM's subject-matter experts implemented the process described above regarding incomplete or unavailable information. While incomplete or unavailable information could result in future shifts in baseline conditions of habitats that could affect BOEM's decisionmaking, BOEM has determined that it can make an informed decision without this incomplete or unavailable information because subject-matter experts can apply 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 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.

4.1.4.2 Cumulative Scenario Summary

Cumulative effects (40 CFR §1508.7) refer to the environmental impact that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. **Chapter 3.4** provides the complete description of the cumulative activities scenario. The cumulative impact analysis focuses on the resources rather than the proposed action and considers impacts that take place on spatial and temporal scales. The cumulative impacts consider impacts to environmental and socioeconomic resources that may result from the incremental impact of a proposed action when added to all past, present, and reasonably foreseeable future activities, including non-G&G-related activities such as shipping and marine transportation and commercial fishing, as well as all OCS and State oil- and gas-related activities.

4.1.4.3 NMFS' Technical Guidance

In July 2016, NMFS released the final version of the "Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts" (USDOC, NMFS, 2016b), hereinafter referred to as NMFS' 2016 Technical Guidance. This document provided acoustic guidelines (specifically those that identify the onset of PTS or TTS) to be used when conducting impact analyses for marine mammals. As NMFS stated in their Executive Summary, "While the Technical Guidance's acoustic thresholds are more complex than those used to date in most cases by NMFS, they reflect the current state of the scientific knowledge regarding the characterization of sound that have the potential to impact marine mammal hearing sensitivity." Throughout the development of this new guidance, BOEM provided comments and review.

Before the final version of the acoustic guidelines was completed in July 2016, BOEM completed modeling efforts to assess the potential acoustic impacts from G&G activities for use in this Programmatic EIS (refer to **Appendix D**). The modeling efforts used the interim sound threshold guidance that was available from NMFS at that time, and these were conservative thresholds, which specified that marine mammals exposed to pulsed sounds with received levels exceeding 180 or 190 dB re 1 μPa (rms) are considered to exceed Level A (injury) levels. At the time, NMFS also specified that cetaceans exposed to levels exceeding 160 dB re 1 μPa (rms) are considered to exceed Level B (behavioral harassment) criteria. The acoustic threshold guidance used in this Programmatic EIS is discussed in detail in **Chapter 1.2.6**.

It is important to note that BOEM does not believe that every exposure to sound results in "take" as defined by the MMPA (16 U.S.C. §§ 1361 *et seq.*), as discussed in **Chapter 1.2.5**. Therefore, exposure estimates used in this Programmatic EIS are not the same as a "take" or an injury to an animal. Where there is an overlap between noise sources and the frequencies of sound used by marine life, there may be concerns related to how such sound may interfere with important biological functions. Noise, either natural or anthropogenic, can adversely affect marine life in various ways—inducing alteration of behavior, reducing of communication ranges or orientation capability, temporarily or permanently damaging the auditory or other systems; and/or, in extreme cases, causing habitat avoidance or even death (e.g., Richardson et al., 1995; NRC, 2003a, 2005; Nowacek et al., 2007; Southall et al., 2007). Noise impacts may also be additive or synergistic to those of other human stressors. While determining the biological importance of noise exposure impacts remains challenging (NRC, 2005), significant substantial strides have been made in quantifying the effects of noise on marine mammals (USDOI, BOEM, 2014b). As such, the exposure estimates presented in this Programmatic EIS were computed from modeled sound levels received by simulated (modeled) animals for several types of geophysical surveying. Animals and sources are constantly moving relative to the environment and each other. The sound fields generated by the sources are shaped by various physical parameters, and the sound levels ultimately received by an animal are a complex function of location and time. The basic modeling approach was to use acoustic models to compute the 3D sound fields and their variations in time. Simulated animals (called animats) were modeled moving through these sound fields to sample the sound levels in a manner similar to how real animals would experience these sounds. This approach allows a history of exposures to be built for the received sound levels of all animats. The numbers of animals exposed to levels exceeding effects threshold criteria were determined and then adjusted by the number of animals expected in the area, based on density information (which may not be an accurate representation of the marine mammal population). This creates an estimate of the potential number of animals exposed to the sounds. This estimate does not reflect an actual expectation that marine mammals would be injured or disturbed; it is a conservative but reasonable estimate. This is due to uncertainty inherent in all modeling. Often times, uncertainty exists around inputs to model efforts. For example, there is no generally accepted scientific consensus on how to quantify mitigation effectiveness. Given this, BOEM did not include the different mitigations proposed specifically to reduce impacts and exposure to marine mammals from sound in the Programmatic EIS into the exposure modelling effort. As such, BOEM believes that the exposure estimates are conservative but reasonable. This reasonable approach is based upon the judgment of subject-matter experts who developed the model and methodologies, addressed reasonable assumptions, and translated the model results for use in this Programmatic EIS, which is to help BOEM develop a comprehensive understanding of the potential for multiple possible activities within the GOM across three Program Areas (i.e., Oil and Gas, Renewable Energy, and Marine Minerals) to impact the marine environment over a 10-year period. Therefore, the biological importance to marine mammals is left to interpretation by subject-matter experts and is included in the impact analysis in **Chapter 4.2**. Using the model estimates most often requires accepting a conservative but reasonable scenario, which ultimately equates the numbers of exposures to the number of “takes” under the MMPA.

The impact analysis by subject-matter experts considered the modeling results in conjunction with subject-matter expert review of scientifically credible information using accepted approaches and research methods. While this analysis required some professional judgment by the subject-matter experts, the resulting impact conclusions remain credible in light of the available scientific record. Throughout this Programmatic EIS, BOEM has clarified the assumptions and scenarios used in the modeling, as well as limitations that may be inherent in any modeling effort (e.g., the inability to account for mitigation measures and aversion). While the results of the modeling may be conservative, they do remain the most credible, science-based information available at this time. The question of implementing mitigation in the modeling was considered at length. There are no generally accepted metrics on the effectiveness of mitigation. Therefore, inclusion of a quantification of mitigation effects was not possible in the model. Though mitigation could not be considered directly in the modeling effort, it is incorporated in the interpretation of the modeling results in the impact analysis presented in **Chapter 4.2**, which includes a synthesis of a variety of qualitative and quantitative available scientific information. It is reasonable to conclude that the proposed mitigation measures would likely reduce the potential impacts to marine mammals, though the amount of such reduction cannot be quantified at this time.

4.1.4.4 Risk Assessment Framework

Throughout this chapter, where information was incomplete or unavailable, BOEM complied with its obligations under NEPA as discussed in **Chapter 4.1.4.4**. The most notable incomplete or unavailable information identified in this Programmatic EIS relates to the development of a novel analytical method to evaluate the effects of human-induced noise on marine mammal hearing and behavior. A research collaboration of world-leading scientists in underwater sound, marine mammal hearing, and marine mammal behavior recently produced an acoustic risk assessment framework (RAF) that may help fill in this gap since it is meant to provide biologically meaningful context to interpret exposures and takes (Southall Environmental Associates, Inc., 2016). The RAF is meant to provide biologically meaningful context to interpret potential behavioral responses of marine mammals to seismic noise, as well as to estimate exposures and takes. The RAF is addressed in greater detail in **Chapter 1.2.6**.

4.1.4.5 Space-Use Conflicts

Marine space-use issues are a continuing problem and an important element in marine spatial planning (Crowder and Norse, 2008; Ehler and Douvere, 2009). Whenever activities take place on the OCS, there is potential for space-use conflict that must be evaluated prior to conducting regulated activities. However, as discussed in **Chapter 3.4**, in the GOM, multiple users have been sharing the OCS for decades, including oil and gas exploration and development, military operations, commercial fishing, and substantial vessel traffic. BOEM's Oil and Gas Program activities have been ongoing since the 1950s and include the presence of approximately 7,271 platforms placed (4,597 removed), 53,961 total miles of pipeline (27,082 miles active), and 53,638 boreholes drilled (26,190 permanently abandoned) (Marine Cadastre, 2015). In addition, BOEM takes into account the restrictions under GOMESA, which preclude leasing, pre-leasing, or any related activity in certain areas of the GOM that conflict with military operations, as well as requiring coordination with USDOD regarding certain activities occurring in USDOD's Operating Areas. Commercial fishing in the GOM includes >9,000 vessels (USEPA, 2010), and AIS vessel traffic data from 2012 included 308,664 total vessel trips in the GOM. Therefore, coordinating space-use conflicts is an ongoing process in the GOM.

The three major components of the cumulative scenario discussed in detail in **Chapter 3.4**, include (1) the OCS Program; (2) oil and gas activities in State waters, and (3) other major factors influencing the AOI. All of these activities spatially coexist with other activities on the OCS but differ in their potential for space-use conflict by their degree of permanence or frequency.

For example, in the GOM, a Military Areas Stipulation is required for leased OCS lands under the Oil and Gas Program; this stipulation specifies points of contact between industry and USDOD facility operators to reduce impacts, particularly in regards to safety. Military and all other GOM activities coexist with mandated routine coordination of activities. The reduction in potential impacts resulting from this stipulation makes multiple-use conflicts unlikely, but without it, some conflict with respect to safety issues is likely. The best indicator of the overall effectiveness of the stipulation may be that, even with the approximately 7,271 oil and gas structures and associated activities ongoing since the 1950s, there has never been an accident involving a conflict between military operations and oil and gas activities in the GOM.

Marine spatial planning is a key factor in reducing space-use conflicts. Coastal and marine spatial planning (CMSP) is "a comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas" (*Federal Register*, 2010). The goal of CMSP is to reduce conflict among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services. BOEM is implementing CMSP as a tool to achieve National Ocean Policy objectives, and CMSP will provide a framework for the coordinated application of existing laws and agency authorities. BOEM is using a phased implementation approach to CMSP that includes engaging State, Tribal, Federal, and public stakeholders and technical experts; consulting with regional Fishery Management Councils (FMCs); drafting Strategic Action Plans; and developing a data portal for applicable Federal data access and sharing. Space-use conflicts for each applicable resource category have been addressed within individual impact discussions and identified within the IPFs associated with the presence of structures, vessel traffic, and vessel stand-off distances. The analyses include direct, indirect, and cumulative impacts to each resource category.

4.1.5 Effects of the *Deepwater Horizon* Oil Spill

On April 20, 2010, the *Deepwater Horizon* mobile drilling unit exploded, caught fire, and eventually sank, resulting in loss of life and a massive release of oil and other substances from BP's Macondo well. The *Deepwater Horizon* oil spill released approximately 134 million gallons (3.19 million barrels) of oil and 1.84 million gallons of dispersant into the environment (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). Every day for 87 days, the well released an average of >1.5 million gallons of fresh oil into the ocean, essentially creating a new major oil spill every day for nearly 3 months.

The Oil Pollution Act (OPA) of 1990, as provided in 33 U.S.C. § 2706, allowed the designation of the Natural Resource Damage Assessment (NRDA) 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 OPA 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 (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" (*Federal Register*, 2012). The Task Force, on the other hand, was charged with creating a plan to improve the overall health of the GOM area and has focused on several 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 Trustee Council, the valuable information gathered by the Task Force has been useful to the Trustee Council in their restoration planning efforts (USDOC, NOAA, 2015c, 2015d).

The NRDA activities for the BP oil spill have been divided into the following categories and focus on specific species, habitats, or uses (USDOC, NOAA, 2015e):

- 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, and beach closures).

In October 2015, NOAA released the "*Deepwater Horizon* Oil Spill: Draft Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement" (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2015). This was followed by the "*Deepwater Horizon* Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement" (Final PDARP/PEIS) in February 2016 (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). The Final PDARP/PEIS considers programmatic alternatives to restore natural resources, ecological services, and recreational use services damaged or lost since the 2010 *Deepwater Horizon* explosion, oil spill, and response. The Final PDARP/PEIS includes an assessment of "injury" to natural resources resulting from the *Deepwater Horizon* explosion, oil spill, and response. The term "injury" refers to impacts of the spill and derives from the OPA of 1990, which requires an assessment of "[d]amages for injury to, destruction of, loss of, or loss of use of, natural resources…" (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). The Final PDARP/PEIS is concerned with impacts to the public's natural resources and the services provided by those resources, such as recreation. It does not analyze economic impacts to private parties and governments caused by the oil spill.

Combining direct observations, remote-sensing data, field sampling data, and other lines of evidence, the Final PDARP/PEIS estimates that *Deepwater Horizon* oil created 112,115 km^2 (43,300 mi^2) of detectable oil slicks on the sea surface. Oil sank to the seafloor over an area of approximately 1,030 km^2 (400 mi^2) and contacted >2,100 km (1,300 mi) of shorelines from Texas to the Florida Panhandle (**Table 4.1-3**). Natural resources were exposed to oil, dispersant, or both across a broad range of habitats, including the deep-sea, water-column, sea-surface, and nearshore habitats such as beach, marsh, mangrove, and submerged aquatic vegetation. A wide variety of biota, including marine mammals, sea turtles, fish and shellfish, benthic communities, and birds, were exposed to oil and/or dispersant throughout the northern GOM. Natural resources were exposed through various pathways, including direct exposure and contact with contaminated water, air, vegetation, and sediments. Despite natural weathering processes over the past 5 years, oil persists in some habitats and continues to affect resources in the northern GOM (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). Impacts to various biotic communities also persists, resulting in new baseline conditions for several living resources and habitats.

The following Federal agencies are the designated natural resource Trustees under the OPA for the *Deepwater Horizon* oil spill:

- the U.S. Department of the Interior, as represented by the Fish and Wildlife Service, Bureau of Land Management, and National Park Service;
- the U.S. Department of Commerce, as represented by the NOAA;
- the U.S. Environmental Protection Agency; and
- the U.S. Department of Agriculture.

The following State agencies are designated natural resources Trustees under the OPA and are currently acting as Trustees for the *Deepwater Horizon* oil spill:

- the State of Florida's Department of Environmental Protection and the Florida Fish and Wildlife Conservation Commission;
- the State of Alabama's Department of Conservation and Natural Resources and the Geological Survey of Alabama;
- the State of Mississippi's Department of Environmental Quality;
- the State of Louisiana's Coastal Protection and Restoration Authority, Oil Spill Coordinator's Office, Department of Environmental Quality, Department of Wildlife and Fisheries, and Department of Natural Resources; and
- the Texas Parks and Wildlife Department, Texas General Land Office, and Texas Commission on Environmental Quality.

Each of the Federal and State co-Trustees participated as a cooperating agency pursuant to NEPA (40 CFR § 1508.5).

A great deal of scientific data regarding the potential short-term and long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response on GOM resources has become available, and studies focusing on long-term effects are continuing. It could be many years before the information regarding the long-term effects becomes available via the NRDA process, BOEM's Environmental Studies Program, and numerous studies by other Federal and State agencies and academia. Nonetheless, the subject-matter experts who prepared this Programmatic EIS used new scientifically credible information that was available and determined that additional information was not available absent exorbitant cost or could not be obtained in a timely manner, regardless of costs. The subject-matter experts determined where gaps remained and exercised best professional judgment to extrapolate baseline conditions and impact analyses using accepted methodologies based on credible information. This approach complies with the requirements of 40 CFR § 1502.22 of the CEQ regulations regarding how agencies should address incomplete or unavailable information. Relevant baseline conditions, including credible scientific information regarding the potential short-term and long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response on GOM resources that are relevant to the proposed action, have been incorporated in the appropriate resource chapters.

4.2 MARINE MAMMALS

4.2.1 Description of the Affected Environment

In the northern GOM, there are 22 marine mammal species likely to occur within the AOI, based on current distributional data (Davis and Fargion, 1996; Würsig et al., 2000; Southall et al., 2007; Jefferson et al., 2008; Waring et al., 2013, 2014, 2015, 2016). These species represent two taxonomic orders: Cetacea (whales and dolphins) and Sirenia (manatees) (**Table 4.2-1**). Cetacea is subdivided into two suborders: Mysticeti (baleen whales) and Odontoceti (toothed whales and dolphins). Seven additional cetacean species may occur within the GOM, but they are considered rare or extralimital within the region (i.e., their presence in the GOM would be outside of their normal distributional range) (Waring et al., 2014). These include six mysticete species (North Atlantic right whale, common minke whale, sei whale, blue whale, fin whale, and humpback whale) and one odontocete species (Sowerby's beaked whale). Because these species are not regular inhabitants of the GOM and therefore are unlikely to be exposed to Gulf of Mexico G&G activities, they are not considered further in this analysis.

A summary of information on these species is presented in **Table 4.2-1**, including distribution and abundance, habitat, behavior, vocalizations and hearing, and status (ESA/MMPA stock). Information details for each species are provided in **Appendix E, Section 2**. Estimates of the relative abundance (or density) of each species, as presented in **Tables 4.2-1 and 4.2-2** and in **Appendix E, Section 2**, are derived from two sources: the Cetacean Density and Distribution Mapping Working Group (CetMap) database (Roberts et al., 2016), and the NMFS Stock Assessment Reports (SARs). CetMap data include species-specific spatial and temporal information to estimate density using predictive environmental factors from the Marine Geospatial Ecology Laboratory (Duke University) model (Roberts et al., 2016). The SARs are prepared annually by NMFS in consultation with regional Scientific Review Groups. Each report includes stock-specific information (when available) but does not provide spatiotemporal density information (Waring et al., 2014).

Data from shipboard cetacean surveys of the shelf-edge and oceanic northern GOM conducted from 1991 to 2001 were reviewed by Maze-Foley and Mullin (2006) to document habitat partitioning between species. From these studies, seafloor depth and topography in the GOM showed the clearest indication of habitat partitioning in the areas surveyed. From these results, marine mammals within the GOM may be divided into two communities: a continental shelf community and an oceanic community. The continental shelf community includes two cetacean species (i.e., the common bottlenose dolphin and the Atlantic spotted dolphin) and occasional sightings of the Florida manatee in coastal and offshore (near-coastal) waters. The oceanic community included 19 cetacean species (Mullin et al., 1994; Davis and Fargion, 1996; Hansen et al., 1996; Mullin and Hansen, 1999; Mullin and Hoggard, 2000; Fulling et al., 2003). Most oceanic species were widely distributed across the GOM within broad or somewhat specific depth ranges of the continental slope. Sperm whales were widely distributed within the GOM (**Figure 4.2-2**). Based on satellite tracking studies conducted by Jochens et al. (2008), the GOM sperm whale's home range (defined as an area over which an animal or group of animals regularly travels in search of food or mates and that may overlap with those of neighboring animals or groups of the same species) is broad, comprising nearly the entire GOM in water depths >500 m (1,640 ft). By contrast, the GOM sperm whale's composite core area (defined as a section of the home range that is utilized more thoroughly and frequently as primary locales for activities such as feeding) generally includes Mississippi Canyon, the Mississippi River Delta, and (to a lesser extent) the Rio Grande Slope (Jochens et al., 2008). These data support the fact that sperm whales aggregate in the Mississippi Canyon area, including the proposed closure area, but regularly move across the northern GOM continental slope. Some oceanic species showed a localized distribution (east or west) within a specific depth range. Most sightings of Bryde's whales were concentrated along the northeastern shelf-edge in the De Soto Canyon area, within a very narrow water-depth range (199 to 302 m [653 to 991 ft]) (**Figure 4.2-3**). Sightings of spinner and Clymene dolphins were at similar depths, east or west, respectively, of the Mississippi River. Most killer whales occurred in the central GOM in water depths >700 m (2,297 ft). False killer whale sightings were uncommon, but nearly all occurred in the far eastern GOM in a wide range of depths.

Survey data suggest that species richness and abundance of oceanic cetaceans remain high throughout the year, with no common species vacating slope waters seasonally. Factors that may affect the distribution and abundance of cetaceans within the GOM (both spatially and temporally) include physicochemical and biotic variables such as seawater temperature and enhanced productivity from Mississippi River outflow or the upwelling of nutrients from the Loop Current and anticyclonic eddies that are periodically shed from the Loop Current (Davis and Fargion, 1996; Biggs and Ressler, 2001; Maze-Foley and Mullin, 2006).

A more complete knowledge base for all types of marine mammals that use the AOI is not available, and such information cannot be acquired without exorbitant cost. Such information certainly cannot be acquired in a timeframe to make it available for this evaluation. While there would never be complete scientific information on marine mammals that live in OCS waters, biological and physiological data, and information about the underwater hearing of representative marine mammals are available. These data are sufficient to draw inferences and conclusions about marine mammal species and species groups that are less understood. Thus, while BOEM reports where limited data and insufficient knowledge challenge our ability to understand how and when specific types of marine mammal species use the AOI, BOEM is able to draw basic conclusions, discuss results using available scientifically credible information, and apply that information using accepted scientific methodologies.

Federal Protection Status of Marine Mammals of the AOI

All marine mammal species within U.S. waters are protected under the MMPA. The sperm whale (Northern GOM stock) is federally listed as endangered and the Florida subspecies of the West Indian manatee is listed as threatened (*Federal Register*, 2017), and they receive further protection under the ESA (Waring et al., 2010). Under the ESA, a species is considered endangered if it is “in danger of extinction throughout all or a significant portion of its range.” A species is considered threatened if it “is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” The West Indian manatee in U.S. waters would remain protected as a threatened species under the ESA and as a depleted species under the MMPA, and these existing regulatory mechanisms will remain in effect (*Federal Register,* 2017).

In 2013, NOAA published a 90-day positive finding to list the sperm whales in the GOM as a Distinct Population Segment (DPS) under the ESA, and subsequently initiated a review of the sperm whale status in the GOM. That 90-day review resulted in NOAA determining that the action to designate a DPS was not warranted, and its listing status remains endangered.

The Northern GOM stock of Bryde’s whale is being considered for listing under the ESA. On April 6, 2015, NMFS issued a 90-day finding on a petition to list this stock as an endangered DPS (*Federal Register*, 2015a). After conducting a status review of the species, NMFS issued a 12-month finding on the aforementioned petition on December 8, 2016, proposing this stock to be listed as endangered under the ESA (*Federal Register*, 2016b). If NOAA issues a final rule listing the Bryde’s whale as endangered, the species would receive additional protections and Federal agencies would be required to consult under Section 7 for Federal actions that may affect the species. A year-round Biologically Important Area (BIA) has been designated for the resident Bryde’s whale population in this area of the eastern GOM (Maze-Foley and Mullin, 2006; Širović et al., 2014; LaBrecque et al., 2015). The BIAs are reproductive areas, feeding areas, migratory corridors, and/or areas in which small and resident populations are concentrated. The delineation of BIAs does not have direct or immediate regulatory consequences. Rather, the BIA assessment is intended to provide the best available science to help inform regulatory and management decisions under existing authorities about some, though not all, important cetacean areas in order to minimize the impacts of anthropogenic activities on cetaceans and to achieve conservation and protection goals. In addition, BIAs and associated information may be used to identify information gaps and prioritize future research and modeling efforts to better understand cetaceans, their habitat, and ecosystems (Van Parijs et al., 2015).

The MMPA prohibits, with certain exceptions, the “take” of marine mammals in U.S. waters and by U.S. citizens on the high seas, as well as the importation of marine mammals and marine mammal products into the U.S. (refer to **Chapter 1.2.5**). “Take” is defined under the MMPA as “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal” (16 U.S.C. § 1362). Harassment, under the 1994 Amendments to the MMPA, is further subdivided into two levels: Level A and Level B (USDOC, NMFS, 2014). Level A harassment is defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild. Level B harassment has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

Some marine mammal stocks (defined as a group of nonspecific individuals that are managed separately [Wang, 2002]) may be designated as strategic under the MMPA, which requires the jurisdictional agency (NMFS or FWS) to impose additional protection measures. According to the MMPA, a stock is considered strategic if

- direct human-caused mortality exceeds its potential biological removal (PBR) level (defined as the maximum number of animals, not including natural mortality, that can be removed from the stock while allowing the stock to reach or maintain its optimum sustainable population [OSP] level);
- it is listed under the ESA;
- it is declining and likely to be listed under the ESA; or
- it is designated as depleted under the MMPA (USDOC, NMFS, 2014).

The OSP is defined by the MMPA (Section 3[9]) as the number of animals within any population stock that will result in the maximum productivity of the population or the species, considering the carrying capacity of the habitat and the health of the ecosystem of which they are a part (16 U.S.C. § 1362(3)(9)). A depleted stock is defined by the MMPA (USDOC, NMFS, 2014) as any case in which

- the Secretary (of the Interior or Commerce, depending on the species), after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals established under MMPA Title II, determines that a species or population stock is below its OSP;
- a state, to which authority for the conservation and management of a species or population stock is transferred under Section 109, determines that such species or stock is below its OSP; or
- a species or population stock is listed as an endangered species or a threatened species under the ESA.

Effects of the *Deepwater Horizon* Oil Spill on Marine Mammals

The *Deepwater Horizon* explosion, oil spill, and response impacted marine mammals that came into contact with oil and remediation efforts (including use of dispersants) (**Figure 4.2-1**). The NRDA process, evaluating the possible effects of the *Deepwater Horizon* explosion, oil spill, and response, focused the quantification efforts on common bottlenose dolphins exposed to oiling. The average annual number of dolphin strandings in Louisiana from 2002 to 2009 was 20. In 2010, common bottlenose dolphin strandings were high in the northern GOM prior to the oil spill (48 strandings) and continued to be elevated after the oil spill (91 strandings) (USDOC, NOAA, 2017a). In Louisiana, there were more strandings in 2011 than in 2010 (2011 had 159 strandings in Louisiana, almost 8 times the 2002 to 2009 average). In Mississippi and Alabama, dolphin strandings were also elevated in 2010 and 2011. In 2011, strandings in Mississippi and Alabama were five times and four times the 2002 to 2009 average, respectively (USDOC, NOAA, 2017a). The Barataria Bay and Mississippi Sound stocks of the common bottlenose dolphin were two of the best-studied populations, and they experienced some decline. Dolphins in concentrated oiling locations have shown overall poor health and prevalence of poor body condition, disease, and abnormalities as compared with common bottlenose dolphins in the GOM that were not exposed to oiling (Schwacke et al., 2013; Venn-Watson et al., 2015).

A UME for cetaceans that encompassed the northern GOM from the Florida Panhandle west to the Louisiana-Texas border began in March 2010, prior to the *Deepwater Horizon* oil spill, and it continued through July 2014 (USDOC, NMFS, 2016e). This UME is now closed (USDOC, NMFS, 2017). A UME is defined under the MMPA as “a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response.” From investigations of stranded dolphins, there is no evidence that two of the most common causes of previous dolphin die-offs in the GOM, morbillivirus and marine biotoxins, were the cause of this UME. The types of impacts observed were consistent with the known routes of exposure and the effects reported in the oil toxicity literature (in other mammals); however, very few studies have examined a dose-specific impact in marine mammals. From these results, the UME investigation and the Deepwater Horizon Natural Resource Damage Assessment Trustees have determined that the *Deepwater Horizon* oil spill resulted in the death of marine mammals and is the most likely explanation of the elevated stranding numbers in the northern GOM after the spill.

Thirty-one stocks of cetaceans were exposed to *Deepwater Horizon* oil (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). While smaller percentages of the oceanic stocks were exposed to oil, they also experienced mortality, reproductive failure, and adverse health effects (Schwacke et al., 2014). Dolphins and other cetaceans are long-lived species that are slow to mature and reproduce; therefore, it could be many years before the full effects of the *Deepwater Horizon* spill on dolphin populations are realized (USDOC, NOAA, 2017b).

The NMFS’ determination of the effects of the *Deepwater Horizon* explosion, oil spill, and response on marine mammals can be found in the Final PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016).

As stated earlier, a great deal of scientific data regarding the potential short-term and long-term impacts of the *Deepwater Horizon* explosion, oil spill, and response on GOM resources has become available. Conditions in the GOM post-*Deepwater Horizon*, however, continue to change. As such, studies focusing on possible long-term effects are continuing. It could be many years before the information regarding the long-term effects becomes available via the NRDA process. The Final PDARP/PEIS information is noted in this Programmatic EIS to provide all known and best available information regarding impacts to the GOM marine environment, as a whole, from the *Deepwater Horizon* explosion, oil spill, and response

Incomplete or Unavailable Information

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 is essential, whether it can be obtained and whether the cost of obtaining the information is exorbitant, as well as whether generally accepted scientific methodologies can be applied in its place (40 CFR § 1502.22) as discussed in **Chapter 4.1.4.1**.

BOEM concludes that there is incomplete or unavailable information (40 CFR § 1502.22) for all marine mammals with respect to the hearing range, the basic biology of specific species and their physiology for underwater hearing, and the effects of noise. All of these species-specific and population variables may be relevant to reasonably foreseeable adverse impacts on marine mammals that are subject to active acoustic sound sources (i.e., airguns). However, what is known about the biology and hearing physiology of representative species, in combination with observations of behavioral response to stimuli, allows inferences and conclusions about reasonably foreseeable adverse impacts on marine mammals to be understood with an adequate degree of certainty. Therefore, BOEM has determined that the data or information on marine mammal biology, hearing physiology, seasonal abundances, and population stock in the AOI identified as incomplete or unavailable are not essential to a reasoned choice among the alternatives, including the No New Activity alternative (i.e., ,the no action alternative).

A more complete knowledge base for all types of marine mammals that use the AOI and that bear on the factors listed previously is not available, and such information cannot be acquired without exorbitant cost. Such information certainly cannot be acquired in a timeframe to make it available for this evaluation. While there would never be complete scientific information on marine mammals that live in OCS waters, biological and physiological data and information about the underwater hearing of representative marine mammals are available. These data are sufficient to draw inferences and conclusions about the types of marine mammals that are less understood. Thus, while BOEM reports where limited data and insufficient knowledge challenge our ability to understand how and when specific types of marine mammal species use the AOI and how that bears on the factors listed previously, incomplete or unavailable information does not affect our ability to understand and assign impacts or design mitigation strategies. Despite incomplete or unavailable information, BOEM is able to draw basic conclusions, discuss results using available scientifically credible information, and apply that information using accepted scientific methodologies.

4.2.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs associated with a proposed action that may impact marine mammals within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; and side-scan sonars); (2) vessel and equipment noise; (3) vessel traffic (i.e., physical disturbance to and risk of collisions); (4) aircraft traffic and noise (e.g., helicopters and fixed-wing aircraft); (5) trash and debris (i.e., ingestion of and entanglement in); (6) entanglement (e.g., with acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines); and (7) accidental fuel spill.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact-level categories. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels when compared with Alternative A.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For marine mammals, the impact-level definitions below have been used to evaluate the level of impact for each IPF.

Nominal impacts to marine mammals include those where no measurable impacts to local populations are observed or expected. Nominal impacts are limited to potential minimal, short-term behavioral or other low-level impacts on individuals (low numbers in relation to population [stock], low severity, and short duration). No potential mortalities or physical injuries are included, and no potential effects on individual fitness (e.g., reduction in reproductive success or survivorship) or on populations are expected.

Minor impacts to marine mammals include those that are not extensive or severe, and are expected to affect individuals or groups from local populations within the AOI. Minor impacts include potential limited behavioral disturbance and low numbers of non-fatal physical injuries in relation to population (stock). These potential effects include a low likelihood of fitness impacts on a low number of individuals in relation to population (stock). No potential mortalities are included, and there are no impacts on population rates.

Moderate impacts to marine mammals at the local population (stock) level may be extensive (potentially affecting large numbers of individuals [or percentage of the local stock] within regions of the AOI) but not severe, or may be severe but not extensive. Moderate impacts include potential significant behavioral disturbance and physical (including auditory) injuries of more than low numbers of individuals in relation to population (stock), including the likelihood of fitness effects on more than a low number of individuals in relation to population (stock). Moderate impacts also include potential mortality of individuals (but below that of PBR for the stock or species), including some negative population-level impacts to stable or increasing populations, but not outside of the existing known variation around measured population trend (i.e., the continued viability of the local population or stock is not threatened, and the annual rates of recruitment or survival of the local population or stock are not seriously affected).

Major impacts to marine mammals would be extensive and severe if they occur. Impacts to marine mammals are considered major if they include potentially extensive levels of life-threatening or debilitating injury or mortality in sufficiently high numbers (above that of PBR for the stock or species) that the continued viability of the population is threatened, including serious diminishment of annual rates of recruitment or survival. Declining species are considered to have major impacts if their population rates are adversely affected, and stable or increasing species are considered to have major impacts if their population rates are reduced beyond previously measured natural variation, as a result of mortality or adverse energetic or health impacts from severe behavioral disturbance or injury. If there is not enough data to assess trends, or populations are unknown, negative population-level effects equate to “major” impacts.

4.2.2.1 Impacts of Routine Activities

4.2.2.1.1 Characteristics of Active Acoustic Sound Sources

Active acoustic sound sources included in the proposed action are airguns and various electromechanical sources. Source characteristics are summarized in **Table 3.3-2**, and detailed characteristics and acoustic modeling assumptions are presented in **Appendix D, Section 5**. The two major sound source groups (i.e., airgun and electromechanical) are discussed separately.

Airgun Survey Activities

Airguns would be used as sound sources during deep-penetration seismic airgun surveys as well as some shallow-penetration HRG surveys to support oil and gas surveys and renewable energy activities (**Appendix F, Sections 1.1 and 1.2**). Deep-penetration surveys include 2D and 3D towed-streamer surveys, 2D and 3D OBC and OBN surveys, WAZ and related multi-vessel surveys (e.g., coil), vertical cable surveys, and 4D surveys. Shallow-penetration airgun seismic surveys include the use of a single airgun with HRG equipment (electromagnetic activities are described later in this Programmatic EIS).

For this Programmatic EIS, one large airgun array and one small airgun are used to represent general configurations and the potential impacts to marine mammals within the AOI (**Appendix D, Section 1.3**).

- Large Airgun Array (approximately 8,000 in^3) – This array is used to represent sound sources for deep-penetration seismic airgun surveys, including 2D, 3D, 4D, WAZ, VSP, and other variations.
- Small Airgun Array (90 in^3) – A single airgun is used to represent sound sources for some HRG airgun surveys to assess shallow hazards and benthic habitats at oil and gas exploration sites.

Representative broadband source levels are 248 dB $SPL_{0\text{-peak}}$ re 1 µPa at 1 m measured broadside for the large airgun array and 228 dB $SPL_{0\text{-peak}}$ re 1 µPa at 1 m for the small airgun array (**Table 3.3-2**). Although airguns typically have a frequency range between 10 and 2,000 Hz, most of the acoustic energy is <600 Hz.

The situations simulated are complex and evolving. The time period evaluated was 10 years of future survey efforts using representative surveys whose precise design, location, and time of performance are not known. There is wide variety in survey and source configurations, and new configurations, sources, or use of sources are likely to be developed in the future. The details of marine mammal density, distributions, and behavior patterns are imprecisely known and change as animal populations vary from year to year and location to location.

Electromechanical (Non-Airgun) Survey Activities

The HRG surveys use electromechanical acoustic sources to support projects or surveys in all three Program Areas (though they may be used in conjunction with airguns). Typical non-airgun HRG surveys utilize one or more of the following high-frequency acoustic sources:

- pinger (2,000 Hz);
- sparker (50 to 4,000 Hz);
- boomer (300 to 3,000 Hz);
- CHIRP subbottom profiler (0.5 to 24 kHz);
- side-scan sonar (16 to 1,500 kHz);
- SBES (12 to 240 kHz); and
- MBES (50 to 400 kHz).

Details of each of these electromechanical sound sources and their applications are in **Appendix F, Section 1.3**.

Background: Potential Effects of Noise on Marine Mammals

Underwater noise can be divided into two main types: (1) pulsed (or impulsive), which is divided into single or multiple pulses; and (2) continuous, non-pulsed (Southall et al., 2007; Science Communication Unit, 2013). Impulsive noises are transient signals that arise as the result of a sudden release of energy (Hamernik and Hsueh, 1991). Impulsive sound is defined within ANSI Standard S12.9-2005/Part 4 as “sound characterized by brief excursions of sound pressure (acoustic impulses) that significantly exceed the ambient environmental sound pressure.” As such, impulsive sound is characterized by extremely rapid rise rates in amplitude over time (rise time), minimal duration, and a rapid decay in amplitude. The duration of a single impulsive sound is usually less than 1 second. However, at the time of publication of this ANSI Standard, no mathematical descriptor existed to unequivocally define the presence of impulsive sound or to separate impulsive sounds into categories. Explosions, pile driving, and seismic surveys are examples of impulsive noise. Continuous sounds have a longer duration, typically with slower rise and decay times. The sounds of an outboard boat engine or wind turbines are examples of continuous, non-pulsed sound.

Underwater noise sources in the proposed action include multiple pulsed sound sources such as airguns, boomers (Verbeek and McGee, 1995; Simpkin, 2005), and sparkers, as well as continuous sound sources such as vessel and aircraft noise, geotechnical drilling, and intermittent sources such as subbottom profilers, MBESs, and side-scan sonars. **Chapter 3.3 and Appendix F** provide a description of these noise sources. Overall, the potential for noise impacts from these sound sources on marine mammals is highly variable and depends on the specific circumstances of a situation. Furthermore, the same sound source can propagate differently depending on the physical environment. How a sound from a specific source propagates through a particular environment depends on a variety of factors, including physical environment factors (e.g., salinity, temperature, bathymetry, seafloor type, and tow depth), sound characteristics associated with different sources (e.g., source level, directionality, source type, and duration for impulsive or continuous signals), frequency (i.e., higher frequencies dissipate faster, lower frequencies may travel farther depending on water depth), and intensity (i.e., decibel level). A review of marine mammal hearing and sensitivity to acoustic impacts is presented in **Appendix H**. More information on acoustical properties and propagation of sound sources under the proposed action can be found in **Appendix D, Section 3.4**.

Past studies on the reactions of animals to noise have shown widely varied responses depending on the species as well as the individual’s age, gender, and activity in which the animal was engaged in at the time of sound exposure (Gordon et al., 2004). Where there is an overlap between noise sources and the sound frequencies used and heard by marine life, sound may interfere with important biological functions. Noise, either natural or anthropogenic, can adversely affect marine life in various ways. Four zones of influence from noise are offered by Richardson et al. (1995) and summarized by Gordon et al. (2004):

(1) zone of **audibility** – the area in which the sound is above the animal's hearing threshold and detectable above background noise;

(2) zone of **responsiveness** – the region in which behavioral reactions in response to the sound occur;

(3) zone of **auditory masking** – the area in which the sound may mask biologically significant sounds (e.g., sounds being heard and used for communication, navigation, or the location of conspecifics and prey); and

(4) zone of **hearing loss**, discomfort, or injury – the area in which the sound level is sufficient to cause TTS, auditory injury, PTS, and potential physiological effects.

These zones of influence broadly define the nature of potential response and impact from acoustic exposure. The range of potential effects from noise, in order of decreasing severity and modified slightly from the four zones initially outlined by Richardson et al. (1995), includes death, non-auditory physiological effects, auditory injury/hearing threshold shift, masking, and stress and disturbance, including behavioral response (Richardson et al., 1995; NRC, 2003a, 2005; Nowacek et al., 2004; Southall et al., 2007). More severe potential effects (e.g., temporary or permanent hearing loss) could occur when exposure is close to a sound source (i.e., the magnitude and probability of some effects decrease with increasing distance from a sound source) and when duration of the exposure(s) is longer. Limited data on potential effects to manatees are available, with no mention of manatees in Southall et al. (2007) or clarification in NMFS' Technical Guidance (USDOC, NMFS, 2016b), as the guidance does not pertain to marine mammal species under the jurisdiction of FWS. Given the coastal distribution of manatees, indirect impacts could occur from activities in nearshore State waters (e.g., vessel strikes), but no direct impacts of noise are expected.

There is extensive interest in forecasting how short-term behavioral responses by individual animals may aggregate and result in population-level consequences. The concept was introduced by the National Research Council (2005) as Population Consequences of Acoustic Disturbance, but given the lack of data on acoustic responses, research studies have generalized the issue to look at environmental and anthropogenic stressors in general and renamed the concept Population Consequences of Disturbance. New et al. (2014) presented a modified conceptual framework to help forecast long-term impacts. The idea is that a series of transfer functions connect increasingly broader impacts, from the initial disturbance to effects on individual health, individual vital rates, and finally population dynamics (New et al., 2014). The concept has been demonstrated with a few species for which there are extensive data from tagged or photo-identified animals so that the effects on individuals can be quantified. Northern elephant seals (Aoki et al., 2011; Adachi et al., 2014) were the first study species where the data from time-depth recorders were able to be linked to an individual animal's body fat condition, which provided insight into foraging success and ultimately individual health and vital rates (Robinson et al., 2010). Rolland et al. (2016) used photographic data of North Atlantic right whales to evaluate individual health and link it to demographic groups and population status. Additional studies exploring population consequences are ongoing, but a common theme is that extensive data documenting individual health and population vital rates is necessary for such analyses. These are the gold standards for future studies, but at present, studies within the GOM have not occurred in sufficient detail for such analyses.

Death and Non-Auditory Physiological Effects from Various Sound Sources

Direct physical injury, which could result in death, may occur from exposure to high levels of sound or, more commonly, to shock waves associated with sound-producing events such as underwater blasting and airguns, where the velocity of expansion of the bubble causing the pulse is higher than the speed of sound in water. These shock wave pulses typically are short, with peak pressures that have been hypothesized to cause damage to internal organs or air-filled body cavities (e.g., lungs) (Yelverton et al., 1973; Goertner, 1982; Young, 1991). Data on direct physical injuries are limited to anecdotal or forensic investigations after accidental events because ethical considerations and legal mandates in the U.S. prevent direct empirical methods to measure such impacts in marine mammals. However, such observations (e.g., Todd et al., 1996; Danil and St. Leger, 2011) and modeling based on impact data for terrestrial animals (e.g., Fletcher et al., 1976; Bauman et al., 1997) and the human vestibular system (e.g., Clark et al., 1996) as well as other organs (e.g., lungs) for underwater sound exposures (e.g., Cudahy and Ellison, 2002), suggest that marine mammals could be susceptible to direct physical injury to particular organ systems and tissues following intense exposure to sound (Ketten, 1995; Hildebrand, 2005). While there are no data that indicate G&G activities have caused this level of injury, possible types of non-auditory physiological effects or injuries that could occur include neurological effects, gas embolisms (i.e., decompression sickness; Ketten, 2014), fat embolisms, resonance effects, and other types of organ or tissue damage (Tasker et al., 2010). However, a marine mammal would have to be very close to the source for direct physical injury to occur, and BOEM believes that mitigation and monitoring measures would prevent marine mammals from being close to the sound source.

Exposure to intense underwater sound may not directly result in death or injury; however, it may be one of the indirect causative factors in death or injury to marine mammals. According to the U.S. Navy’s Atlantic Fleet Training and Testing Final EIS (U.S. Dept. of the Navy, 2013), “Sonar use during exercises involving U.S. Navy (most often in association with other nations’ defense forces) has been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira Island, Portugal in 2000; the Canary Islands in 2002; and Spain in 2006. These five mass strandings resulted in approximately 40 known, scientifically verifiable sonar-related deaths among cetaceans consisting mostly of beaked whales.” Exposure to noise from seismic surveys has been implicated in the deaths of two beaked whales in the Gulf of California in 2002 (Lamont-Doherty Earth Observatory survey), although no direct correlation has been proven (Cox et al., 2006). In these circumstances, exposure to impulsive acoustic energy has been considered to have been a potential indirect cause of the death of marine mammals (Cox et al., 2006). While large airgun arrays have a similar RMS source level to U.S. Navy tactical sonars, there are substantial differences in duration, frequency, and mode of operation between the two classes of sound sources.

In September 2013, an International Scientific Review Panel released a report following an investigation of a 2008 mass stranding of approximately 100 melon-headed whales in the Loza Lagoon system in Madagascar (Southall et al., 2013). The development of this investigation and report was supported by the International Whaling Commission, Marine Mammal Commission, NOAA, BOEM, ExxonMobil, the Wildlife Conservation Society, the International Fund for Animal Welfare, and the Government of Madagascar. The International Scientific Review Panel determined that the use of a 12-kHz MBES system (i.e., Kongsberg EM 120 MBES with a source level of 236 to 246 dB re 1 µPa at 1 m, sound exposure level [SEL] per pulse of 218 to 224 dB re 1 μPa^2•s [decibels referenced to 1 micropascal per second] at 1 m, pulse rate of ≤5 Hz, and pulse duration of 2, 5, or 15 ms) was “the most plausible and likely initial behavioral trigger of the stranding event, but that a variety of secondary factors contributed to or ultimately caused mortalities...” (Southall et al., 2013). According to the report, this was the first time that a relatively high-frequency mapping sonar system had been associated with a stranding event.

Given the predominant low-frequency sound sources, coupled with limited pulse durations, mode of operation, and directionality of large airgun arrays, and the mitigation and monitoring measures associated with Alternative A, it is not likely that geophysical survey activities would generate propagated seismic signals strong enough to cause direct mortality (DNV Energy, 2007). However, as noted in the previous examples, there is the potential (albeit limited) for sound sources to lead to indirect mortality through strandings under certain circumstances. In addition, survey protocols and underwater noise mitigation procedures (**Appendix B, Section 1**) would be implemented to decrease the potential for any marine mammal to be within the exclusion zone of an operating airgun array, thereby avoiding the highest (and injurious) received levels and minimizing marine mammals’ exposure to these sound sources.

Auditory Injuries – Hearing Threshold Shift

The minimum sound level an animal can hear at a specific frequency is called the hearing threshold at that frequency. Sounds above a hearing threshold are accommodated until a certain level of sound intensity or duration is reached, after which the ear’s hearing sensitivity decreases (the hearing threshold increases) (Southall et al., 2007). This process is referred to as a threshold shift, meaning that only sounds louder than a certain level will be heard within a certain frequency range. Threshold shifts can be temporary (TTS) or permanent (PTS) and are defined as follows (Southall et al., 2007; Au and Hastings, 2008):

- **TTS** – also known as auditory fatigue, the milder form of hearing impairment that is non-permanent and reversible, results from exposure to high-intensity sounds for short durations or lower-intensity sounds for longer durations, both conditions of which are species-specific and lead to an elevation in the hearing threshold, meaning it is more difficult for an animal to hear sounds. A TTS can last for minutes, hours, or days; the magnitude of the TTS depends on the level (frequency and amplitude), energy distribution, and duration of the noise exposure, among other considerations. Because TTS is recoverable, it does not constitute an injury (Ward, 1997).

- **PTS** – a permanent elevation in the hearing threshold and permanent loss of hearing, which is considered an auditory injury. Because few direct data are currently available regarding noise levels that might induce PTS in marine mammals, PTS onset thresholds are inferred from TTS marine mammal data (USDOC, NMFS, 2016b). The PTS is attributed to exposure to very high peak pressures and short rise times or very prolonged or repeated exposures to noise strong enough to elicit TTS. Permanent damage to the inner ear, such as irreparable damage to the sensory hair cells in the cochlea, is associated with noise-induced PTS. The relationship between the onset of PTS and TTS is complex and not completely understood.

Several factors relate to the type and magnitude of threshold shift, including exposure level, frequency content, duration, and temporal pattern of exposure. A range of mechanical effects (e.g., excessive vibrations of the inner ear stereocilia [organelles of hair cells that sense fluid motion] and hair cells may cause structural damage) and metabolic processes (e.g., inner ear hair cell metabolism such as energy production, protein synthesis, and ion transport) within the auditory system underlie TTS and PTS. Additional discussion of TTS and PTS is presented in **Appendix H, Section 4.2**.

Auditory impairment, either temporary or permanent, is a possibility when marine mammals are exposed to underwater noise. The minimum SPL (or SEL) necessary to cause PTS is higher than the level that induces TTS, although there are insufficient data to determine the precise differential. Extrapolation from human data indicates that a threshold shift of 40 dB may result in PTS onset (USDOC, NMFS, 2016b). Data indicate that TTS onset in marine mammals is more closely correlated with the received SEL than with SPL_{rms} and that received sound energy over time, not just the single strongest pulse, should be considered a primary measure of potential impact (Southall et al., 2007).

The NMFS published guidance on determining the impacts on the hearing of marine mammals from anthropogenic sound sources (USDOC, NMFS, 2016b). Southall et al. (2007) provided a comprehensive summary of noise exposure results and offered a series of new approaches to noise impact determinations for marine mammals, with U.S. Navy (Finneran and Jenkins, 2012; Finneran, 2015) and NOAA guidance (USDOC, NMFS, 2016b) further refining the methodology, criteria, and thresholds of acoustic impact analyses for marine mammals. This guidance from NOAA was not available when the acoustic exposure analysis was conducted. New data and information continue to become available (e.g., Finneran and Schlundt, 2011; Ellison et al., 2012; Kastelein et al., 2014; Tougaard et al., 2014), as this is an active area of scientific research.

Southall et al. (2007) segregated marine mammals into functional hearing groups (**Table 4.2-3**) and categorized sound sources based on their acoustic and temporal properties.

Three sound source categories (i.e., single pulse, multiple pulses, and non-pulses [continuous]) were defined based on an understanding of sound exposure, auditory fatigue, and acoustic trauma in terrestrial mammals and applicable damage risk criteria in humans. They also devised dual metric criteria (peak pressure and SEL) for TTS and PTS onsets, as well as the incorporation of frequency-weighting functions (M-weighting) to account for the differential hearing abilities in the different functional hearing groups.

As in Southall et al. (2007), NMFS' Technical Guidance (USDOC, NMFS, 2016b) delineated the acoustic threshold levels for the onset of PTS and TTS, recommending the use of the dual criteria metrics of SEL (specifically, cumulative SEL [SEL_{cum}] over a 24-hour period) and peak SPL (SPL_{peak}) as most appropriate for establishing the onset levels for TTS and PTS in specific hearing groups of marine mammals (USDOC, NMFS, 2016b). The SPL_{peak} threshold would be applied to unweighted (unfiltered) sound levels received from impulsive sources, while the SEL_{cum} metric would be calculated using auditory weighting functions derived for each marine mammal hearing group for impulsive and non-impulsive sources. Thus, any received noise from an impulsive source that exceeds the SPL_{peak} or SEL_{cum} criterion for injury is assumed to cause tissue injury in an exposed marine mammal.

The SEL takes into account the duration of the sound exposure as well as the sound's received level. Southall et al. (2007) normalize a single sound exposure to a duration of 1 second. Southall et al. (2007) did not specify a time period to capture the energy for multiple transmissions, but the typical application of these thresholds at that time employed a time period of minutes or tens of minutes around the maximum signal received for this calculation. Additionally, Southall et al. (2007) suggested a 24-hour "rest time," which was interpreted to be the time period necessary for an animal to return to a naive state before it could be impacted again. In NMFS' acoustic guidance (**Appendix N**; USDOC, NMFS (2016a), the SEL metric is intended to account for the accumulated exposure over the duration of the activity or over a 24-hour period, whichever was shorter; thus, SEL_{cum} is used. The SEL metric is advantageous because it can account for cumulative sound exposure, sounds of differing duration, and multiple sound exposures. The SEL metric also allows comparison between different sound exposures based on total energy (i.e., calculation of a single exposure "equivalent" value) (Southall et al., 2007). It is worthwhile to note that this application of the SEL_{cum} approach does not include the possibility of hearing recovery between repeated exposures.

Represented by dual criteria (SEL_{cum} and SPL_{peak}), the lowest received levels of impulsive sounds that might elicit auditory injury (PTS) according to Southall et al. (2007) are 198 dB re 1 $\mu Pa^2 \cdot s$ (SEL, which is now changed to SEL_{cum}) or 230 dB re 1 μPa (SPL_{peak}) in cetaceans (**Table 4.2-4**). The USDOC, NMFS (2016a) further refined the dual onset criteria for PTS, deriving different criteria for low-, mid-, and high-frequency cetaceans (**Table 4.2-4**). The PTS onset for impulsive sounds is 219 dB_{peak} for low-frequency cetaceans, 230 dB_{peak} for mid-frequency cetaceans, and 202 dB_{peak} for high-frequency cetaceans. The SEL_{cum} criteria are 183 dB, 185 dB, and 155 dB, respectively, for low-, mid-, and high-frequency cetaceans for impulsive sounds. The potential impact calculations made for the Draft Programmatic EIS used the available acoustic propagation and exposure modeling described in **Appendix D**, and the estimate of these values were 192 dB, 187 dB, and 161 dB, respectively, for low-, mid-, and high-frequency cetaceans. At the time, NMFS' regulatory thresholds were based on SPL_{rms} metrics (i.e., 180 dB re 1 μPa [rms] for injury; 160 dB re 1 μPa [rms] for behavioral disturbance); thus, the SPL_{rms} metrics cannot be directly compared with the SPL_{peak} metrics. However, the analysis in **Appendix D** includes the stepped threshold function that was developed and presented in Finneran and Jenkins (2012) and Wood et al. (2012). Further discussion of the current noise exposure thresholds is provided in a subsequent section below titled "Acoustic Exposure Criteria."

Sound sources used during G&G activities produce sound levels sufficient to cause TTS or PTS in marine mammals present within the range of operational sound sources, with range to exposure thresholds dependent upon the size of the sound source and other factors. A summary of active acoustic sound source impacts is provided in **Chapter 4.2.2.1.2**, with full descriptions included in **Appendix D, Section 3.4**. The predicted sound exposures are evaluated with the then current NMFS criteria as well as those presented in Southall et al. (2007). The final NMFS Technical Guidance was not employed in **Appendix D** as it was released in July 2016 (USDOC, NMFS, 2016b); however, **Appendix N** employed the updated criteria from this guidance for Level A exposures. Survey protocols and underwater noise mitigation procedures (**Appendix B, Section 1**) would be implemented to decrease the potential for any marine mammal to be within the exclusion zone of an operating airgun array or other sound source, thereby avoiding the highest sound levels. However, this does not imply that animals will not be exposed to sound that exceeds threshold levels; therefore, animals may still experience TTS or PTS due to exposure to a sound produced by proposed activities.

Since publication of the Draft Programmatic EIS, BOEM has been provided an addendum that conveys the updated 24-hour, injury-exposure probability estimates to account for the revised dual onset criteria for PTS in NMFS' Technical Guidance (refer to **Appendix N**). All other aspects of the modeling remained the same as described in **Appendix D**. While work in the addendum updates the peak SPL and SEL injury estimates, the tables contain the (unchanged) exposure probability estimates for potential behavior disruption and prior NMFS criteria so that all the current data are located together. BOEM has utilized this addendum to incorporate NMFS' Technical Guidance (**Appendix N**) for Level A exposure estimates. The NMFS also completed a chronic and cumulative effects model (**Appendix K**), which is now incorporated in this Final Programmatic EIS.

Auditory Masking

Noise can affect hearing and can partially or completely reduce an individual's ability to effectively communicate; detect important predator, prey, and conspecific signals; and detect important environmental features associated with spatial orientation (Clark et al., 2009). Increases in ambient noise levels can result in auditory masking, which is the reduction in the detectability of a sound signal of interest (e.g., communication calls and echolocation) due to the presence of another sound, which usually is noise in the environment, often at a similar frequency. Under normal circumstances, in the absence of high ambient noise levels, an animal would hear a sound signal because the sound is above its absolute hearing threshold. Auditory masking prevents part or all of a sound signal from being heard and decreases the distances that underwater sound can be detected by marine animals (i.e., reduction in communication space). These effects could cause a long-term decrease in a marine mammal's efficiency at foraging, navigating, or communicating (International Council for the Exploration of the Sea, 2005). For some types of marine mammals, specifically common bottlenose dolphins, beluga whales, and killer whales, empirical evidence confirms that the degree of masking depends strongly on the relative directions at which sound arrives and the characteristics of the masking noise (Penner et al., 1986; Dubrovskiy, 1990; Bain et al., 1993; Bain and Dahlheim, 1994).

Ambient noise from natural and anthropogenic sources can cause masking in marine animals, effectively interfering with the ability of an animal to detect a sound signal that it otherwise would hear. Spectral, temporal, and spatial overlap between the masking noise and the sender/receiver determines the extent of interference; the greater the spectral and temporal overlap, the greater the potential for masking. Naturally occurring ambient noise is produced from various sources, including environmental sounds from wind, waves, precipitation, earthquakes; biological sounds produced by animals; and thermal noise resulting from molecular agitation (at frequencies >30 kHz) (Richardson et al., 1995). Marine biota produce sounds that contribute to the ambient noise environment. Fish, for example, create low-frequency sounds (50 to 2,000 Hz, most often from 100 to 500 Hz) that can be a significant component of local ambient sound levels (Zelick et al., 1999). Ambient noise also can be generated by anthropogenic sources such as boats and ships, sonars (military and commercial), geophysical exploration, acoustic deterrent devices, construction noise, and scientific research sensors. Ambient noise is highly variable in the shallower waters over continental shelves (Desharnais et al., 1999) where many anthropogenic activities occur, effectively creating a high degree of variability in the range at which marine mammals can detect anthropogenic sounds. In coastal waters, noise from boats and ships, particularly commercial vessels, are the predominant source of anthropogenic noise (Parks et al., 2011). Snyder and Orlin (2007) noted that shipping noise dominated the low frequencies (25 to 400 Hz) of the ambient underwater noise environment of the GOM.

Over the past 50 years, commercial shipping, the largest contributor of masking noise (McDonald et al., 2008), has increased the ambient sound levels in the deep ocean at low frequencies by 10 to 15 dB (Hatch and Wright, 2007). This increase in low-frequency ambient noise coincides with a significant increase in the number and size of vessels making up the world's commercial shipping fleet (Hildebrand, 2009). Tournadre (2014) estimated from satellite altimetry data that, globally, ship traffic grew by approximately 60 percent from 1992 to 2002, at a nearly constant rate of approximately 6 percent per year; however, after 2002, the rate at which shipping increased rose steadily to >10 percent by 2011, except in 2008 to 2009, when ship traffic remained steady. Globally, Tournadre (2014) estimated that shipping between 1992 and 2011 grew by a factor of four, with the highest growth in the Indian and western North Pacific Oceans, especially in the continental seas along China; growth in shipping in the Atlantic Ocean and Mediterranean Sea, however, decreased after 2008. Aguilar-Soto et al. (2006) reported that the noise from a passing vessel masked ultrasonic vocalizations of a Cuvier's beaked whale and reduced the maximum communication range by 82 percent when exposed to a 15-dB increase in ambient sound levels at the vocalization frequencies; the effective detection distance of the Cuvier's beaked whale's echolocation clicks was reduced by 58 percent. Low-frequency noise (20 to 200 Hz) from large ships overlaps the frequency range of acoustic vocalizations of some mysticetes, and increased levels of underwater noise have been documented in areas with high shipping traffic, causing responses in some mysticetes that have included habitat displacement; changes in behavior; and alterations in the intensity, frequency, and intervals of their calls (Rolland et al., 2012).

Marine mammals are able to compensate, to a limited extent, for auditory masking through a variety of mechanisms, including increasing source levels (Lombard effect) or durations of their vocalizations or by changing spectral and temporal properties of their vocalizations (Parks et al., 2010; Hotchkin and Parks, 2013). In the presence of ship noise, beluga whales produced whistles of higher frequency and longer duration (Lesage et al., 1999). Di Iorio and Clark (2009a) found that blue whales increased their rate of social calling in the presence of seismic exploration sparkers (plasma sound sources), which presumably represented a compensatory behavior to elevated ambient noise levels from seismic surveys. Bowhead whales were found to increase their calling rate in response to seismic airgun signals at low levels (approximately 94 dB re 1 $\mu Pa^2 \cdot s$, SEL_{cum}; integrated over 10 minutes) (Di Iorio and Clark, 2009a). However, when those signals exceeded approximately 127 dB SEL_{cum}, their calling rate began to decrease, and when it reached approximately 160 dB SEL_{cum}, the whales stopped calling completely (Blackwell et al., 2015). Note that these received levels were measured at a recorder within 2 km (1 mi) of the whales; therefore, the received levels at the whales are approximations. These examples of mysticete responses to sound are informative, even though these species are not found in the GOM. Several marine mammal species are known to increase the source levels of their calls in the presence of elevated sound levels (Dahlheim, 1987; Au, 1993; Lesage et al., 1999; Terhune, 1999). Holt et al. (2009) studied the effects of anthropogenic sound exposure on the endangered southern resident killer whales in Puget Sound, reporting that these whales increased their call amplitude by 1 dB SPL for every 1 dB SPL increase in background noise (1 to 40 kHz). Castellote et al. (2012) reported that male fin whales from two different subpopulations not only modified their song characteristics during increased ambient noise conditions but also left the area for an extended period during seismic airgun activity, not returning for 14 days. Castellote et al. (2012) hypothesized that the fin whales modified their acoustic communications to compensate for the increased background noise and that the animals had a lower tolerance for seismic airgun noise than for shipping noise, perhaps having become desensitized to the ambient shipping noise. Melcón et al. (2012) found that blue whales stopped calling in the presence of mid-frequency active sonar transmissions and conversely increased their vocalization rate in the presence of ship sonar noise.

Sound sources used during geophysical survey activities could mask marine mammal communication and monitoring of the environment around them if the hearing sensitivities of the marine mammals present coincide with the frequency of the sound source being used. As airgun signals propagate away from the source, their amplitude drops, which reduces their masking effect. However, the multipath effects of propagation increase the duration of the signals, which increases the proportion of time that they could mask animal signals. Survey protocols and underwater noise mitigation procedures (**Chapter 2.3.2**), particularly shutdowns that are designed to reduce the potential for injury (PTS), may decrease the potential risk for nearby marine mammals to experience auditory masking associated with individual surveys but would have little implication for animals at greater distances and within areas with more chronic exposure to survey noise.

Stress and Behavioral Responses

Stress and behavioral changes are the result of marine mammals responding to extreme or excessive disturbances in their environment, either of natural or anthropogenic origin. Stress responses typically are physiological changes in a marine mammal's blood chemistry while behavioral responses involve changes in a marine mammal's normal actions.

Stress is a change in the body's equilibrium in response to an extreme environmental or physiological disruption. Marine mammals respond to environmental stress by releasing biochemicals into their blood streams. Thus, stress responses can be measured by changes in an animal's blood chemistry. Stress responses in marine mammals are immediate, acute, and characterized by the release of the neurohormones such as norepinephrine, epinephrine, and dopamine (U.S. Dept. of the Navy, Office of Naval Research, 2009). The NRC (2003a) discussed acoustically induced stress in marine mammals, stating that one-time exposures to sound are less likely to have population-level effects than sounds that animals are exposed to repeatedly over extended periods of time. Various researchers have summarized the available evidence regarding stress-induced events (e.g., Romano et al., 2004; Cowan and Curry, 2008; Mashburn and Atkinson, 2008; Eskesen et al., 2009). Romano et al. (2004) exposed a beluga whale to varying levels of an impulsive signal produced by a water gun and measured the levels of three stress-related blood hormones (i.e., norepinephrine, epinephrine, and dopamine) after control, low-level sound (171 to 181 dB SEL), and high-level sound (184 to 187 dB SEL) exposure; no significant differences in the hormone blood concentrations were found between the control and low-level sound exposure, but elevated levels of all three hormones were produced in response to high-level sound exposure. Furthermore, regression analysis demonstrated a linear trend for increased hormone level with sound level, and Romano et al. (2004) noted that no quantitative approach to estimating changes in mortality or fecundity due to stress has been identified, though qualitative effects may include increased susceptibility to disease and early termination of pregnancy. Rolland et al. (2012) showed that a 6-dB decrease in the ambient underwater noise level, including a significant reduction below 150 Hz, was associated with decreased baseline levels of stress-related hormone metabolites in whales. This reduction in ambient noise levels associated with shipping was the first evidence that exposure to low-frequency noise from shipping may be associated with chronic stress in whales (Rolland et al., 2012).

Disturbances can cause subtle to extreme changes in normal behavior, with some behavioral responses resulting in biologically significant consequences. Behavioral responses, including startle, avoidance (swim speed and direction changes), displacement, diving, and vocalization alterations, have been observed in mysticetes, odontocetes, and pinnipeds, and in some cases, these have occurred at ranges of tens to hundreds of kilometers from the sound source (Gordon et al., 2004; Tyack, 2008; Miller et al., 2014). However, behavioral observations are variable, some findings contradictory, and the biological importance of the effects has not been measured (Gordon et al., 2004). Behavioral reactions of marine mammals to sound are difficult to predict because reactions depend on numerous factors, including the species being evaluated; the animal's state of maturity, prior experience and exposure to anthropogenic sounds, current activity patterns, and reproductive state; time of day; and weather state (Wartzok et al., 2004), as well as the potential for individual differences within species (Castellote et al., 2014). If a marine mammal reacts to an underwater sound by changing its behavior or moving to avoid a sound source, the impacts of that change may not be important to the individual, stock, or species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area, impacts on individuals and the population could be important.

Assessing the severity of marine mammal behavioral effects associated with anthropogenic sound exposure presents unique challenges associated with the inherent complexity of behavioral responses and the contextual factors affecting them, within and between individuals and species. The severity of responses can vary depending on characteristics of the sound source (e.g., moving or stationary, number and spatial distribution of sound source[s], similarity to predator sounds, and other relevant factors) (Richardson et al., 1995; NRC, 2005; Southall et al., 2007; Bejder et al., 2009; Barber et al., 2010; Ellison et al., 2012).

Many examples have been reported of individuals of the same species exposed to the same sound reacting differently (Nowacek et al., 2004), as well as different species reacting differently to the same sounds (Bain and Williams, 2006). Odontocetes, for instance, appear to exhibit a greater variety of reactions to man-made underwater noise than do mysticetes. Odontocete reactions can vary from approaching vessels (e.g., bow-riding) to strong avoidance. Richardson et al. (1995) noted that most small- and medium-sized odontocetes exposed to prolonged or repeated underwater sounds are unlikely to be displaced unless the overall received level is at least 140 dB re 1 μPa.

Research on the effects resulting from exposure to seismic survey noise on marine mammals is ongoing. Bain and Williams (2006) examined the effects of large airgun arrays (4,821 to 6,713 in^3) on six species of marine mammals (i.e., California sea lions, Steller sea lions, harbor seals, Dall's porpoises, harbor porpoises, and gray whales) offshore British Columbia, Canada and Washington, U.S. at distances of 1 km to >70 km (0.6 to 43.5 mi). Visual and acoustic observations were made as part of a monitoring program conducted in conjunction with a USGS survey. The behavior is reported for those observations where the received sound level was measured. The maximum theoretical source level generated by this large airgun array was calculated to be on the order of 260 dB re 1 μPa at 1 m (Bain and Williams, 2006). Received noise levels near the observed marine mammals were measured and, although airguns concentrate energy at low frequencies, the airguns produced sound above ambient levels at all frequencies up to 100 kHz, providing a mechanism to affect marine mammals with strong high-frequency hearing (Bain and Williams, 2006). All of the observed marine mammal species moved away from the airguns, but each species was observed in waters ensonified at varied received levels; the Dall's porpoise was observed in waters ensonified at the highest exposure level of 181 dB moving at right angles away from the airgun source, while harbor porpoises were observed in waters with no higher exposure level than 155 dB (Bain and Williams, 2006). Observations of cetaceans during seismic airgun surveys in United Kingdom waters demonstrated that small odontocetes showed the strongest lateral spatial avoidance, mysticetes and killer whales showed more localized spatial avoidance, long-finned pilot whales only showed a change in orientation, and sperm whales did not show any significant avoidance response (Stone and Tasker, 2006). For impulsive sounds, there is evidence that the behavioral state of mysticetes, combined with their proximity to airgun sounds, affects how the whales react to the sounds (McCauley et al., 1998; Gordon et al., 2004). Several species of mysticetes showed avoidance behavior to sounds from seismic surveys (Richardson et al., 1995), including bowhead whales avoiding distant seismic airguns at received levels of 120 to 130 dB re 1 μPa SPL_{rms} during fall migration (Richardson et al., 1999).

Acoustic reactions of cetaceans to airgun activity may include increased and/or reduced vocalization rates (Goold, 1996; Blackwell et al., 2015), no vocal changes (Madsen et al., 2002), or cessation of singing (McDonald et al., 1995). Other short-term vocal adjustments observed across species exposed to elevated ambient noise levels include shifting call frequency, increasing call amplitude or duration, and ceasing to call (Nowacek et al., 2007). Traveling blue and fin whales exposed to seismic noise from airguns stopped emitting repeated songs (McDonald et al., 1995; Clark and Gagnon, 2002). By contrast, Di Iorio and Clark (2009a) found that blue whales responded to seismic sparker operations by increasing their call production, likely to increase the probability that other blue whales would hear their calls in a higher ambient noise environment. As Di Iorio and Clark (2009a) suggested, later supported by Ellison et al. (2012), the exposure context of the received seismic sparker sound strongly influenced the probability and type of behavioral response in the blue whales. Di Iorio and Clark (2009a) suggested that it was advantageous for the blue whales to expend energy by increasing the rate of their vocalizations so that communication with nearby blue whales would not be lost. There were insufficient data to determine the relevance of the observed vocal adjustment to an individual whale's well-being. However, observations by Di Iorio and Clark (2009b) were conducted in an important feeding area where blue whales acquire energy and where this wide-roaming, highly dispersed population congregates to engage in social interactions. Acoustic and behavioral changes by fin whales in response to shipping and airgun noise found that the acoustic features of fin whale 20-Hz song notes were affected in high-noise conditions. In these conditions, duration was shortened, bandwidth decreased, center frequency decreased, and peak frequency decreased. Similar results were obtained in 20-Hz song notes recorded during a 10-day seismic survey. Castellote et al. (2012) provided evidence that male fin whales from two different subpopulations modify song characteristics under increased background noise conditions and that, under seismic airgun activity conditions, they leave an area for an extended period. Similar results were recorded for vocalizing humpback whales off Angola during seismic surveys (Cerchio et al., 2014). Other studies on humpback whales reported their avoidance of seismic surveys (McCauley et al., 2000). Resting females diverted to remain 7 to 12 km (4 to 7 mi) away, although males occasionally were attracted to the sounds.

Few dedicated studies of the behavioral responses of GOM marine mammals have been conducted, especially to seismic activities. Mate et al. (1994) noted that sperm whales were displaced in the northern GOM off the Louisiana coast following seismic surveys in the area. Sperm whales were sighted at a rate of 0.092 whales per kilometer prior to the seismic survey, but the sperm whale abundance declined significantly within the seismic survey area after the survey began, to where none were detected for 5 consecutive days; only one group of four sperm whales was observed within 61 km (38 mi) of the seismic survey area (Mate et al., 1994). Sperm whale sightings during seismic surveys in the GOM showed a significant difference in the closest point of approach distance between times of airgun silence and full power, with greater distances from the source displayed during full power (Barkaszi et al., 2012). Miller et al. (2009) reported the lack of a behavioral response in eight tagged sperm whales in the GOM that were exposed to received levels of 111 to 147 dB rms from a large airgun array. The whales were 1 to 13 km (0.6 to 8.1 mi) away from the vessel. The sperm whales did not change their resting or foraging behavior when the airguns started up or approached the whales, indicating that sperm whales in the GOM did not, in this instance, exhibit avoidance behavioral responses to airguns (Miller et al., 2009). However, Miller et al. (2009) suggested that, while the surface observations were indicative of no behavioral disruption, the lower pitch and buzz rates the tags recorded while the sperm whales were exposed to the airgun noise may have been indicative of impacts to feeding rates. The most closely approached of the eight tagged whales maintained a prolonged resting period while the airguns were operating, but they immediately resumed foraging dives when the airguns were turned off.

There is substantial species-specific contextual variability in the behavioral responses of marine mammals to noise exposure. Furthermore, variability can occur within a species at the individual level where hearing loss or prior experience with a certain sound type can influence whether an individual reacts (Castellote et al., 2014). There also is a broad spectrum of behavioral responses, each of which has varying importance to the individual. Recognizing these issues, Southall et al. (2007) concluded that (1) there are many more published accounts of behavioral responses to noise by marine mammals than of direct auditory or physiological effects; (2) available data on behavioral responses do not converge on specific exposure conditions resulting in particular reactions, nor do they point to a common behavioral mechanism; (3) study data obtained with substantial controls, precision, and standardized metrics indicate high variance in behavioral responses and in exposure conditions required to elicit a given response; and (4) distinguishing a significant behavioral response from an insignificant momentary alteration in behavior is difficult. Wartzok et al. (2005) suggested that a major scientific effort is required to enable the prediction of long-term behavioral and physiological effects in marine mammal populations from anthropogenic noise. Sound sources used during geophysical survey activities can produce stress, disturbance, and behavioral responses in marine mammals if they are present within the range of the operational airgun array. Survey protocols and underwater noise mitigation procedures (**Chapter 2**), designed to prevent injury (PTS), may decrease the duration any marine mammal would be within the exclusion zone of an operating sound source, thereby reducing the level of behavioral disturbance and injury within defined zones near the sound source. Outside the exclusion zone, behavioral responses may occur. As seismic airgun signals commonly occur in the GOM, it is possible that behavioral reactions to them may be reduced with time and repeated exposure, although there are no published data from the GOM to support this. The mechanism for such reduction could be habituation or tolerance (Bejder et al., 2009). Habituation is "the relative persistent waning of a response as a result of repeated stimulation, which is not followed by any kind of reinforcement" (Thorpe, 1963). Thus, habituation occurs in response to a neutral stimulus. Tolerance is "the intensity of disturbance that an individual tolerates without responding" (Nisbet, 2000). If reduced behavioral response is observed, discerning if it represents habituation or tolerance is difficult without detailed study.

Reduction of Prey Availability

Sound may indirectly affect marine mammals through its effects on the abundance, behavior, or distribution of prey species such as crustaceans, cephalopods, and fish. These species are important prey for marine mammals, and many are important commercial and recreational fishery species in the GOM. To better understand the effects of anthropogenic sound on invertebrates, fishes, and fisheries, about which less research has been conducted, BOEM funded a three-phase program consisting of a literature synthesis, workshop to discuss the state of knowledge, and a gap analysis. The literature synthesis was completed prior to the 2012 workshop, with a summarization of the workshop and gap analysis published in December 2012, focusing on the U.S. Atlantic and Arctic OCS areas (Normandeau Associates, Inc., 2012).

There are limited data on hearing mechanisms and the potential effects of sound on marine mammal prey (e.g., crustaceans, cephalopods, and fish). These species have been increasingly researched and the results published as concern has grown. Invertebrates appear to be able to detect sounds (Pumphrey, 1950; Frings and Frings, 1967) and are most sensitive to low-frequency sounds (Packard et al., 1990; Budelmann and Williamson, 1994; Lovell et al., 2005; Mooney et al., 2010). Of invertebrates, cephalopods are the most researched group to date.

The effects of sound on pelagic invertebrates (cephalopods) are discussed in **Chapter 4.4.2.1.1**. Available data suggest that cephalopods are capable of sensing the particle motion of sounds and detect low frequencies up to 1,000 to 1,500 Hz, depending on the species, and so are likely to detect seismic airgun noise (Kaifu et al., 2008; Hu et al., 2009; Mooney et al., 2010; Samson et al., 2014). McCauley et al. (2000) reported that exposure of caged squid to seismic airguns showed behavioral response, including inking. André et al. (2011) reported auditory injuries (lesions occurring on the statocyst sensory hair cells) on cephalopods of different species exposed to 2 hours of continuous low-frequency sounds, suggesting that cephalopods are particularly sensitive to low-frequency sound.

The effects of sound on benthic invertebrates are discussed in **Chapter 4.5.2.1.1**. Impacts to benthic communities from impulsive sound generated by active acoustic sound sources (e.g., airguns and HRG surveys) are not well documented. There are no published data that indicate whether threshold shift injuries occur or effects of auditory masking occur in benthic invertebrates, and there are little data to suggest whether sounds from seismic surveys would have any substantial impact on invertebrate behavior (Hawkins et al., 2014). Potentially relevant data showed no short-term or long-term effects of seismic exposure in adult or juvenile snow crabs or crab eggs (Boudreau et al., 2009), shrimps (Andriguetto-Filho et al., 2005), and American lobster (Payne et al., 2007, 2008). However, some invertebrates may be especially sensitive to substratum vibrations. Exposure of the octopus *Octopus vulgaris* to low-frequency sounds by André et al. (2011) resulted in permanent and substantial alterations of the sensory hair cells of the statocysts.

The effects of sound on fishes is discussed in **Chapter 4.5.2.1.1**. Fish utilize the soundscape and components of sound in their environment to perform these functions (Fay, 2009). Depending on their hearing anatomy and peripheral sensory structures, which vary among species, fishes hear sounds using pressure and particle motion sensitivity capabilities and detect the motion of surrounding water (Popper et al., 2008). Fishes hear within a frequency range of 25 Hz to 3 kHz; sharks and rays (including smalltooth sawfish) are at the lower end of this range; and herrings, which have specialized anatomy (connection between gas-filled swim bladder and the inner ear) that enhances their ability to hear high frequencies, are at the higher end of the range. This hearing range overlaps with the frequency ranges of several G&G-related noise sources; seismic airguns range from 1 to 100 Hz. The potential direct effects of seismic noise on fishes depend not only on this overlapping frequency range but also on the distance of an organism from a sound source; water depth of exposure; and species-specific hearing sensitivity, anatomy, and physiology. In order of increasing likelihood with decreasing distance from a sound source, key impacts include behavioral responses, masking, TTS impairment, barotrauma (pressure-related injuries), and mortality.

Marine Mammal Estimates of Potentially Occurring Exposures

A workshop was held in January 2014 where experts in sound propagation and exposure modeling came together to provide NMFS and BOEM with information to assess available methods for modeling marine mammal exposures at given levels of sound for seismic activities of the oil and gas industry in the GOM. During this workshop, participants discussed sound propagation modeling, including approaches to modeling sound fields from airgun arrays and other active acoustic sources, and the integration of modeled sound fields with biological data to estimate marine mammal exposures. BOEM and NMFS used information from the workshop to determine the best exposure modeling approach to support MMPA and ESA regulatory requirements for G&G survey activities in the GOM.

It is important to note that BOEM does not equate every exposure to sound as a “take” as defined by the MMPA (16 U.S.C. §§ 1361 *et seq*.) due to several factors discussed in **Chapter 1.2.5**. Therefore, exposure estimates used in this Programmatic EIS are not necessarily the same as a “take” of an animal, as discussed in **Chapter 4.1.4.3**. The impact conclusions presented are a synthesis of a variety of qualitative and quantitative available scientific information and considered the modeling results in conjunction with subject-matter expert review of scientifically credible information using accepted approaches and research methods. While this analysis required some professional judgement by the subject-matter experts, the resulting impact conclusions remain credible in light of the available scientific record.

The acoustic modeling was divided into two phases. In Phase I, a WAZ survey was simulated at two locations within Mississippi Canyon. This was done based on the recommendation from the workshop that the modeling needs to represent real-world scenarios in that location (in this case, WAZ surveys occur frequently in Mississippi Canyon) and also to establish the basic methodological approach. The results were used to evaluate scenarios that may influence exposure estimates. Results from the test scenarios were then used to guide the main modeling effort of Phase II. In Phase II, the AOI was divided into seven modeling zones, and each survey type was simulated in each zone to estimate potential effects. Exposure statistics were determined by sampling numerically estimated acoustic fields for each operation using an animat model (Marine Mammal Movement and Behavior [3MB] model; Houser, 2006). Exposure estimates were determined for 24-hour periods within 7-day simulations to attain representative estimates of exposures associated with each operation. Using survey level-of-effort projections provided by BOEM, the 24-hour exposure estimates were used to calculate annual exposure estimates for each marine mammal species likely to be affected by airgun and selected HRG survey operations in the entire GOM for a 10-year period. The operations for which exposure estimates were calculated included the following:

- 2D surveys (single source vessel with 8,000-in^3 airgun array);
- 3D NAZ surveys (two source vessels, each with 8,000-in^3 airgun array);
- 3D WAZ surveys (four source vessels, each with 8,000-in^3 airgun array);
- coil surveys (four source vessels, each with 8,000-in^3 airgun array);
- 90-in^3 airgun;
- boomers; and
- HRG surveys using side-scan sonar, subbottom profilers, and MBESs.

The results from each zone were summed to provide Gulfwide estimates of the effects on each marine mammal species for each survey type for each year, as well as 10-year totals for the activities. Despite uncertainty and variability in future actions (e.g., survey size, survey techniques, and timing and location of a survey predicted over the 10-year period), the employment of source and propagation models required numerous specific details during their calculations. Not all survey configurations can be modeled, and the exact numbers of surveys that will occur during the 10-year period are not known. Therefore, this modeling effort represents BOEM's predictions and industry input on reasonably foreseeable levels of activity, using the best information of current activity levels and trends. Calculations of acoustic exposures to marine mammals from airgun and electromechanical sound sources associated with the proposed action are presented in **Appendix D**, new Level A exposure estimates are in **Appendix N**, and chronic and cumulative estimates are in **Appendix K**. The issue of realistic and reasonable parameter selection is stated and expanded upon in the modeling report (**Appendix D**). The modeled exposure estimates may not represent the actual takes that will occur during geophysical surveys in the GOM for a variety of reasons, as discussed in **Chapter 1.2.5**. The best estimate of exposures is based on conservative modeling parameters, which are further discussed in the Test Case Scenarios of **Appendix D, Section 6**. Furthermore, exposures do not necessarily qualify as take, as the term is defined under the MMPA. For example, representative sound sources are modeled at highest sound levels and always at maximum power and operation, sound levels received by an animal are calculated at highest levels, and numbers generated by models do not include the effect of all mitigations in reducing the potential for actual take. Additional assumptions that add to the conservative nature of the models are discussed here and are further examined in the JASCO modeling report (**Appendix D**).

In order to better explain how these results differ from actual *in situ* impacts, several of the most prominent conservative assumptions from **Appendix D** are listed here. Details of each assumption are provided in **Appendix D**.

- **Acoustic Source Specifications:** There is a large variation in the size, configuration, and source level of the airgun arrays employed during surveys. Details of acoustic source modeling are provided in **Appendix D, Section 5.1**. Additionally, it was assumed that the modeled array was always at maximum power and that all airguns were fully operational for completed survey scenarios.
- **Acoustic Source Modeling:** For simplicity, the acoustic modeling replaces the actual predicted airgun array sound field with one produced by a point source (i.e., a single larger airgun versus a distributed airgun array) and a beam pattern. This is fairly accurate in the far-field (typically 100 to 300 m [328 to 984 ft] from the array center and outward) but, within the near-field, this can greatly overestimate the apparent source level and subsequent impacts calculated. Simply replacing this conservative near-field approximation is feasible from a mathematical modeling point of view. However, because it heavily depends on the actual source parameters, it would be difficult to justify it in this Programmatic EIS, and it would greatly enlarge the modeling effort while not necessarily remaining conservative. Details of acoustic source modeling are provided in **Appendix D, Section 5.1**.
- **Acoustic Propagation Modeling:** Typically, the acoustic parameters used in acoustic modeling (including sound velocity profile, surface wind and wave values, and seafloor sediment types/distributions/thicknesses/coefficients) are averaged seasonal values over reasonably sampled areas and time periods. For example, sea state greatly affects sound propagation and it is often over estimated for that reason. These averaging processes remove most local variability while capturing the general effect of the sound speed on acoustic propagation. In some cases, this can underestimate the transmission loss and therefore overestimate the received levels at all ranges. Actual *in situ* propagation typically displays much more fading and disruption of the signal, especially for signals shorter than 1 second (i.e., airguns).

- **Acoustic Modeling of the Multipath:** When a signal propagates through the ocean, it typically follows many pathways between the source and a receiver. For example, one path may be directly between the source and receiver, while others may reflect off the ocean surface or seafloor before arriving at the receiver. For most of the models used in acoustic propagation analyses, the model assumes that the signals continue until all the significant paths have arrived at the receiver, then the energy from these different pathways is summed to derive a final received value. This is a conservative approach for short signals such as airgun pulses; the spreading of a signal (and its energy) generally increases as range increases. This is not a simple or easy correction to make as it can heavily depend on the receiver's position in range and depth. The assumption is that, for very short duration signals like for airguns, the modeling assumes that arrival of the multipath is added together for a total received signal level, but the reality is that the signal is spread out in time and is additive together at one peak pressure. Details of acoustic propagation modeling are provided in **Appendix D, Section 5.2**.

- **Marine Mammal Congregations:** Marine mammals, especially dolphins, often occur in groups and occasionally in mixed-species aggregations. When this occurs, the actual density near that group can be greater than those used in the calculations, but the corresponding reduction of density for much of the surrounding areas has been decreased. Statistically, this averages out for multiple model runs that are not accounting for this.

- **Mitigation:** The inclusion of mitigation in the modeling was discussed during the January 2014 modeling workshop and considered in the modeling project. A test case was run to determine the effectiveness of mitigation in the modeling (**Appendix D**) to reduce cumulative exposure levels. Incorporation of mitigation measures and mitigation effectiveness into the modeling is discussed in Test Scenario 3 (but not incorporated in the Phase II overall modeling effort) of the Modeling Report (**Appendix D**). This is because the effectiveness at reducing marine mammal exposure to potentially injurious sound levels with this commonly used approach cannot be quantified with confidence at this time. Mitigation effectiveness, as measured by the percent reduction in exposure estimates, is predominantly a function of animal detection probability during a seismic survey. The greater the detection probability, the greater the effectiveness of shutdown mitigation, which reduces the duration of the exposure. From this test, the inclusion of mitigation procedures in the simulations reduced the numbers of exposures based on SPL_{peak} and SPL_{rms} criteria for five out of six species and detection probabilities considered, even though an extension in the survey period due to line re-shoot was taken into account. The percent reduction in exposures for species with relatively high detection probability (e.g., common bottlenose dolphins, short-finned pilot whales, and sperm whales) was higher than the percentage reduction for species

> with relatively low detection probability (e.g., Cuvier's beaked whales and dwarf sperm whales). Bryde's whales had no exposures in the test case with or without mitigation. The numbers of exposures based on the SEL criteria were zero for most species (even without mitigation), except for dwarf sperm whales. Considering the results of the test case, however, it was determined that the overall modeling should not include mitigation because detection probability can vary due to several factors that cannot be forecasted with any certainty. The calculations included here do not include any mitigation effects that would reduce the potential for exposure. Therefore, the modeled exposure estimates are likely to overestimate actual takes that will occur during geophysical surveys in the GOM. Details of mitigation effectiveness are provided in **Appendix D, Section 6.5.3**.

The assessment of acoustic exposures to marine mammals within the AOI from various active sound sources projected in the scenario (**Chapter 3.2**) was partially based on species-specific spatial and temporal distribution and density information, as detailed in **Appendix D**. These numbers represent a conservative best estimate. CetMap density data for each species were estimated within seven modeling zones in the AOI during four seasons (**Appendix D, Figure 110**). The species density estimates within each modeling zone were used to estimate potential acoustic exposures to marine mammal species from proposed acoustic survey activities. These estimates are provided in **Appendix D, Tables 62 through 68**, and updated Level A exposure estimates that incorporate the revised criteria in NMFS' Technical Guidance into the same model described in **Appendix D** are provided in **Appendix N**. As discussed previously, the issue of realistic and reasonable parameter selection is stated and expanded upon in the source and exposure estimate modeling report (**Appendix D**). However, it must be emphasized that each of these typical assumptions accumulate throughout the analysis and result in fairly conservative but reasonable exposure estimates.

Lastly, some of the marine mammal exposure estimates provided in this chapter, which are referenced from **Appendices D and N**, include a decimal; these numbers are expected to be rounded up to the next whole number.

4.2.2.1.2 Analysis of Active Acoustic Sound Sources

Active acoustic sound sources associated with proposed G&G activities include airguns and electromechanical sources. Airguns commonly are used to characterize the shallow and deep structure of the continental shelf, continental slope, and deepwater ocean environments. Details of airguns and seismic survey types that utilize airguns are discussed in **Chapter 3 and Appendix F** and include oil and gas exploration and development surveys (e.g., deep-penetration seismic airgun surveys) and some HRG surveys of oil and gas leases. The HRG site surveys are conducted to investigate the shallow subsurface for geohazards and soil conditions in a specific location or over a broad area, and to identify potential benthic biological communities and archaeological resources. The HRG surveys use several techniques, including airgun(s) and/or electromechanical sources such as side-scan sonars, shallow- and medium-penetration subbottom profilers, SBESs, and MBESs. For this analysis, shallow-penetration airgun seismic surveys used for HRG site surveys are discussed separately from electromechanical source (non-airgun) surveys. The HRG surveys and related equipment are discussed in **Chapter 3 and Appendix F**.

Deep-Penetration Seismic Airgun Survey Activities

Level A Estimates of Potentially Occurring Exposures

BOEM exhibited every effort to incorporate additional information on the revised criteria described in **Appendix N** appropriately throughout this Programmatic EIS. However, an in-depth analysis comparable to the analysis described in **Appendix D** was not provided and could not be incorporated in some aspects of this analysis. Therefore, BOEM has incorporated the most updated and best available science from **Appendices N and D** where appropriate and has specified which data were being analyzed.

Deep-penetration seismic airgun seismic surveys include 2D, 3D, and 4D OBS, and WAZ. To estimate the number of exposures that may occur, modeling was conducted for 2D, 3D NAZ, 3D WAZ, and coil survey activities during the 10-year period covered by this Programmatic EIS. Summaries of the potential exposures to the acoustic criteria outlined above are provided here. **Appendix D** provides more detail regarding the modeling while **Appendix N** provides Level A exposure estimates that could occur using the revised criteria in NMFS' Technical Guidance.

Annual estimates of exposures that may occur were calculated for proposed deep-penetration seismic airgun 2D, 3D NAZ, 3D WAZ, and coil survey activities during the time period covered by this Programmatic EIS for each survey type are presented in **Appendices D and N**. Total decadal, deep-penetration airgun seismic survey Level A estimates of exposures that may occur using these metrics for each survey type are presented in **Appendix N**. For review, an overview of the Level A estimates of exposures that may occur is provided for each survey type.

Deep-penetration 2D airgun seismic surveys are anticipated to be conducted in the EPA and CPA, primarily in continental shelf and slope waters. This type of survey activity is projected to occur in 6 of the 10 years, with decreasing levels of activity expected for 2 to 3 of those years (**Appendix D, Table 75**). For the decadal period, *Kogia* spp. are estimated to have the highest number of exposures that may occur, with 549.8 and 2.4 potential exposures for the SPL_{peak} and SEL criteria, respectively (**Appendix N**). At an annual level, the highest numbers of potentially occurring *Kogia* spp. exposures are estimated as 188.9 and 0.9, respectively, for the SPL_{peak} and SEL criteria. Bryde's whales are the only low-frequency specialist. An estimated 0.5 and 1.7 Bryde's whales for the SPL_{peak} and SEL criteria, respectively, are predicted during the decadal period, with annual maxima of 0.2 and 0.6 exposures that may occur, respectively. For the endangered sperm whale, an estimated 5.2 and 0.0 exposures may occur for the SPL_{peak} and SEL criteria, respectively, during the decadal period, with annual maxima of 1.7 and 0.0 exposures that may occur, respectively.

Deep-penetration 3D NAZ airgun seismic surveys are anticipated to be conducted on the continental shelf in the CPA (modeling Zone 2), a small amount on the WPA continental shelf (modeling Zone 3), but mostly in the deeper waters of the WPA, CPA, and EPA slope regions (modeling Zones 4, 5, 6, and 7; **Appendix D, Table 75**). No surveys are projected to occur on the EPA continental shelf (modeling Zone 1), and slightly decreasing levels of activity are expected in deeper waters. For the decadal period, common bottlenose dolphins and Bryde's whales are estimated to have the highest number of exposures that may occur, with 20,660.6 and 107.4 exposures for the SPL_{peak} and SEL criteria, respectively. At an annual level, the highest numbers of common bottlenose dolphin and *Kogia* spp. exposures are estimated at 2,513.7 and 376.1, respectively, for the SPL_{peak} and SEL criteria. An estimated 19.9 and 107.4 Bryde's whale exposures may occur for the SPL_{peak} and SEL criteria, respectively, during the decadal period, with annual maxima of 2.5 and 13.5 potential exposures, respectively. For the endangered sperm whale, an estimated 209.4 and 0.0 exposures may occur for the SPL_{peak} and SEL criteria, respectively, during the decadal period, with annual maxima of 26.8 and 1.5 potential exposures, respectively.

Deep-penetration 3D WAZ airgun seismic surveys are anticipated to be conducted on the continental shelf in the CPA (modeling Zone 2) and on the WPA and EPA continental shelf and slope (modeling Zones 4, 6, and 7), but mostly in the CPA slope regions (modeling Zones 5 and 7; **Appendix D, Table 75**). No surveys are projected to occur in certain areas within the WPA and EPA continental shelf (modeling Zones 1 and 3). For the decadal period, *Kogia* spp. are estimated to have the highest number of exposures that may occur, with 14,164.7 and 15.5 potential exposures for the SPL_{peak} and SEL criteria, respectively. At an annual level, the highest number of potentially occurring *Kogia* spp. exposures are estimated as 1,732.3 and 1.8, respectively, for the SPL_{peak} and SEL criteria. An estimated 5.7 and 6.4 exposures of Bryde's whales may occur for the SPL_{peak} and SEL criteria, respectively, during the decadal period, with annual maxima of 0.8 and 0.8 exposures potentially occurring, respectively. For the endangered sperm whale, an estimated 70.2 and 0.0 exposures may occur for the SPL_{peak} and SEL criteria, respectively, during the decadal period, with annual maxima of 8.4 and 0. potentially occurring exposures, respectively.

Deep-penetration coil seismic surveys are anticipated to be conducted on the continental shelf in the CPA (modeling Zone 2) and on the WPA and EPA continental shelf and slope (modeling Zones 4, 6, and 7), but mostly in the CPA slope regions (modeling Zones 5 and 7; **Appendix D, Table 75**). No surveys are projected to occur in certain areas within the WPA and EPA continental shelf (modeling Zones 1 and 3). For the decadal period, pantropical spotted dolphins and Bryde's whale are estimated to have the highest number of exposures that may occur, with 5,086.1 and 36.3 potential exposures, respectively, for the SPL_{peak} and SEL criteria. At an annual level, the highest number of pantropical spotted dolphin and Bryde's whale exposures that may occur are estimated at 610.4 and 4.8, respectively, for the SPL_{peak} and SEL criteria. An estimated 6.1 and 36.3 potentially occurring exposures of Bryde's whales for the SPL_{peak} and SEL criteria, respectively, are predicted during the decadal period, with annual maxima of 0.1 and 3.7 potential exposures, respectively. For the endangered sperm whale, an estimated 65.3 and 5.5 exposures may occur for the SPL_{peak} and SEL criteria, respectively, during the decadal period, with annual maxima of 8.2 and 0.0 potentially occurring exposures, respectively.

Level B Estimates of Potentially Occurring Exposures

Level B (160 dB SPL_{rms} and the step function criteria) exposure estimates were calculated for 21 cetacean species from proposed 2D, 3D NAZ, 3D WAZ, and coil survey activities during the 10-year period covered by this Programmatic EIS. Annual estimates of potentially occurring exposures for these taxa are presented in **Appendix D**. Total decadal deep-penetration airgun seismic survey Level B estimates of potentially occurring exposures for each survey type are presented in **Appendix D, Tables 76 through 79**. For review, an overview of the Level B potentially occurring exposure estimates using NMFS' 160 dB SPL_{rms} metric is provided for each survey type.

Deep-penetration 2D airgun seismic surveys are anticipated to be conducted in the EPA and CPA, primarily in continental shelf and slope waters. This type of survey activity is projected to occur in 6 of the 10 years, with decreasing levels of activity expected for 2 to 3 of those years (**Appendix D, Table 75**). Over the decadal period, the highest number of 160 dB SPL_{rms} exposures that may occur are expected for pantropical spotted dolphins (233,759.0; **Appendix D, Table 76**), with the highest annual estimate of exposures that may occur for this species at 78,810.7 in 2019 (**Appendix D, Table F-33**). Bryde's whales are the only low-frequency specialist. An estimated 206.9 potentially occurring exposures of Bryde's whales at received SPL_{rms} >160 dB are predicted during the decadal period, with an annual maximum of 68.5 potentially occurring exposures. For the endangered sperm whale, an estimated 17,049.9 exposures may occur at received SPL_{rms} >160 dB during the decadal period, with an annual maximum of 5,749.3 potentially occurring exposures.

Deep-penetration 3D NAZ airgun seismic surveys are anticipated to be conducted on the CPA continental shelf (modeling Zone 2), a small amount on the WPA continental shelf (modeling Zone 3), but mostly in in the deeper waters of the WPA, CPA, and EPA slope regions (modeling Zones 4, 5, 6, and 7; **Appendix D, Table 75**). No surveys are projected to occur in certain areas of the EPA continental shelf (modeling Zone 1), and slightly decreasing levels of activity are expected in deeper waters (**Appendix D, Table 75**). Over the decadal period, the highest number of 160 dB SPL_{rms} exposures that may occur are expected for common bottlenose dolphins (8,897,488.1; **Appendix D, Table 77**), with the highest annual estimate for this species at 1,058,083 exposures in 2019 (**Appendix D, Table F-34**). An estimated 4,136.5 potentially occurring exposures of Bryde's whales at received SPL_{rms} >160 dB are predicted during the decadal period, with an annual maximum of 534.2 potentially occurring exposures. For the endangered sperm whale, an estimated 440,333.7 exposures may occur at received SPL_{rms} >160 dB during the decadal period, with an annual maximum of 59,889.8 exposures potentially occurring.

Deep-penetration 3D WAZ airgun seismic surveys are anticipated to be conducted on the CPA continental shelf (modeling Zone 2) and on the WPA and EPA continental shelf and slope (modeling Zones 4, 6, and 7), but mostly in the CPA slope regions (modeling Zones 5 and 7; **Appendix D, Table 75**). No surveys are projected to occur in certain areas within the WPA and EPA continental shelf (modeling Zones 1 and 3). Over the decadal period, the highest number of 160 dB SPL_{rms} exposures that may occur are expected for pantropical spotted dolphins (2,233,856.1; **Appendix D, Table 78**), with the highest annual estimate at 274,838.2 in 2016

(**Appendix D, Table F-14**). An estimated 1,778.4 potentially occurring exposures of Bryde's whales at received SPL_{rms} >160 dB are predicted during the decadal period, with an annual maximum of 229.3. For the endangered sperm whale, an estimated 182,929.6 exposures may occur at received SPL_{rms} >160 dB during the decadal period, with an annual maximum of 23,183.1.

Deep-penetration coil seismic surveys are anticipated to be conducted on the CPA continental shelf (modeling Zone 2) and on the WPA and EPA continental shelf and slope (modeling Zones 4, 6, and 7), but mostly in the CPA slope regions (modeling Zones 5 and 7; **Appendix D, Table 75**). No surveys are projected to occur in certain areas within the WPA and EPA continental shelf (modeling Zones 1 and 3). Over the decadal period, the highest number of 160 dB SPL_{rms} exposures that may occur are expected for pantropical spotted dolphins (473,365.5; **Appendix D, Table 79**), with the highest annual estimate at 58,113.2 in 2016 (**Appendix D, Table F-15**). An estimated 365.1 potentially occurring exposures of Bryde's whales at received SPL_{rms} >160 dB are predicted during the decadal period, with an annual maximum of 46.9. For the endangered sperm whale, an estimated 40,181.5 exposures may occur at received SPL_{rms} >160 dB during the decadal period, with an annual maximum of 5,157.4.

Fitness Level Consequences of Level A and Level B Exposures

The deep-penetration seismic airgun survey activities could impact marine mammals more substantially than other activities included in the proposed action. Individual summaries of the potential exposures from each type of seismic airgun survey (i.e., 2D, 3D NAZ, 3D WAZ, and coil) on an annual and decadal basis were provided earlier. These exposures are based on modeling of 24 hours of survey activities, which is then scaled by line-miles for each annual projection of activity level. There is insufficient information at this time to generalize a nominal duration for each survey type or to estimate the number of each type of survey that may occur; the finest temporal resolution of activity level that can be projected is an annual estimate of the length of line-miles that likely would be surveyed based on historical trends. These projected activity levels have been spatially divided among seven zones representing shallow and deep waters of the EPA, CPA, and WPA, in addition to a deepwater zone spanning the three planning areas.

To evaluate the potential for fitness level consequences to a population from Level A exposures (onset PTS), the potential for multiple exposures to an individual over an annual period is evaluated. With the given 24-hour duration data, there is no mechanism to account for an individual animal being exposed more than once across multiple days of survey activity. To estimate the number of animals that may be exposed during a specific survey, the exposure estimates must be considered within the context of the size of a nominal survey, the acoustic footprint of the sources, and the behavior patterns of the species in the given region. It is a reasonable conclusion that the geometry of the survey and the speed and movement characteristics of an animal/modeled animat will drive the probability of repeated exposure during any given model scenario or actual survey. An investigation of these occurences can be found in Test Scenario 1 in **Appendix D, Section 6.5.1**. Test Scenario 1 also provides evidence for the duration of exposures over threshold criteria to bound the extent of potential behavioral responses.

Nominal 2D, 3D NAZ, and 3D WAZ surveys were estimated to cover an area of approximately 6,960 km^2 (2,029 nmi^2; 2,687 mi^2) (**Appendix D, Table 47**). A nominal coil survey is expected to cover an area of approximately 3,364 km^2 (980.8 nmi^2; 1,298.8 mi^2). If nominal offshore density estimates for a coastal and offshore dolphin species, the endangered sperm whale, the Bryde's whale (a low-frequency specialist), and *Kogia* spp. (high-frequency specialists) are considered from the CPA (Zones 5 and 7) (**Appendix D, Tables 66 and 68**), which is the region projected to encompass the majority of deep-penetration airgun seismic survey activities (**Appendix D, Table 75**), approximately 399 common bottlenose dolphins, 238 Clymene dolphins, 50 sperm whales, 1 Bryde's whale, and 51 *Kogia* whales would occur within the modeled survey area in Zone 5; and 2 common bottlenose dolphins, 183 Clymene dolphins, 33 sperm whales, 0 Bryde's whales (amended after the JASCO modelling when Duke University adjusted density estimates), and 24 *Kogia* whales would occur within the modeled survey area in Zone 7 for each 2D, 3D NAZ, and 3D WAZ survey.

The next component to consider is the acoustic footprint of the 8,000-in^3 airgun array for each exposure criteria. While BOEM exhibited effort to provide additional information on the revised criteria described in NMFS' Technical Guidance using the addendum (**Appendix N**), an in-depth analysis comparable to the analysis provided in **Appendix D** was not provided. Therefore, this section considers the best available science at the time. Using the ranges to specific thresholds as calculated in **Appendix D**, the acoustic footprint was calculated as the 2D circular area around the airgun array. For the SPL_{peak} criteria, low- and mid-frequency cetaceans would be exposed within a 0.0010 km^2 (0.000386 mi^2) acoustic footprint; high-frequency cetaceans (*Kogia* spp.) would be exposed within a 1.04 km^2 (0.40 mi^2) acoustic footprint. For the SEL criteria and the 95 percent ranges, low-, mid-, and high-frequency cetaceans would be exposed within 0.045 km^2 (0.017 mi^2), 0.008 km^2 (0.0031 mi^2), and 3.80 km^2 (1.47 mi^2) acoustic footprints, respectively. Considering the same offshore density estimates from the CPA (Zones 5 and 7), no (0.00) common bottlenose dolphins, Clymene dolphins, sperm whales, or Bryde's whales would occur within the SPL_{peak} or SEL acoustic footprints; only 0.01 and 0.03 *Kogia* whales would be in SPL_{peak} or SEL acoustic footprints, respectively, in Zone 5; and 0.00 and 0.01 *Kogia* whales would be in SPL_{peak} or SEL acoustic footprints, respectively, in Zone 7. For the 160 dB SPL_{rms} and the 95 percent ranges, the acoustic footprint for all species is 706.86 km^2 (272.93 mi^2). Approximately 40 common bottlenose dolphins, 24 Clymene dolphins, 5 sperm whales, 0.1 Bryde's whales, and 5 *Kogia* whales would occur within the 160 dB footprint in Zone 5; and 2 common bottlenose dolphins, 183 Clymene dolphins, 33 sperm whales, and 0 Bryde's whales would occur within the acoustic footprint in Zone 7.

The behavioral patterns of the species discussed here are detailed in **Appendix D**; but in general, the travel sub-models specifying horizontal movement (travel direction and rate) are fairly uniform. Though there are distributional habitat preferences reflected in the density estimates, there are no behavioral patterns that would restrict an animal to remain within the acoustic footprint or the survey area of deep-penetration airgun seismic survey activities.

To evaluate the potential for fitness impacts to an individual from Level A exposures (onset PTS), the number of animals within the acoustic footprint is compared with the number of animals within a nominal deep-penetration seismic survey area. Because of the small area of the Level A acoustic footprints, there is a vanishingly small probability for a low- or mid-frequency hearing specialist to be within the acoustic footprint at any one time, and thus an even smaller probability of experiencing multiple exposures to Level A (onset PTS) acoustic energy. Because of the predicted higher sensitivity of high-frequency specialists (*Kogia* spp.), the acoustic footprint is slightly larger. However, there is still a very small probability for an animal to be in the acoustic footprint (0.01 and 0.03 for SPL_{peak} and SEL criteria), and thus an even smaller probability of experiencing multiple exposures to Level A (onset PTS) acoustic energy.

Further insight into the potential for fitness-level impacts is provided with the results of Test Scenario 1. The difference between the number of exposures for the average of the 24-hour sliding windows and the number of exposures for a full-duration survey (5 or 30 days) is shown in **Appendix D, Tables 22 and 23**. Except for estimates of exposure for dwarf sperm whales above the SPL_{peak} criterion, the percent change between the 24-hour and full-duration surveys is minimal. This means that very few, if any, individuals are being exposed more than once during a full survey. For the dwarf sperm whale, approximately 30 percent of the individuals may receive more than one exposure above the SPL_{peak} criterion.

The average duration that animats were exposed above the 180 dB SPL_{rms} injury criterion is provided in **Appendix D, Tables 26 and 27**. The average duration is very short, less than 2 minutes for all species except the Bryde's whale, which is 2.2 minutes. Given the small number of individuals that might experience repeated exposures and the short duration of possible exposures over the SPL_{rms} threshold criterion, it is not anticipated that any animal would experience fitness-level impacts from Level A exposures.

Level B exposures may result in animals experiencing temporary disturbance that might result in them leaving the area or staying and exhibiting behavioral changes, both conditions that could affect their metabolic rate (daily energy expenditures). Very limited research has been conducted on the basic energetic expenditures of cetaceans or how specific behavioral activities affect daily energy requirements. Metabolic rates are influenced by age, body size, growth, reproductive status, activity level, and environmental conditions (Noren, 2011). The swimming costs of minke whales and common bottlenose dolphins were estimated from model parameters at ranges of 2 to 3.5 and 2 to 4 times basal metabolic rate (Hind and Gurney, 1997). It is more appropriate to consider the energetic cost of swimming within a normal activity budget rather than comparing with basal metabolic rates. Field metabolic rates calculated from daily activity budgets of resident killer whales were estimated at 5 to 7 times that of predicted basal metabolic rates (Noren, 2011). Of the activities that killer whales performed on a daily basis, traveling was the least demanding, whereas foraging required >10 times more energy to be expended. Examining common bottlenose dolphins, Williams et al. (1993) found they exhibited a minimum cost of transport at their routine cruising speeds, but when trained to perform workload-bearing exercises, they could exhibit maximum oxygen consumption rates that were 7 to 11 times greater than standard metabolic rates. A similar result was determined for killer whales, in which the minimum cost of transport occurred at an optimal swim speed of 2.6 to 3 meters per second (m/s) (Williams and Noren, 2009); however, the average swimming speed (1.6 m/s) was lower than the predicted optimal swim speed. Given the range to the behavioral threshold is 15,000 m (49,213 ft), an animal swimming at 3 m/s (10 feet per second [ft/s]) would need 83.3 minutes or 1.4 hours to move out of the acoustic footprint. Using the daily activity budget calculated for killer whales (Noren, 2011) as a proxy for other species, this would double the time devoted to traveling, resulting in an additional 4.2 percent energy requirement. It is not anticipated that this additional energy requirement would result in fitness consequences to an individual; therefore, the energetic costs due to a behavioral reaction of leaving the acoustic footprint are estimated to be minimal.

If an animal decides to remain in the area of the deep-penetration seismic survey, it may exhibit vocal responses to the increased noise, such as signaling louder, longer, or more often. Only one study has experimentally measured the energetic consequences of vocal modifications in a marine mammal, the common bottlenose dolphin (Holt et al., 2015). The study found that metabolic rates during the vocal period were, on average, 1.2 to 1.5 times the resting metabolic rate. Given the radial range to the behavioral threshold is 15,000 m (49,213 ft) (thus the diameter of the zone of influence would be 30,000 m [98,425 ft]), and the modeled vessel speed of a deep-penetration seismic airgun survey was 4 kn (4.6 mph) (**Appendix D**), it would take 242.7 minutes or 4.05 hours for the acoustic footprint to transit past a stationary marine mammal. It is unlikely that an animal would continuously vocalize for that entire period, but if it did, considering the potential energetic costs, the effect on an individual's fitness level would be quite small.

Furthermore, consideration must be made of the average duration that animats were exposed over the 160 dB SPL_{rms} behavior criterion, which is provided in **Appendix D, Tables 26 and 27**. During the 30-day simulation at Survey Site A, the average duration of exposure above 160 dB_{rms} was approximately 10 minutes (±2 minutes), except for the Bryde's whale, which had an average exposure duration of 75.6 minutes. During the 30-day simulation at Survey Site B, the average duration of exposure above 160 dB_{rms} was approximately 7 minutes (±2 minutes), except for the Bryde's whale, which had an average exposure duration of 20.5 minutes. Given these results, the times calculated for energetic disturbances (83.3 minutes for animals to leave the acoustic footprint or 242.7 minutes for vocal compensation) are overestimates. It is not anticipated that animals would be exposed for extensive durations, and therefore would not have fitness-level consequences.

While a single exposure could affect an individual, as stated in **Chapter 3**, the proposed action could result in repeated exposures to individual or groups/pods over multiple sequential days or in the form of repeated exposures throughout the year (refer to the modeling results in **Appendix D**). The difference between the number of exposures for the average of the 24-hour sliding windows and the number of exposures for a full-duration survey (5 or 30 days) is shown in **Appendix D, Tables 22 and 23**. Except for estimates of exposure for Cuvier's beaked whales above the step function SPL_{rms} criterion, the percent change between the 24-hour and full-duration surveys is 66 to 494 percent, which suggests that individual animals were exposed approximately 1.5 to 6 times during the 30-day survey. For the Cuvier's beaked whale, it is predicted that individual animals would experience approximately 11 behavioral exposures. The potential for repeated exposures should be considered in the context of the estimated duration of exposure.

In addition to these calculations, there are multiple factors that indicate the potential for repeated exposures is unlikely to result in reduced fitness in individuals or populations. First, G&G surveys have been ongoing in the northern GOM for many years, with no direct information indicating reduced fitness in individuals or populations. Additionally, most surveys are mobile, as are the marine mammals in the GOM, which makes it unlikely that any single action will result in increased noise levels that prevent marine mammals from exploiting an area for a period of time. Additionally, marine mammals have some ability to avoid impacts by moving away from the source of the disturbance. Minimum survey spacing will ensure that marine mammals will have areas where sound levels will not meet the threshold of harassment, and therefore are better able to fully exploit these areas for feeding, migration, rearing, etc. Lastly, seasonal closures (for the appropriate alternative) will be especially protective for marine mammals present in the closure areas during critical life history stages; therefore, these animals will avoid impacts during times when they are less able to cope with those impacts.

NMFS' Analysis of Chronic Effects in the Gulf of Mexico in Support of the MMPA Petition for Incidental Take Regulations

Effective detection of sounds is critical for aquatic animals, and methods are needed to assess and minimize the longer term and aggregate effects of noise on marine species and their habitat, in addition to acute impacts at closer range. This chapter provides the results of a first-order assessment of the chronic and cumulative effects of noise produced by seismic activities in the GOM performed in support of the MMPA rulemaking process (refer to **Appendix K** for the full report).

Modeling was conducted for 10 locations (receiver sites; **Appendix K, Table 1 and Figure 1**) of biological importance and for 4 scenarios corresponding to G&G survey alternatives in this Programmatic EIS, including full proposed levels of seismic activity, a 25 percent reduction in seismic activity, and with and without seasonal closures at each of these activity levels (Alternatives C, E1, E2, and F as described in **Appendix K, Table 2**). "Lost listening area" was calculated for each of the four scenarios and relative to a baseline ambient noise estimate for the full modeled frequency bandwidth (10 to 5,000 Hz) then adjusted to account for the hearing sensitivity of low-, mid-, and high-frequency cetaceans. Because of heightened concern for low-frequency hearing specialists, loss of listening area in this bandwidth is biologically relevant for the majority of GOM cetacean species, as well as for ESA-listed sea turtles and a wide variety of fishes and invertebrates in the region. In addition, "lost communication space" was calculated for each scenario and relative to ambient estimates for the specific 1/3 octave band centered at 100 Hz, representing the dominant frequencies of Bryde's whale vocalizations. The Bryde's whale is the only GOM cetacean species classified within the low-frequency hearing group, producing calls in a low-frequency range that directly overlaps the dominant energies produced by airguns. Results are reported as remaining listening area or communication space for a maximum of three depths (5, 30, and 500 m [16, 98, and 1,640 ft]) at each of the 10 locations. Broadly, results for projected full seismic activity levels indicate significant losses in the listening area (6 of 10 locations lost >50% area) and communication space (5 of 10 locations lost >50% space), including severe losses at the deepest off-shelf location chosen for modeling (Site 5; >99% listening space loss for low-frequency cetaceans) and within the Flower Garden Banks National Marine Sanctuary (FGBNMS) (Site 10; 82% to 90% losses for low- to mid-frequency cetaceans). Two locations within cetacean BIAs (Sites 7 and 10, within the Bryde's whale area and the bay, sound, and estuary (BSE) common bottlenose dolphin area, respectively) incurred virtually no losses due to a combination of lower projected seismic levels in and around the area and local propagation conditions. Losses generally were more severe at lower frequencies and at greater depths. Scenarios that reduced overall levels of seismic activity in the GOM resulted in locations retaining more listening space relative to ambient levels and to full seismic projections. At locations within closure areas where losses were otherwise noted (e.g., Sites 6 and 8), applying closures maintained more listening and communication area.

There is ample evidence to support the fact that significant reductions in listening area or communication space can negatively affect aquatic animals; however, data are lacking to document links to consequences for long-lived and often wide-ranging species such as marine mammals. In contrast with estimation of acoustic harassment, this analysis is not designed to evaluate the exposure of individual animals to seismic sources from one moment to the next. Rather, this analysis is intended to ensure consideration of the longer-term and wider-ranging noise effects from these sources and to augment the more traditional analysis of acute effects (i.e., occurrence of exposure that may cause injury and behavioral harassment) addressed in **Chapter 4**.

While these results are broadly informative (especially when considered as a whole across the GOM), it is important to remain cognizant of the methods and simplifying assumptions when making location-specific interpretations and comparisons. For example, the distribution in space and time of seismic survey activity will significantly influence the resulting cumulative noise exposure at a specific location. Here, projected levels are distributed uniformly within planning areas, but actual survey activity may result in higher concentrations of noise in some areas and lower concentrations in others. The effect of concentrations of activity in proximity to selected locations will continue to be offset by the methods applied here to remove the closest 10 percent of pulses in order to focus on long-term accumulation of energy at regional scales. However, this same method can result in an under-representation of the value of closure areas at maintaining listening and communication space. Similarly, the assumption made here that 25 percent of the activity that would have occurred in a seasonally restricted area would be redistributed outside that area must be carefully considered when interpreting results, as this consequence is yet unknown (i.e., applying seasonal restrictions results in increased levels of activity in remaining area outside of the restricted areas).

Finally, all of the listening area losses presented here are relativistic, and most examine the differences in areas available under different seismic activity scenarios, without reliance on the difficult task of evaluating the levels of noise in the absence of seismic activity in the GOM. However, NEPA requires a no activity scenario be included to further assess the impacts resulting from various alternatives. Because of the lack of available measured data, ambient noise was estimated for this exercise using modeled noise contributed by ship traffic and wind, which are the most common, “non-seismic,” noise-contributing factors in the GOM. Limited acoustic measurements, as well as contributions to modeled estimates from additional noise sources (especially in coastal areas), suggest that the values used here would be lower than the actual noise levels in the GOM in the absence of seismic activity and point to the need for spatially varying baseline measurements in the region.

Conclusions

Based on the understanding of the best available scientific data and estimated exposure modeling results, sounds produced during deep-penetration seismic airgun survey activities will impact individuals and groups of marine mammals within the AOI, including the ESA-listed (endangered) sperm whale and other whale and dolphin species on the continental shelf, shelf edge, and slope. The only mysticete species that was modeled for exposure estimates, based on its distribution and relative density within the GOM, was the Bryde’s whale.

Using the SPL_{peak} and SEL criteria to estimate Level A exposures and the 160 dB SPL_{rms} criterion for Level B exposures, marine mammal species with the highest exposure estimates are the delphinids, all of which are mid-frequency specialists relatively insensitive to low-frequency sounds. Despite their low sensitivity to deep-penetration seismic airgun survey noise, the relatively high density estimates for delphinids, such as the pantropical spotted dolphin and common bottlenose dolphin, result in large numbers of Level A and Level B exposures that may occur. However, when considered within their estimated population sizes, the percentage of the population potentially exposed each year are 0.05 and 0.00 percent for pantropical spotted dolphins and common bottlenose dolphins, respectively, to the SPL_{peak} threshold, and 0.00 percent for pantropical spotted dolphins and common bottlenose dolphins to the SEL threshold. The highest percentages of annual Level A exposures that may occur relative to population size were for *Kogia* spp. at 3.11 and 0.25 percent for the SPL_{peak} and SEL criteria, respectively. The highest percentages of populations potentially experiencing Level B exposures were the sperm whale (80.12%) and beaked whales (49.74%); most delphinid species are estimated at 30 to 40 percent of the population on an annual basis. The relatively high percentages of Level B exposures potentially occurring for sperm whales and beaked whales in the AOI may be attributed to the relatively high proportion of deep-penetration seismic airgun activities planned in deepwater environments within the CPA, including the area within Mississippi Canyon and the GOM deepwater area >2,000 m (6,562 ft) that support relatively high densities of sperm and beaked whales.

The direct impact of any actual Level A harassment to marine mammals within the AOI from deep-penetration seismic airgun activities would include hearing (auditory) injury onset, specifically the onset of PTS impairment to individual or small groups of whales and dolphins. The PTS onset injury is likely to be measured in a few decibel loss in hearing sensitivity, not profound loss, because most predicted incidents of auditory injury would occur at greater distances from the source. The effects of hearing (auditory) injury to marine mammals could cause some reduction in communication and foraging ability.

The onset of TTS, part of MMPA Level B harassment, might occur in individuals or small groups. The TTS could decrease the range over which socially significant communication takes place (e.g., communication between competing males, between males and females during mating season, between mothers and calves). The effect of Level B harassment to marine mammals beyond the immediate behavioral response is a matter of ongoing investigation, but an attempt to estimate the potential fitness consequence to an individual is included in the previous section. Given the estimated densities of local whale and dolphin populations, large survey areas (**Table 4.2-1**), and duration of some G&G activities (**Table 3.2-7**), it is likely that individual animals may experience multiple days of exposure to airgun noise causing TTS each year during the 10-year period covered by this Programmatic EIS.

Potential behavioral harassment was estimated using the current NMFS Level B MMPA criterion (160 dB rms). Estimates of potential exposure suggest that large numbers of individual cetaceans could experience non-injurious impacts from seismic airgun surveys during the project period. Studies demonstrate disturbance of activities and/or avoidance or temporary displacement from seismic surveyed areas, both at long ranges within the acoustic footprint of the seismic airgun array and at short ranges as received levels increase (Miller et al., 2009). Behavioral responses of marine mammals to acoustic stimuli vary depending on the species, the context of the animals' activities at the time of ensonification (e.g., feeding, migrating, calving), the properties of the stimuli, and prior exposure of the animals (Wartzok et al., 2004; Nowacek et al., 2007). Species-related response to anthropogenic noise may vary between taxonomic groups that have different hearing and sensitivity frequencies (NRC, 2005). Studies suggest that anthropogenic sounds such as seismic airgun surveys may affect behaviors of vocalizing mysticetes at distances greater than what is presently calculated, based on sound source characteristics and sound propagation modeling (Risch et al., 2012). Furthermore, the acoustic response to seismic sounds can be more complex than initially thought (Blackwell et al., 2015).

There are no data on the response of Bryde's whales to seismic sound. Širović et al. (2014) suggested that a representative source level for Bryde's whale vocalizations is 152 dB re 1 μPa at 1 m for the 100-Hz band based on the broadband source level for Bryde's whale moans of 155 dB re 1 μPa at 1 m. Intermediate range communication between individuals, therefore, cannot be ruled out and may be impacted for short durations during deep-penetration seismic airgun surveys. First order methods for assessing chronic effects from airgun noise, with a particular emphasis on assessing the potential loss of Bryde's whale communication space, suggest variability in such risks, both within the region and at specific locations under different alternatives (refer to **Appendix K**).

Seismic airgun surveys associated with the proposed activity would occur in open ocean areas following standard survey lines where highly mobile whales and dolphins are able to move freely to avoid the acoustic footprint of a relatively slow-moving sound source, thus avoiding potential exposure to injurious sound levels. Because these surveys will occur within the open GOM, there are no physical features that would restrict the movement of animals, and it is not likely that a survey vessel would entrap animals between a sound source and shore. It is presumed that exposure to elevated sound for any given survey would be limited to some distance outside of a survey plot (and not Gulfwide at any given time) and somewhat temporary in duration. In summary, the best available information, while providing evidence for concern and a basis for continuing research, does not, at this time, provide grounds to conclude that these surveys would disrupt behavioral patterns with more than negligible population-level impacts.

The Seismic Airgun Survey Protocol (**Appendix B, Attachment 1**) required under Alternative A specifies mitigation measures for marine mammals that are meant to decrease and possibly reduce Level A exposures. This includes an exclusion zone, ramp-up requirements, visual monitoring by PSOs, and airgun array shutdown requirements for specific whale species (i.e., Bryde's, beaked, sperm, or dwarf and pygmy sperm whales). Even with these mitigation measures in place, airgun surveys could expose animals in survey areas. Although the duration of potential exposure on any given day is assumed to be limited, vessels may remain in the foraging range of animals for days or weeks. Any affected individuals might remain in a particular area for varying lengths of time (i.e., they may have different residency patterns). The model output predicts the number of potentially occurring exposures on a 24-hour basis, which is then scaled to annual and decadal exposures based on historical use trends. In the previous section, an attempt is made to estimate the potential for repeated exposure of an individual.

This analysis uses the potential exposures provided in the modeled estimates, applies what is known about the likelihood of species in the AOI reacting to seismic airgun noise, and considers the range of responses from animals that may occur, thereby limiting the potential for Level A exposure and reducing the potential for Level B exposure. Implementation of mitigation measures for all marine mammals provide additional protection not considered in the modelling. The effects of project-related seismic airgun survey noise on marine mammals within the AOI, when considering the estimated potential exposures and the applicable mitigation for Alternative A, are expected to be **moderate** depending on the population (stock), as potential exposures of marine mammals are expected to be extensive (possibly affecting large numbers of individuals within areas of the AOI) but not severe (the definition of severe is a life-threatening or debilitating injury or mortality in sufficiently high numbers that the continued viability of the population is threatened). The likelihood of fitness effects to individuals from potential exposures is considered minimal. Depending on the population (stock), however, a large percentage of individuals may experience exposures that could induce behavioral reactions. Potential injurious impacts to individual species of marine mammals would include PTS in low enough numbers such that the continued viability of the local populations or stocks will not be threatened if actual impacts were to occur, and the annual rates of recruitment or survival of the local populations or stocks will not be seriously affected.

General human activity, including shipping and distant seismic surveys, has raised the ambient noise level in the GOM, chronically reducing the communication space of marine animals (Clark et al., 2009). Non-injurious potential impacts resulting from a change in acoustic habitat (Merchant et al., 2015) would depend on the level of seismic activity present in an animal's acoustic habitat, including the frequency and duration of survey activity. For example, in areas where seismic activity is more limited, effects might include temporary displacement of individuals from preferred areas. In these instances, animals are expected to return to these areas following the distancing of the sound source, which would occur after approximately 4 hours as calculated in the previous section, or the cessation of survey activities. In areas where seismic noise is more chronic, animals may be displaced longer from important biological areas, communication between individuals may be hampered, and greater energetic consequences may result. Further development of metrics to examine contexts for such risk is needed and would benefit from regionwide monitoring of noise conditions to better document longer-term status and trends in ambient noise conditions in the GOM. While this information is currently unknown, BOEM has determined that it can make an informed decision at this time without this information. BOEM determined that, while further documentation of long-term trends in ambient noise conditions in the GOM is relevant to reasonably foreseeable significant adverse impacts and would be useful, it is not essential to a reasoned choice among alternatives at the programmatic stage because other scientifically credible and best available information as presented in this Programmatic EIS (e.g., data on hearing thresholds, behavioral responses to anthropogenic noise, protected species observer reports, etc.) has provided a sufficient amount of relevant and accessible data needed to determine the potential impacts to marine mammals that would be reasonably foreseeable. Also, site-specific NEPA reviews, based on specific survey activities within a discrete area or areas over a specified timeframe, will address potential impacts to resources. BOEM's subject-matter experts have applied other scientifically credible information using accepted approaches and research methods, such as that used in the *Acoustic Propagation and Marine Mammal Exposure Modeling of Geological and Geophysical Sources in the Gulf of Mexico*, which was conducted by JASCO Applied Sciences (refer to **Appendices D and N**). Refer to **Appendix K** for further discussion on cumulative and chronic effects from airgun noise in the GOM, with a particular emphasis on assessing the potential loss of Bryde's whale communication space.

4.2.2.1.3 HRG Survey Activities

The HRG site surveys are conducted to investigate the shallow subsurface for geohazards and soil conditions in a specific location or over a broad area, and to identify potential benthic biological communities and archaeological resources. The HRG surveys and related equipment are discussed in **Appendix F, Sections 1.2 and 1.3**. The HRG surveys use several techniques, including airguns and electromechanical sources such as side-scan sonars, shallow- and medium-penetration subbottom profilers, and SBESs or MBESs. For this analysis, shallow-penetration seismic airgun surveys used for HRG site surveys are discussed separately from electromechanical source (non-airgun) surveys, though these sources may be used together. In such a scenario, the airgun sources are the dominant sound producers.

Shallow-Penetration Seismic Airgun HRG Survey Activities

Airgun sources (typically 1 or 2 airguns) used for shallow-penetration seismic airgun surveys are smaller (typically 20 to 100 in^3), and the interval between airgun shotpoints are shorter than for conventional deep-penetration 2D and 3D airgun seismic surveys. For this study, a single 90-in^3 airgun was modeled (**Appendix D**). Shallow-penetration seismic airgun surveys are anticipated to be conducted on the continental shelf and slope in the CPA (modeling Zones 2 and 5) and in deep water in all three planning areas (modeling Zone 7) (**Appendix D, Table 75**).

Level A Estimates of Potentially Occurring Exposures

Total decadal estimates of potentially occurring exposures for proposed shallow-penetration airgun seismic surveys over the 10-year period covered by this Programmatic EIS using the SEL and SPL_{peak} criteria are presented in **Appendix D, Table 80**. Annual estimates of potentially occurring exposures are provided in Appendix F of **Appendix D**. Level A estimates of potential exposure were not predicted for any species for 5 of the 10 years because no shallow-penetration seismic airgun survey activity is projected during that time (**Appendix D, Table 75**). When considering the SPL_{peak} and SEL criteria for the decadal period, no SEL potential exposures are predicted and the only 0.1 potentially occurring exposures for the SPL_{peak} criteria are predicted for *Kogia* spp. (**Appendix D, Table 80**). At an annual level, the 0.1 potential exposures for *Kogia* spp. are estimated to occur in only 1 of the 10 years (**Appendix D, Table F-44**). No potential Level A exposures of Bryde's whale, the only mysticete in the GOM, or the endangered sperm whale are anticipated.

Level B Estimates of Potentially Occuring Exposures

Level B (NMFS 160 dB SPL_{rms}) estimates of potentially occurring exposures were calculated for proposed HRG airgun (shallow-penetration seismic) survey activities conducted over the 10-year period covered in this Programmatic EIS. Total Level B potential exposure estimates are presented in **Appendix D, Table 80**. The highest number of 160 dB SPL_{rms} potential exposures is expected for common bottlenose dolphins (353.6 over 10 years), with the highest annual estimate for this species at 95.7 potentially occurring exposures in one of the projected years (**Appendix D, Table F-37**). Bryde's whales are the only low-frequency specialist. No potentially occurring exposures of Bryde's whales at received SPL_{rms} >160 dB are predicted during the decadal period because no surveys are projected for the EPA. For the endangered sperm whale, an estimated 4.6 exposures could occur at received SPL_{rms} >160 dB during the decadal period, with these potential exposures occurring in one of the projected years (**Appendix D, Table F-44**).

Conclusions

Noise from shallow-penetration seismic airgun surveys may impact individual marine mammals within the AOI. As for other survey types previously analyzed in this Programmatic EIS, no lethal impacts are predicted to occur during shallow-penetration airgun surveys. When considering the SPL_{peak} and SEL criteria for the decadal period, no SEL exposures are predicted to occur for any species. The only decadal SPL_{peak} potential exposures are predicted for *Kogia* spp. (0.1). Level B potential exposure estimates for shallow-penetration airgun surveys predicted using NMFS' 160 dB SPL_{rms} criteria were very low for the 10-year project period, with the highest estimated potentially occurring exposures for common bottlenose dolphins (353.6), Atlantic spotted dolphins (104.1), and pantropical spotted dolphins (25.3) over the 10-year period; <5 potential exposures to any other species are expected.

Shallow-penetration seismic airgun surveys associated with the proposed action are planned to occur in open ocean areas where highly mobile cetaceans may move freely to avoid a relatively slow-moving sound source, thus reducing or minimizing any potential exposure to injurious sound levels and reducing the potential to receive sound at levels that may affect behavior. In addition, the Seismic Airgun Survey Protocol required under Alternative A includes mitigation measures such as an exclusion zone, ramp-up requirements, visual monitoring by PSOs, and shutdown requirements for specific whale species (i.e., Bryde's, beaked, sperm, or dwarf and pygmy sperm whales), which were not factored into the modeling. These single airgun surveys would be performed in relatively small areas (72.5 km^2 [28.0 mi^2]) and conducted in a systematic and predictable fashion along closely spaced, pre-plotted transects; therefore, exposure to elevated sound is presumed to be localized and temporary.

Based on the output (source level) of the single airgun used in shallow-penetration seismic airgun surveys, estimates of potential exposure of marine mammals within the AOI are low or zero; therefore, these impacts are considered neither extensive nor severe. Potential impacts to marine mammals would include temporary auditory injuries (TTS); temporary disruptions of communication or echolocation (auditory masking); behavioral disruptions of individual or localized groups of marine mammals; and limited, localized, and short-term displacement of individuals of any species, including strategic stocks, from project-related areas of ensonification. No mortality and very limited potential for physical injury (PTS) to any individual marine mammal would be expected to occur. No fitness impacts to any species are expected. Based on the potential impacts described above and the impact-level criteria listed in **Chapter 4.2.2.1**, the effects of project-related, shallow-penetration seismic airgun survey noise on marine mammals within the AOI would be **minor**.

Non-Airgun HRG Survey Activities

Equipment and methods associated with acoustic non-airgun HRG surveys are discussed in **Appendix F, Section 1.3**. Projected non-airgun HRG survey levels are discussed in **Chapter 3.2** and listed in **Table 3.2-7**. Electromechanical (non-airgun) equipment commonly used in acoustic HRG surveys includes shallow- or medium-penetration subbottom profilers (e.g., pingers, sparkers, boomers, CHIRP subbottom profilers), side-scan sonars, and SBESs or MBESs. These electromechanical sources have adjustable main operating frequency bands; however, they can be considered narrow band sources, as the acoustic energy emitted outside the main operating frequency band is nominal. Electromechanical sources can be highly directive, with beam widths as narrow as a few degrees or less.

Several electromechanical sound sources, including a 400-kHz side-scan sonar, 200-kHz CHIRP subbottom profiler, and 240-kHz MBES, would operate within a frequency range that is inaudible to cetaceans within the AOI. Frequency outputs from other electromechanical sources would be audible to marine mammals in the AOI, including a 0.3- to 3-kHz boomer, 16-kHz side-scan sonar, and 0.5- and 24-kHz CHIRP subbottom profilers. **Appendix F, Section 1.3** provides more discussion regarding the application of non-airgun HRG surveys and their operational frequencies.

This analysis of potential impacts of non-airgun HRG surveys associated with the proposed action to marine mammals within the AOI is based on modeled estimates of total Level A and Level B exposures from proposed boomer surveys and other non-airgun HRG surveys within the AOI. In this analysis, other non-airgun HRG surveys assume the use of side-scan sonars, subbottom profilers, and MBESs. Methods for the estimation of the acoustic field of each non-airgun HRG survey sound source and subsequent estimations of incidental exposure are provided in **Appendix D, Section 5**. These non-airgun HRG electromechanical sound sources may be used in combination with airgun sources. In such cases, exposures from the airgun sources will dominate over potential exposures from the HRG electromagnetic sources.

Boomer Survey Activities

The representative boomer system modeled was the Applied Acoustics AA301 Boomer system, based on a single plate with an approximate baffle diameter of 40 cm (15.7 in) (**Appendix D**). The parameters of the AA301 boomer used for modeling are described in **Appendix D**. Boomer survey activities are anticipated to be conducted on the continental shelf and slope in the CPA (modeling Zones 2 and 5) and in deep water in all three planning areas (modeling Zone 7) (**Appendix D, Table 75**). Boomer survey activities are projected to occur in 2 of the 10 years.

Level A Estimates of Potentially Occurring Exposures

Total decadal estimates of potentially occurring exposures for proposed boomer activity during the time period covered by this Programmatic EIS using the SEL and SPL_{peak} criteria are presented in **Appendix D, Table 81**. Level A potential exposure estimates were not predicted for any species for 5 of the 10 years because no boomer activity is projected (**Appendix D, Table 75**). When considering the SPL_{peak} and SEL criteria for the decadal period, no SEL potentially occurring exposures are predicted, and the only SPL_{peak} potentially occurring exposures are predicted for *Kogia* spp., with 0.1 potential exposures (**Appendix D, Table 81**). At an annual level, the 0.1 *Kogia* spp. potential exposures are estimated to occur in one of the projected years. No Level A potential exposures of Bryde's whale, the only mysticete in the GOM, or the endangered sperm whale are anticipated.

Level B Estimates of Potentially Occurring Exposures

Level B (NMFS 160 dB SPL_{rms}) estimates of potentially occurring exposures were calculated for proposed boomer activities projected to occur over the 10-year period. Total decadal Level B potentially occurring exposure estimates are presented in **Appendix D, Table 81**. Over the decadal period, the highest number of 160 dB SPL_{rms} potential exposures is expected for common bottlenose dolphins (51.0; **Appendix D, Table 81**), with the highest annual estimate for this species at 48.1 potential exposures (**Appendix D, Table F-38**). Bryde's whales are the only low-frequency specialist. No exposures of Bryde's whales at received SPL_{rms} >160 dB are predicted to occur during the decadal period because no surveys are projected for the EPA. For the endangered sperm whale, an estimated 3.1 exposures at received SPL_{rms} >160 dB may occur during the decadal period, with these potential exposures occurring during one of the projected years (**Appendix D, Table F-45**).

Other Non-Airgun HRG (Electromechanical) Survey Activities

Other non-airgun HRG electromechanical survey equipment considered for this modeling effort included an MBES, side-scan sonar, and a CHIRP subbottom profiler (**Appendix D**). All three sources were considered to operate simultaneously. The towing depth was considered to be 4 m (13 ft) below the sea surface if the water depth was <100 m (328 ft), and 40 m (131 ft) above the seafloor in water depths >100 m (328 ft).

For the MBES, the operational parameters producing the greatest acoustic impact were modeled. In this case, the Simrad EM2000 MBES was modeled at the operational frequency of 200 kHz, with a maximum source level of 203 dB re 1 μPa at 1 m and pulse length of 1.3 ms.

The representative side-scan sonar (EdgeTech 2200 IM) was modeled at two operational frequencies: 120 and 410 kHz. The SPL_{rms} was estimated based on the peak source levels of 207 and 213 dB re 1 μPa at 1 m for the 120- and 410-kHz center frequencies, respectively. The SEL was estimated based on the SPL_{rms} values and the pulse lengths to derive SEL source levels of 186 and 187 dB re 1 μPa^2•s for the 120- and 410-kHz center frequencies, respectively.

The representative CHIRP subbottom profiler was the EdgeTech 2200 IM, DW-424. The EdgeTech 2200 IM system was modeled at a single frequency (14 kHz). The SPL_{rms} source level was 200 dB re 1 μPa at 1 m. The SEL source level was estimated based on the SPL_{rms} and the pulse length to derive an SEL source level of 180 dB re 1 μPa^2•s. The beam width was estimated at 20° at the center frequency.

Other non-airgun HRG electromagnetic survey activities are anticipated to be conducted on the continental shelf in the WPA, CPA, and EPA (modeling Zones 1, 2, and 3) and on the WPA, CPA, and EPA continental shelf, slope, and deep waters (modeling Zones 4, 5, 6, and 7; **Appendix D, Table 75**). No surveys are projected to occur on the EPA continental shelf (modeling Zone 1) after the first 3 years (**Appendix D, Table 75**).

Level A Estimates of Potentially Occurring Exposures

Total decadal estimates of potentially occurring exposures for proposed non-airgun HRG electromagnetic activities during the time period covered by this Programmatic EIS using the SEL and SPL_{peak} criteria are presented in **Appendix D, Table 82**. Furthermore, **Appendix F of Appendix D** provides annual potentially occurring exposure tables for all species by each survey type for each year. Level A potential exposures are provided using the SEL, SPL_{peak}, and SPL (180dB) threshold criteria. When considering the SPL_{peak} and SEL criteria for the decadal period, no SPL_{peak} potential exposures are predicted. The highest decadal SEL potentially occurring exposures are predicted for common bottlenose dolphins, with 95.2 potential exposures (**Appendix D, Table 82**). The highest annual common bottlenose dolphin potentially occurring exposure is predicted at 11.0 potential exposures in one of the projected years (**Appendix D, Table F-46**), though similar numbers of potentially occurring exposures are predicted for three additional years (**Appendix F of Appendix D**). No Level A potential exposures of Bryde's whale, the only mysticete in the GOM, are anticipated. For the endangered sperm whale, 0.3 SEL potential exposures are predicted for the decadal period (**Appendix D, Table 82**), with all annual estimates being <0.1 potential exposures.

Level B Estimates of Potentially Occurring Exposures

Level B (NMFS 160 dB SPL_{rms}) estimates of potentially occurring exposures were calculated for proposed other non-airgun HRG electromagnetic activities projected to occur over the 10-year period. Total decadal Level B potential exposure estimates are presented in **Appendix D, Table 82**. Over the decadal period, the highest number of 160 dB SPL_{rms} potentially occurring exposures are expected for common bottlenose dolphins (68.5; **Appendix D, Table 82**), with the highest annual estimate for this species at 8.3 potential exposures (**Appendix D, Table F-18**), though similar numbers of potential exposures are predicted for three additional years. Bryde's whales are the only low-frequency specialist. No potentially occurring exposures of Bryde's whales or sperm whales at received SPL_{rms} >160 dB are predicted during the decadal period.

Conclusions

Noise from non-airgun HRG electrometrical surveys utilizing boomers and other selected acoustic HRG survey equipment (i.e., MBES, side-scan sonar, and subbottom profiler) may impact individual marine mammals within the AOI. Similar to other survey types previously analyzed in this Programmatic EIS, no lethal impacts are predicted for HRG electromechanical surveys. When considering the SPL_{peak} and SEL criteria for the decadal period, the only decadal SPL_{peak} potentially occurring exposures are predicted for *Kogia* spp. (0.1). The highest decadal SEL potential exposures are predicted for common bottlenose dolphins, with 95.2 potential exposures (**Appendix D, Table 82**). The next highest species are Atlantic spotted dolphins and striped dolphins with 8.2 potentially occurring exposures; seven other species have potential exposures <0.7. Total Level B potentially occurring exposure estimates for boomer and other HRG electromechanical surveys using NMFS' 160 dB SPL_{rms} criteria also were very low for the 10-year project period, with the highest estimated potential exposures for common bottlenose dolphins (119.5) and Atlantic spotted dolphins (26.4).

Based on the results of this analysis, the effects of HRG electromechanical survey noise on marine mammals within the AOI are expected to be **minor**. Potential impacts from potentially occurring exposures over the project period include limited behavioral impacts and low (limited) numbers of physical injuries (PTS). Behavioral impacts may include temporary disruption of communication or echolocation from auditory masking; behavior disruptions of individual or localized groups of marine mammals; and limited, localized, and short-term displacement of individuals from the area of ensonification. None of these effects are expected to result in fitness impacts to any species.

4.2.2.1.4 Vessel and Equipment Noise

Proposed G&G activities would generate vessel and equipment noise that could disturb marine mammals. The types of sounds produced by these sources are classified as non-pulsed, or continuous. As discussed in **Chapter 3.3.1.2.1**, vessel noise is a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995). Tones typically dominate up to approximately 50 Hz, whereas broadband sounds may extend to 100 kHz. Analyses of radiated sound from ships have revealed that they are the dominant source of underwater noise at frequencies <300 Hz in many areas (Wright, 2008).

Vessel and equipment noise from G&G vessels, including survey and support vessels associated with activities described in Alternative A, would produce sound levels typically <190 dB rms re 1 µPa at 1 m (Richardson et al., 1995; NRC, 2003a; OSPAR Commission, 2009). The primary sources of noise from all vessel classes are propeller cavitation and singing, propulsion machinery (including DP thrusters), and other sources (such as auxiliary machinery and flow noise) (Richardson et al., 1995). The current acoustic threshold established by NMFS for sub-injurious exposure to a continuous noise source is 120 dB re 1 µPa (rms). This threshold was based on avoidance responses observed in whales, specifically from research on migrating gray whales and bowhead whales (Malme et al., 1983, 1984, 1988; Richardson et al., 1986, 1990; Dahlheim and Ljunblad, 1990; Richardson and Malme, 1993). As discussed in **Chapter 4.2.2.1**, the one mysticete that occurs within the AOI, the Bryde's whale, is especially vulnerable to impacts from vessel noise because they produce and perceive low-frequency sounds (Southall, 2005). Broadband propulsion source levels for seismic survey and DP vessels drilling COST or shallow test wells are anticipated to be 170 to 180 dB re 1 µPa at 1 m, and source levels for smaller boats are 150 to 170 dB re 1 µPa at 1 m (Richardson et al., 1995). These noise and frequency levels are within the audible range for all GOM cetacean species (including Bryde's whales) and, near these sources, exceed NMFS' threshold for Level B harassment by continuous sound sources (120 re 1 µPa at 1 m dB received level). In the open ocean, deepwater environment where spherical spreading conditions apply, an attenuation of 60 dB re 1 µPa at 1 m (e.g., reduction from a source level of 180 dB re 1 µPa at 1 m to the 120-dB continuous noise threshold) would occur within 1 km (0.6 mi) of the source. Where modified spherical spreading conditions may apply, the distance from the source to the 120-dB threshold would be greater.

As discussed in **Appendix F, Section 1.1**, vessels conducting deep-penetration seismic airgun surveys (i.e., 2D, 3D, and 4D surveys) are large in size (60 to 90 m [197 to 295 ft] in length) and would account for most of the proposed survey miles traveled, and (under Alternative A) these surveys could occur anywhere within the AOI. Most seismic surveys, however, will occur in deepwater areas of the CPA throughout the project period (**Table 3.2-2**). The WAZ surveys generally involve multiple vessels operating in concert in a variety of vessel geometries (**Appendix F, Section 1.1.4**). Vessel and helicopter traffic associated with the proposed activities is described in **Chapters 3.3.1.3 and 3.3.1.4**, and the level of activity is estimated in **Table 3.3-3**.

Vessels conducting sampling activities for HRG surveys would be smaller and operate mainly at specific sites (consisting of one or more OCS lease blocks) and along potential cable routes to shore. Survey vessels for nearshore projects are expected to make daily round-trips to their shore base.

Many marine mammal species may be vulnerable to impacts from vessel noise because marine mammals produce and perceive low- to mid-frequency sounds. Most of the acoustic energy radiated from commercial vessels is <1 kHz; however, other sources of sound often dominate ambient noise at frequencies >300 Hz. In addition to direct disturbance, an additional effect of increased ambient noise on marine mammals is the potential for that noise to mask biologically significant sounds (**Chapter 4.2.2**).

Studies of vessel noise on GOM sperm whales indicate a significant decrease in the total number of acoustic clicks detected as a tanker ship approached an area (Azzara et al., 2013). Individuals of several small-toothed whale and dolphin species have been observed avoiding boats when they are within 0.5 to 1.5 km (0.3 to 0.9 mi), with occasional reports of avoidance at greater distances (Richardson et al., 1995). Most beaked whales tend to avoid vessels (Würsig et al., 1998; Aguilar-Soto et al., 2006) and may dive for an extended period of time when approached by a vessel (Kasuya, 1986). Dolphins may tolerate boats of all sizes, sometimes approaching and riding the bow and stern waves (Shane et al., 1986; Barkaszi et al., 2012). At other times, dolphin species typically attracted to boats will avoid them. Such avoidance often is linked to previous boat-based harassment of the animals (Richardson et al., 1995). Coastal common bottlenose dolphins that are the object of whale-watching activities have been observed to swim erratically (Acevedo, 1991), remain submerged for longer periods of time (Janik and Thompson, 1996; Nowacek et al., 2001), display less cohesiveness among group members (Cope et al., 1999), whistle more frequently (Scarpaci et al., 2000), and display restless behavior (Constantine et al., 2004) when boats are nearby.

Marine geophysical vessels are designed to operate relatively quietly to minimize potential sources of interference to collected seismic data (International Association of Geophysical Contractors, 2002; Polarcus, 2011). From these reports, it is conservative to assume that noise associated with G&G survey vessels associated with the proposed action but not actively surveying may elicit behavioral changes in marine mammals that are in close proximity to the vessels. As discussed previously, behavioral changes range from evasive maneuvers (such as diving or changes in swimming direction or speed) to attraction to the moving vessel (bow-riding). Because these vessels generally are quiet, machinery and other propulsion-related noise is transitory and does not propagate great distances from the vessel. For the majority of time that seismic vessels are underway within the AOI, they would be operating airguns or other active acoustic sound sources; under these conditions, estimates of potential acoustic disturbance or harassment (Level B exposure) numbers already have been accounted for. When non-airgun HRG seismic vessels are operating, or when seismic vessels are not actively surveying, the potential for behavioral impacts from vessel and equipment noise remains.

Under Alternative A, all authorizations for G&G surveys would include guidance for maintaining safe distances between G&G vessels and protected species during transit to minimize potential impacts from vessel noise (NTL 2016-BOEM-G01). The NTL addresses protected species identification, vessel strike avoidance, and injured/dead protected species reporting. Mitigation measures are listed in **Chapter 2.3.2** and detailed in **Appendix B, Section 1**.

For this analysis, the proposed additional volume of vessel traffic associated with Alternative A is not expected to constitute a significant increase to existing vessel traffic within the AOI. Based on the proposed volume of vessel traffic (**Table 3.3-3**) and the presumption that individual or groups of marine mammals within the AOI are familiar with various and common vessel-related noises, particularly within trafficked areas of the continental shelf and shipping lanes, the effects of project-related vessel and equipment noise on marine mammals within the AOI would be **nominal** to **minor**. Impacts to marine mammals from project-related vessel and equipment noise are expected but are not likely to be extensive or severe. Likely impacts would include temporary disruption of communication or echolocation from auditory masking; behavior disruptions of individual or localized groups of marine mammals; and limited, localized, and short-term displacement of individuals of any species, including strategic stocks, from localized areas around the vessels.

4.2.2.1.5 Drilling-Related Noise

In addition to the ship and DP vessel noise discussed earlier, drilling-related noises anticipated during the time period of this Programmatic EIS include the completion of one possible COST well and up to two shallow test wells in the AOI. A COST well is funded by industry consortia; drilled off structure so as not to encounter hydrocarbons; and intended to provide information about regional stratigraphy, the existence and potential quality of reservoir beds, and the existence of potential hydrocarbon source rocks. Drilling is done by conventional rotary drilling equipment from a drilling rig. Noise generated by COST well completion includes drilling noise and rig positioning noise (specifically, noise from DP equipment). Drilling rigs used for COST well operations are assumed to be jack-up or semisubmersible rigs in deepwater areas.

Noise from drilling operations includes strong tonal components at low frequencies (<500 Hz), including infrasonic frequencies in at least some cases (Richardson et al., 1995). Machinery noise can be continuous or transient, and variable in intensity. Noise levels vary with the type of drilling rig and water depth. Drilling-related noise from bottom-founded platforms is continuous and generally of very low frequencies (near 5 Hz); therefore, it is expected to be within the audible range of mysticetes only. Sound source levels of drilling from jack-up platforms may range from 119 to 127 dB re 1 μPa at near-field locations (Richardson et al., 1995). Drilling-related noises from semisubmersible platforms in deeper waters range in frequency from 10 to 4,000 Hz; therefore, drilling noise from these sources is audible to all cetacean species within the AOI. Drilling sound source levels from semisubmersible platforms are estimated at 154 dB re 1 μPa-m. Studies on drillships using DP recorded noise between 20 and 35 kHz (at close range to the drillship). Source levels recorded for the vessel were 190 dB re 1 μPa (rms) during maintenance work and

184 dB re 1 μPa (rms) during drilling (Kyhn et al., 2011). Noise levels from drillships generally are higher than semisubmersibles, as the drillships have a large hull area that is well coupled to the water, and sound paths of vessel and drill machinery to the water are direct as compared with semisubmersibles, where sound and vibration paths are through the air or risers (Richardson et al., 1995).

Marine mammals are expected to detect drilling-related noises within a radius of audibility. The range of audibility radii is based on the sound source level and local attenuation from factors such as water depth and seafloor characteristics. Based on predominantly low-frequency sounds produced by drilling, jack-up drilling operations are expected to affect only mysticetes (Richardson et al., 1995). From Gales (1982), measurements of received levels of the low-frequency tones (199 to 127 dB re 1 μPa) were recorded only at near-field measurement locations. Based on the 120 dB re 1 μPa (rms) acoustic sub-injurious threshold established by NMFS for continuous sounds, potential impacts to cetaceans would be limited to alterations in behavior close to the platform, and semisubmersible rigs would affect all marine mammal species within the 120-dB acoustic radii. For semisubmersible platforms, the 120-dB radius would be 50 m (164 ft) under conditions where spherical spreading applies. In the instances where a drillship will be employed (i.e., in deep water where seafloor anchoring is not feasible), drilling noise may be expected to attenuate under spherical spreading conditions in most circumstances; the 120-dB radius would extend 3.5 km (2.2 mi) from the drillship. In project-specific cases where drilling operations are proposed and the sound source and propagation may be of concern, BOEM will consider the acoustic effects from these activities, along with other IPFs specific to these activities. It is expected that these sources of noise would elicit alterations of behavior such as changes in swimming direction or speed. However, studies indicate that the sensitivity of marine mammals to drilling sound varies among and within species (Richardson et al., 1990).

Considering the low number of proposed drilling operations and the continuous nature of sounds produced during drilling operations, impacts from noise associated with drilling operations are expected to be **nominal** to **minor**.

4.2.2.1.6 Vessel Traffic

Marine mammals may be vulnerable to physical disturbance from or collisions (ship strike) with moving vessels (Laist et al., 2001; Douglas et al., 2008; Pace, 2011). Most reports of collisions involve large whales, but collisions with smaller species have been reported as well (van Waerebeek et al., 2007). Laist et al. (2001) provided records of the vessel types associated with collisions with whales. These include (in descending order) tanker/cargo vessels, whale-watching vessels, passenger liners, ferries, Naval vessels, recreational vessels, USCG vessels, fishing vessels, research vessels, dredges, and pilot boats. From these records, most severe and lethal whale injuries involved large ships >80 m (262 ft) long. Vessel speed was found to be a significant factor as well, with 89 percent of the records involving vessels moving at 14 kn (16 mph) or greater.

Marine mammal species that are most at risk for possible ship strikes in the GOM include slow-moving species and deep-diving species on the surface (e.g., Bryde’s whales, sperm whales, pygmy/dwarf sperm whales, beaked whales). Certain fast-moving cetacean species, including several delphinids such as the common bottlenose dolphin and *Stenella* spp., actively approach vessels to swim within the pressure wave produced by the vessel’s bow and are at lower risk of possible ship strike. Only four confirmed large whale ship strikes have been reported in the GOM (Laist et al., 2001; Jensen and Silber, 2004; Glass et al., 2009; Cole and Henry, 2015).

Ship strikes directly associated with survey operations included in Alternative A are considered accidental and unlikely to occur during routine G&G survey operations. Seismic vessels and other G&G survey vessels will travel at relatively slow speeds during active survey operations. Seismic vessels, which account for most of the project-related vessel traffic associated with Alternative A activities, survey at a speed of approximately 4.5 kn (5.2 mph). In addition, waters surrounding survey vessels would be visually monitored (during daylight hours) by PSOs for the presence of marine mammals during survey activities. During transit to and from shore bases, seismic vessels and other G&G survey vessels are expected to travel at greater speeds (generally <10 to 12 kn [12 to 14 mph]). Support vessels associated with the proposed activities travel at faster speeds, which may increase the likelihood of collisions with marine mammals; support vessels are estimated to make up to 19,689 vessel trips over the 10-year period (**Table 3.4-2**). All authorizations for shipboard surveys would include guidance for vessel strike avoidance (i.e., NTL 2016-BOEM-G01), which incorporates NMFS “Vessel Strike Avoidance Measures and Reporting for Mariners” addressing protected species identification, vessel strike avoidance, and injured/dead protected species reporting. Furthermore, 33 CFR § 164.46(a) requires that vessels be outfitted with a USCG “type-approved” and “properly installed” AIS. The AIS automatically provides vessel information, including the vessel’s identity, type, position, course, speed, navigational status, and other safety-related information, to appropriately equipped shore stations, other ships, and aircraft; automatically receives such information from similarly fitted ships; monitors and tracks ships; and exchanges data with shore-based facilities (U.S. Dept. of Homeland Security, CG, 2016).

In this analysis, the likelihood of a collision between a project-related vessel during surveys and a marine mammal within the AOI is considered low because of several factors: preponderance of higher speed vessel activity taking place in shelf waters; relatively low vessel speeds once on a survey site; the presence of visual observers (including vessel officers and crew) on board survey vessels; and adherence to vessel strike avoidance measures (i.e., NTL 2016-BOEM-G01) for all vessels operating in the Gulf of Mexico OCS. Under these conditions and with the limited number of project-specific support vessel transits (19,689 over the 10-year period; **Table 3.3-3**), vessel collisions with marine mammals are likely to be avoided and impacts would be **nominal**. Furthermore, when considering the level of commercial traffic (**Tables 3.4-7 through 3.4-9**), as well as oil and gas traffic (more than a million trips in a 10-year period, **Table 3.4-2**) in the GOM, the proposed activities do not contribute considerably to the overall traffic. Interactions between marine mammals attracted to project-related vessel traffic are not considered to result in injury or disturbance to those individuals. However, in the unlikely event a collision did occur, it could result in a mortality, which would be a **moderate** impact to certain species; therefore, overall, the impacts from vessel traffic would range from **nominal** to **moderate**.

4.2.2.1.7 Aircraft Traffic and Noise

Aircraft traffic and noise would result from remote-sensing surveys (aeromagnetic surveys) and helicopter support. BOEM anticipates that one aeromagnetic survey may be conducted in the AOI during the time period covered by this Programmatic EIS (**Table 3.2 2**). The aeromagnetic survey would be conducted by fixed-wing aircraft flying at speeds of approximately 135 kn (155 mph) (Reeves, 2005). Most offshore aeromagnetic surveys are flown at altitudes between 61 and 152 m (200 and 500 ft). Line spacing depends on the objectives, but typical grids are 0.5 × 1.0 mi (0.8 × 1.6 km) or 1.0 × 1.0 mi (1.6 × 1.6 km). A typical aeromagnetic survey is expected to require 1 to 3 months to complete.

Helicopter support is necessary during the drilling of COST wells, shallow test wells (**Chapter 3.3.1.4**), and support and service during deep-penetration seismic airgun surveys. Helicopter flights will be used to conduct crew changes for larger seismic vessels; the number of anticipated transits is provided in **Table 3.3-3** and discussed in **Chapter 3.3.1.4**. Most of the larger survey vessels are equipped with integrated helicopter landing pads to facilitate such airborne support, while smaller vessels may use vessel-to-vessel crew transfer or may return to shore for crew changes and resupply.

Potential IPFs to marine mammals from aircraft include noise and physical (visual) disturbances. Noise generated by project-related aircraft that are directly relevant to marine mammals include airborne sounds to individuals resting on the sea surface and underwater sounds from air-to-water transmission from passing aircraft. Helicopters and fixed-wing aircraft generate noise from their engines, airframes, and propellers. The sound sources from both types of aircraft are classified as continuous with dominant tones <500 Hz (Richardson et al., 1995); therefore, these sources are within the auditory range of all marine mammals in the GOM (**Appendix H, Section 3**). The current acoustic threshold established by NMFS for continuous sounds is 120 dB re 1 μPa (rms) for sub-injurious behavioral modification. Richardson et al. (1995) reported received in-water SPLs (receiver depths between 3 and 18 m [9.8 and 59 ft]) from aircraft flying at altitudes of 152 m (500 ft) were 109 dB re 1 μPa for a helicopter (Bell 212) and 101 dB re 1 μPa for a small, fixed-wing aircraft (B-N Islander). Generally, helicopters are approximately 10 dB louder than fixed-wing aircraft of similar size (Richardson et al., 1995). Penetration of aircraft noise into the water is greatest directly below the aircraft; at angles >13° from vertical, much of the sound is reflected and does not penetrate into the water (Richardson et al., 1995). The duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 152 m (500 ft) that is audible in air for 4 minutes may be detectable underwater for only 38 seconds at 3 m (10 ft) depth and for 11 seconds at 18 m (59 ft) depth (Richardson et al., 1995). Levels of noise received underwater from passing aircraft depend on the aircraft's altitude, the aspect (direction and angle) of the aircraft relative to the receiver, receiver depth, water depth, and seafloor type (Richardson et al., 1995). Received level diminishes with increasing receiver depth when an aircraft is directly overhead, but it may be stronger at mid-water than at shallow depths when an aircraft is not directly overhead (Richardson et al., 1995). Because of the relatively high expected airspeed (135 kn [155 mph]) and these physical variables, aircraft-related noise (including airborne and underwater noise) is expected to be very brief in duration.

The physical presence of low-flying aircraft can disturb marine mammals, particularly individuals resting on the sea surface. Observations made from low-altitude aerial surveys report behavioral responses of marine mammals are highly variable and range from no observable reaction to diving or rapid changes in swimming speed or direction (Efroymson et al., 2001; Smultea et al., 2008).

Only one aeromagnetic survey and drilling of one COST and two shallow test wells are associated with Alternative A. Seismic survey crew changes and other service runs are assumed in this analysis to be relatively infrequent (estimated every 5 weeks), and the locations for these visits are variable based on survey design. Aircraft noise SPLs are moderate at the sea surface and underwater based on the relative distance of the sound sources (operational altitudes) and the short duration of potential exposure (operational airspeeds). It is expected that impacts from aircraft traffic will be slight or not measureable and limited to temporary behavioral disruptions. Potential impacts from this activity are expected to be **nominal**.

4.2.2.1.8 Trash and Debris

Marine debris (here termed trash and debris) is defined as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally disposed of or abandoned into the marine environment (USDOC, NOAA, 2015a). Trash and debris relative to G&G activities is described in **Chapter 3.3.1.7**. Survey operations generate trash made of paper, plastic, wood, glass, and metal that could be accidentally lost overboard.

Impacts to marine mammals from trash and debris include entanglement and ingestion. Although not necessarily related to G&G activity, derelict nets, ropes, line, or other fishing gear; packing bands; rubber bands; balloon string; six-pack rings; and a variety of other debris can become entangled with marine life, including marine mammals. Global entanglement records with trash and debris for marine mammals show that entanglement is most common in pinnipeds, less common in mysticetes, and rare among odontocetes (Laist et al., 1999). Entanglement data for mysticetes may reflect a high interaction rate with active fishing gear rather than with discarded trash and debris (Laist, 1996). Entanglement records for odontocetes that are not clearly related to bycatch in active fisheries are almost absent (Laist, 1996).

Marine mammals have been known to ingest trash and debris. Debris items may be mistaken for food or ingested accidentally with other food. Debris ingestion can lead to loss of nutrition, internal injury, intestinal blockage, starvation, and even death (USDOC, NOAA, 2015a). However, records suggest that entanglement is a far more likely cause of mortality to marine mammals than ingestion-related interactions (Laist et al., 1999).

The MARPOL is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL includes regulations aimed at preventing and minimizing pollution from ships (accidental and from routine operations) and currently includes six technical Annexes. Special areas with strict controls on operational discharges are included in most Annexes. Annex V ("Prevention of Pollution by Garbage from Ships") addresses different types of trash and debris, specifying the distances from land and the manner in which they may be disposed of; the most important feature of Annex V is the complete ban imposed on the disposal of all forms of plastics into the sea. The revised Annex V prohibits the discharge of all trash and debris into the sea, except as provided otherwise. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste.

The G&G survey operations associated with Alternative A will generate trash made of paper, plastic, wood, glass, and metal that may be accidentally lost overboard. In addition to adherence to revised provisions of MARPOL Annex V, USCG and USEPA regulations require operators to be proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. Under the proposed action, all authorizations for offshore G&G activities would include guidance for the handling and disposal of trash and debris as required in NTL 2015-BSEE-G03 and described in **Appendix B, Section 1.2.1.2**.

Taking into account USCG and USEPA regulations as well as BSEE guidance, significant amounts of trash and debris from routine G&G activities are considered accidental and unlikely to be released into the marine environment. Therefore, debris entanglement and ingestion impacts on marine mammals are expected to be **nominal**.

4.2.2.1.9 Entanglement

Entanglement that may impact marine mammals within the AOI as a result of the proposed action include placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor for various activities included in the three Program Areas. Acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines pose an entanglement risk to marine mammals and other marine life (i.e., sea turtles). Entanglement has occurred in the past with OBC/OBN surveys and other activities where rope tethers were used (e.g., anchors and buoys); further discussion can be found in **Chapter 3.3.1.8 and Appendix F, Section 1.1.3**. The deployment of nodes and cables is accomplished by an ROV, by dropping nodes on a tether, or by laying cables off the back of a layout boat. There was one recent (2014) report of a fatal marine mammal entanglement incident during a nodal seismic survey in the GOM.

There is a risk of entanglement any time gear, particularly lines and cables, is put in the water. Entanglements of marine mammals in tethered gear are considered accidental and are very unlikely to occur during routine OBC/OBN operations. Authorizations for surveys that use OBNs and OBCs would include guidance for implementing the following best management practices:

(1) shortening the acoustic buoy line and tethered acoustic pinger line to the shortest length practical using only a single line rather than a loop; (2) replacing the line with wire, clasps, or shackles to connect directly to the OBN; (3) maximizing the tension on acoustic buoy release lines; and (4) minimizing the time between release of the acoustic buoy and retrieval. Additional measures include the requirement of a PSO on board each vessel during tethered node retrieval operations. The PSOs will document any entanglement of marine species in the gear, specifically noting the location where entanglement occurred (e.g., pinger tether and acoustic buoy line). The PSO will contact NMFS to report the incident and condition of the marine mammal and will request additional instructions to reduce risk of injury or mortality, including rehabilitation and salvage techniques.

The OBC/OBN (nodal) survey locations and projected levels are not estimated (they are included in the modeling for 3D surveys); however, nodal surveys are relatively uncommon and typically used in shallow waters. Given the scope and limited spatial extent of nodal surveys associated with Alternative A, the rarity of entanglements (only one documented incident), and the implementation of mitigation measures (described earlier), impacts to marine mammals from entanglement during OBC/OBN surveys are expected to be **nominal**.

4.2.2.1.10 Routine Activities Impact Conclusions

This analysis evaluated impacts and considered the impact-level criteria, AOI, and 10-year timeframe. As outlined in **Chapter 2.3** and detailed in **Appendix B**, mitigation measures associated with Alternative A that may reduce impacts to marine mammals include the following:

- guidance for vessel strike avoidance;
- guidance for marine debris awareness;
- avoidance of sensitive benthic resources;
- guidance for shallow hazards survey and reporting;
- regulations for activities in or near NMSs;
- guidance for avoidance of historic and prehistoric sites;
- guidance for military coordination;
- guidance for ancillary activities (Oil and Gas Program only);
- implementation of PSO Program (Oil and Gas Program only); and
- implementation of the Seismic Airgun Survey Protocol.

As discussed previously in routine activities, the degree to which proposed mitigation measures (collectively) will affect or change the levels of impact to marine mammals from each IPF is as follows:

- deep-penetration airgun survey noise – **moderate**;
- HRG airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **minor**;
- vessel and equipment noise – **nominal** to **minor**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris – **nominal**; and
- entanglement – **nominal**.

Impacts to marine mammals from routine activities under Alternative A are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Implementation of mitigation measures described under Alternative A may reduce potential impacts from the IPFs listed above to individuals and groups of marine mammals within the AOI. Impact ratings by IPF were determined using impact-level criteria discussed in **Chapter 4.2.2**, and each impact level was determined by considering effects to marine mammals within the AOI collectively.

4.2.2.2 Impacts of an Accidental Fuel Spill

An accidental fuel spill scenario was evaluated for Alternative A and consisted of the release of 1.2 to 7.1 bbl of diesel fuel from a vessel collision or spillage during at-sea fuel transfer operations (**Chapter 3.3.2**). This volume of spilled fuel is considered a "small diesel spill" by NOAA's Office of Response and Restoration (USDOC, NOAA, 2015b), and characteristics of this type of spill are described in **Chapter 3.3.2**. The likelihood of a fuel spill occurring during G&G surveys or activities was considered remote (**Chapter 4.2.2.3**). Collisions between vessels transiting within State and OCS waters could result in the overboard loss of fuel. It is improbable that an accidental fuel spill would occur within State waters; rather, operations involving vessel transfers, including fuel transfers, would occur on the OCS. However, spilled fuel could drift into State waters. As discussed in **Chapter 3.3.2**, diesel fuel spilled at the ocean surface would readily disperse and weather. Diesel fuel most often is a light, refined petroleum product classified by the API as a Group 1 oil based on its specific gravity and density, and it is not persistent within the marine environment (API, 1999).

When spilled on water, diesel fuel spreads very quickly to a thin sheen, except for marine diesel, which may form a thicker film of dull or dark colors. Because diesel oil is much lighter than water (specific gravity is between 0.83 and 0.88, compared with 1.03 for seawater), it is not possible for the oil to sink and accumulate on the seafloor as pooled or free oil unless adsorption occurs with sediment. However, it is possible for diesel oil dispersed by wave action to form droplets that are small enough be kept in suspension and moved by currents (USDOC, NOAA, 2015b). As diesel spreads on the sea surface, the lighter components of the oil evaporate. The evaporation rate increases in conditions of high winds, sea state, and atmospheric and sea surface temperatures (API, 1999; USDOC, NOAA, 2015b). Small diesel spills (11.9 to 119 bbl) usually evaporate and disperse naturally within a day (USDOC, NOAA, 2015b).

Marine mammals could be affected by spilled diesel fuel. Effects of spilled oil on marine mammals are discussed by Geraci and St. Aubin (1980, 1982, 1985, 1990) as well as Lee and Anderson (2005) and within spill-specific study results (e.g., *Exxon Valdez*; Frost and Lowry, 1994; Paine et al., 1996; Hoover-Miller et al., 2001; Peterson et al., 2003). Quantities of diesel fuel on the sea surface may directly affect marine mammals through various pathways: surface contact of the fuel with skin and mucous membranes of eyes and mouth; inhalation of concentrated petroleum vapors; or ingestion of the fuel (direct ingestion or by the ingestion of oiled prey).

As discussed in **Chapter 3.3.2**, the likelihood of a fuel spill during G&G activities is considered remote, and the potential for contact with and impacts to marine mammals would depend heavily on the size and location of the spill as well as weather and sea conditions at the time of the spill. For this scenario, fuel spilled on the sea surface is assumed to rapidly spread to a thin layer and break into narrow bands or windrows that are aligned parallel to the wind direction. Lighter volatile components of the fuel would evaporate almost completely in a few days. The accidental spill of fuel presumably would occur during a vessel collision or during fuel transfer operations. Seismic support vessels usually transfer fuel to the survey vessel at slow speed or while stopped, so it is reasonable to assume that groups of marine mammals, such as dolphins, would not be attracted to these vessels during fueling operations.

Because of the thickness of the slick and rapid weathering, it is not likely that many animals would come into contact with the fuel on the surface. Potential impacts are assumed to be limited to minor mucous membrane irritation and behavioral alteration (temporary displacement) from the affected area. Spilled fuel, therefore, is expected to result in **nominal** to **minor** impacts to marine mammals within the AOI, depending on the number of individuals coming into contact with the spilled fuel and their exposure time as well as the exposure of federally listed species to the spilled fuel.

The incremental increase of a 1.2- to 7.1-bbl fuel spill as a reasonably foreseeable result of the proposed action to the cumulative scenario is expected to be **nominal**. Potential impacts to marine mammals in the AOI are expected to remain nominal to minor, depending on the number of individuals coming into contact with the spilled fuel and their exposure time. These impacts may affect individuals within OCS and State waters, depending on the location of the spill and local surface circulation patterns.

4.2.2.3 Cumulative Impacts

This analysis considers the incremental contribution from the proposed action to effects on marine mammals when compared to the total effects to marine mammals from the all past, present, and reasonably foreseeable future activities that could cause impacts, i.e., the proposed action in combination with other impact sources such as previously permitted ongoing G&G activities and other activities not associated with Outer Continental Shelf G&G activities, such as Federal and State oil and gas activities and noise from other sources.

4.2.2.3.1 OCS Program G&G Survey Activities

Cumulative G&G survey activities associated with the OCS Program consist of those activities that have been previously permitted and are ongoing. The G&G activity IPFs that are included in this cumulative assessment associated with previously permitted G&G survey activity are the same IPFs as those assessed under routine activities and accidental events' fuel spills presented above in **Chapters 4.2.2.1 and 4.2.2.2**. The impact analyses in **Chapters 4.2.2.1 and 4.2.2.2** state that activities projected to occur under Alternative A would result in **nominal** to **moderate** impacts to marine mammals. Implementation of mitigation measures described under Alternative A may reduce potential impacts from the IPFs listed above to individuals and groups of marine mammals within the AOI. The determination of noise-related impacts to marine mammals was made with the assumption that seismic survey protocols and associated mitigation measures would prevent the lethal take of any marine mammal through noise exposure. The determination of vessel traffic impacts was based on the very low likelihood of vessel strikes on marine mammals. Impacts from previously permitted G&G survey activity routine activities or accidental fuel spills may be greater on individuals or populations already impacted by other OCS or non-OCS oil- and gas-related IPFs. However, within the GOM, there is a long-standing (more than 50 years) and well-developed OCS Program, and there are no data to suggest that activities from the previous OCS Programs are significantly impacting marine mammal populations.

4.2.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. Non-OCS-related activities that may affect marine mammal populations include the Federal and State oil and gas programs, pollution, marine debris, explosive severance of structures, vessel traffic and related noise (e.g., from military operations, commercial shipping, and research vessels), commercial and recreational fishing (**Chapter 3.4.3.2**), scientific research, diseases, UMEs, and natural phenomena. Specific types of IPFs considered in this cumulative analysis include noise from numerous sources, pollution, ingestion and entanglement in non-OCS marine debris, vessel strikes, climate change, and natural events and processes.

Federal and State Oil and Gas Activity

Federal and State oil- and gas-related activities, including transportation, operational discharges, decommissioning, and noise would contribute incrementally to the overall cumulative effects experienced by marine mammal populations. These activities are discussed in more detail below. At the regional, population-level scope of this analysis, impacts from reasonably foreseeable oil and gas routine activities from Federal and State oil and gas activity could be nominal to moderate. More detailed information on Federal oil and gas activities may be found in **Chapters 3.4.1 and 3.4.2**, as well as Chapter 4.9.1 of the 2017-2022 GOM Multisale EIS, which is hereby incorporated by reference.

Accidental, reasonably foreseeable unexpected events as a result of Federal or State oil and gas activity could negatively impact marine mammals and would primarily be the result of oil spills and spill-response activities. The impacts of an oil spill on marine mammals depend on many variables, such as the 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. More detailed information may be found in the **Chapters 3.4.1 and 3.4.2**, as well as Chapter 4.9.1 of the 2017-2022 GOM Multisale EIS, which uses a model to determine the size and probability of a reasonably foreseeable oil spill occurring in the GOM.

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. Impacts from dispersants are unknown but could include nonlethal injury (e.g., tissue irritation and inhalation), long-term exposure through bioaccumulation, and potential shifts in distribution from some habitats (NRC, 2005). More information on Federal and State oil and gas programs, including oil spills, can be found in Chapter 3 of the 2017-2022 GOM Multisale EIS. The incremental increase determination of the proposed action under the cumulative scenario for accidental fuel spills is described in **Chapter 4.2.2.3.3** below.

Noise

Primary sources of noise associated with the cumulative scenario that may impact marine mammals include active acoustic sound sources, vessel and equipment, and aircraft from other activities not associated with the OCS Program. Each source is discussed in separate sections below.

Active Acoustic Sound Sources

Cumulative impacts are assessed in this analysis for the cumulative activities that produce active acoustic sound sources, including oil and gas activities in State waters, commercial fishing, cable installation, military, and scientific research activities (**Table 3.4-1**). Certain program-related activities such as drilling, trenching, pile-driving, and decommissioning are discussed later under vessel and equipment noise because they are not active acoustic sounds, but rather related to equipment.

From the analysis provided in **Chapter 4.2.2.1**, it is expected that surveys using active sound sources would contribute to ambient acoustic noise levels in the northern Gulf of Mexico OCS on a transient and intermittent basis over the 10-year period. No deaths to marine mammals from active acoustic sound source impacts are predicted for this analysis. It is assumed that impacts may include PTS auditory injuries as well as TTS effects, auditory masking, and short-term disruption of behavioral patterns or displacement of individual marine mammals from localized areas within the AOI. Although G&G activities are spatially limited to selected survey areas, some large surveys may take months to complete. The NMFS modeled the impacts of chronic and cumulative noise on marine mammals (**Appendix K**). This modeling sought to account for the known attributes of airgun noise, by which low-frequency energy lost laterally attenuates over large spatial scales with loss of impulsive features, leading to elevated background noise conditions, particularly when multiple surveys are concurrent with an acoustic region. Though the modeling estimated a range of decrease in communication space, with the highest decrease found for low-frequency cetaceans, for marine mammals based on area, species, and sound source, this is a tool to help understand the exposure of acoustic sound relative to other OCS activity and ambient noise.

Oil and gas activities in State waters would produce active acoustic sounds in shelf waters, whereas scientific research, military activities, and commercial fishing activities (using sonar) could contribute active acoustic sound throughout the AOI. In addition, within the southern GOM, beyond the U.S. EEZ (and beyond the boundaries of the AOI), Mexico exploration and development activities occur within several fields offshore Campeche, Tabasco, and Tampico (Index Mundi, 2015; USDOI, GS, 2000); these activities would contribute active acoustic sound sources also. Activities in the cumulative scenario are not expected to overlap spatially with proposed G&G activities; however, temporal overlap may occur. Due to distance, it is assumed that the intensity of active acoustic source sounds associated with the proposed activity entering State waters will be significantly attenuated from source levels, and the effects to marine mammals will range from no observable effect to some behavioral disturbances.

Vessel and Equipment Noise

Cumulative activities associated with vessel and equipment noise are listed in **Table 3.4-1**. Vessel traffic is a major contributor to ambient noise levels within the GOM, particularly in the low-frequency bands (Snyder, 2007). Vessel noise is contributed by all of the cumulative scenario activities (**Table 3.4-1**). As discussed in **Chapter 4.2.2.1**, noise from vessel traffic is generated from vessel propulsion systems and internal machinery (the latter also termed equipment noise), and is the dominant source of underwater noise at frequencies <300 Hz in many areas. **Table 3.3-3** provides the number of estimated vessels required by survey type and Program Area for the proposed action, which includes 19,689 trips for support vessels and 1,008 trips for survey vessels. For cumulative vessel traffic, **Table 3.4-2** provides a summary of projected support vessel operations anticipated for the Oil and Gas Program, and estimates that support vessel trips will range from 828,000 to 1,096,000 for the 10-year span of the cumulative scenario. **Tables 3.4-7 and 3.4-8** provide vessel trip data for all vessels in the GOM. Exact numbers of cumulative vessel traffic associated with renewable energy and marine mineral support activities are not known, but they are expected to be relatively small as well as spatially and temporally limited. Oil and Gas Program support vessel traffic projected in the cumulative scenario is expected to be most concentrated within the WPA and CPA, as would the proposed action vessel traffic. Vessel traffic within the AOI is expected to be somewhat concentrated in lanes and channels near major service centers such as Port Fourchon, Port of Morgan City, and Port of Iberia, Louisiana; and Port of Galveston, Texas (**Figure 3.4-1, Panel B**) (Jayawardana and Hochstein, 2004).

Generally, vessels produce underwater noise (originating from vessel propulsion machinery, hull movement through the water, and other machinery), and potential impacts to marine mammals are expected but are not extensive or severe. Impacts may include disruption of communication or echolocation from auditory masking; behavior disruptions of individual or localized groups of marine mammals; and limited, localized, and short-term displacement of individuals of any species, including strategic stocks, from localized areas around the vessels and equipment. Furthermore, noise from vessels may add to existing ambient conditions, including natural and human-produced sources (e.g., seismic airguns and shipping), and these effects may result in a greater cumulative impact on affected animals. Further, noise from vessels may add to existing ambient level conditions, including natural and human-produced sources (e.g., seismic airguns, shipping), and these effects may result in a greater cumulative impact on affected animals.

Historically, support vessel traffic associated with oil and gas activities within State waters and the OCS originated from several ports inshore of the CPA and WPA. Consequently, noise associated with vessel traffic primarily affected shelf species such as the common bottlenose dolphin, Atlantic spotted dolphin, and manatees (individuals that travelled from Florida into central and western GOM State waters during warmer weather months). Currently, noise-related impacts from oil and gas activities in State waters and other activities in coastal waters are largely limited to these species. As oil and gas exploration and development moved into deepwater environments in the 1960s, exposure to and impacts from noise affected a much larger suite of shelf edge and oceanic species. Today, service activities for deepwater oil and gas operations have been centralized at Port Fourchon, Louisiana, which services approximately 90 percent of all deepwater rigs and platforms in the GOM; therefore, a large percentage of supply, service, and construction vessel traffic associated with oil and gas activities utilizes this port and travels through various shipping lanes that funnel into the port. Consequently, noise produced by these vessels is concentrated within this area.

Waterborne commerce in the GOM relies heavily on regional ports for the import and export of foreign and domestic goods. A survey conducted in 2009 ranked 13 of the top 20 U.S. ports, by tonnage, in the GOM region (including ports in Mississippi, Louisiana, and Texas) (USDOC, NOAA, 2012b). South Louisiana was ranked as the leading port in tonnage in 2009. Also, from this survey, three of the top six commercial fishing ports in the U.S. (by pounds) were in the GOM region (Louisiana and Mississippi) (USDOC, NOAA, 2012b). Spatially, vessel traffic utilizes all areas of the GOM, though levels generally are concentrated within shipping channels near major ports (**Figure 3.4-1, Panel B**). Overall levels of commercial shipping have increased over time, along with vessel-related noise. Past research shows that this increase in shipping worldwide has led to an increase in ambient noise level of 3 to 5 dB per decade. Military use areas in the GOM are shown in **Figure 3.4-1, Panel C**. Military exercises involving one or several vessels may occur within these areas on the continental shelf and deepwater regions; however, specific locations and times cannot be projected. Commercial fishing vessel-related noise may affect marine mammals in all parts of the GOM (Andrew et al., 2002). Overall, when compared with the combined vessel noise within the GOM, a **minor** incremental increase in vessel traffic from G&G operations would be expected.

Sources of equipment noise associated with the cumulative scenario include drilling and production activities, pipeline trenching and placement, decommissioning of offshore structures, pile-driving associated with renewable energy installations, dredging from marine mineral activities, military activities, channel dredging, and coastal restoration activities. Sources of equipment noise from the proposed action include drilling noise from a limited number of test wells and noise from DP and jack-up vessels (**Chapter 3.3.1.2**).

Decommissioning under the cumulative scenario, as described in **Chapter 3.4.1.2**, may utilize explosives for removal. These operations generally are undertaken following lease expiration if the well or facility is no longer economically viable or if the physical condition of the structure becomes unsafe or a navigational hazard. In 2005, MMS (BOEM's predecessor) prepared a Programmatic EA to determine the potential impacts that may result from decommissioning activities related to the explosive and nonexplosive severing of seafloor obstructions (e.g., wellheads, caissons, casing strings, platforms, and mooring devices) and the subsequent salvage and site-clearance operations that may be employed (USDOI, MMS, 2005). Impact mitigation measures for these activities were refined from previous regulations such as those in the *Federal Register* (2002). The MMS determined that impacts to marine mammals from underwater detonations associated with proposed decommissioning activities may injure marine mammals. With specific mitigation measures in place, no deaths or serious injuries were projected, and the Programmatic EA resulted in a Finding of No Significant Impact. The 2005 Programmatic EA is in the process of being updated by BOEM and will serve as the basis for a new Bureau of Safety and Environmental Enforcement MMPA petition to NMFS in support of new rulemaking for decommissioning activities.

The contribution of explosive severance methods to noise in the GOM is projected under the cumulative scenario in **Table 3.4-2**. Most active platforms within the AOI occur on the continental shelf within the CPA and WPA. Consequently, noise associated with explosive removal activities may affect shelf species such as the common bottlenose dolphin and Atlantic spotted dolphin. Temporally, most operators conduct removal projects from June to December (USDOI, MMS, 2005).

Underwater noise-associated impacts to marine mammals from offshore drilling operations are summarized in **Chapter 4.2.2.1**. Drilling noise includes strong tonal components at low frequencies and, in at least some cases, infrasonic frequencies (Richardson et al., 1995; USDOI, MMS, 2000). Other sources of drilling-related sounds include riser rotation, DP thrusters, and ROV operations. Production wells are drilled using mobile offshore drilling units (MODUs); the type of production platform installed (i.e., fixed, floating, or subsea [only in deep water]) will depend on water depth and other factors. As discussed in **Chapter 4.2.2.1**, noise levels from drilling operations vary with the type of drilling rig and water depth.

Other activities included within the cumulative scenario that generate equipment noise include dredging and pile-driving operations. Dredging activities within the northern GOM have occurred for decades. Dredging is projected during dredged material disposal operations (**Chapter 3.4.3.4**), maintenance dredging operations (**Chapter 3.4.3.8**), coastal restoration programs (**Chapter 3.4.3.9**), Mississippi River hydromodification and subsidence operations (**Chapter 3.4.3.10**), renewable energy development (**Chapter 3.4.1.3**), and marine minerals operations (**Chapter 3.4.1.4**). **Figure 3.4-1** shows the spatial distribution of cumulative activities, indicating that most cumulative activities are concentrated in shallow shelf waters. Other equipment noise includes plowing, jetting, or trenching operations conducted during the installation of new submarine cable systems (**Chapter 3.4.3.5**). Dredging activities produce strong levels of continuous sounds (primarily at low frequencies) in coastal and inner shelf waters. Due to the rapid attenuation of low-frequency sound in shallow water, dredge noise usually is undetectable beyond 20 to 25 km (12 to 16 mi) from the source (Richardson et al., 1995).

Pile-driving activities also are likely to occur, including during renewable energy development activities under the cumulative scenario (**Chapter 3.4.1.3**). Underwater pile-driving operations produce extremely high sound levels in the surrounding air and underwater environments that are known to produce deleterious effects on fish and marine mammals (Madsen et al., 2006; Reinhall and Dahl, 2011).

Overall, the minimal level of equipment noise associated with the proposed action (i.e., drilling noise from a limited number of test wells, noise from DP and jack-up vessels) would produce a **nominal** incremental increase in equipment noise impacts to marine mammals under the cumulative scenario.

Aircraft Noise

Aircraft noise in the cumulative scenario is associated with oil and gas exploration and development on the OCS and in State waters, military operations, and scientific research (**Table 3.4-1**). The use of rotary-winged aircraft (helicopters) for offshore oil and gas support operations (as an alternate personnel transportation option) began in the 1950s (American Oil and

Gas Historical Society, 2015). Today, helicopters are used regularlyfor operations within State and OCS waters for a wide variety of tasks.

Impacts to marine mammals from fixed-wing and rotary-wing aircraft traffic and noise associated with the proposed action is described in **Chapter 4.2.2.1**. Under the proposed action, possibly one aeromagnetic survey using fixed-wing aircraft is projected. Projections for helicopter operations supporting G&G activities within the AOI over the 10-year project period are estimated to be a minimum of 7,497 transits (**Table 3.3-3**). The cumulative scenario estimates that 7.2 to 13.9 million helicopter trips would occur over the 10-year period (**Table 3.4-2**) to support oil and gas activities. There are no helicopter operations expected for the Renewable Energy or Marine Minerals Programs because G&G activities would occur close to shore, and only daily trips are expected to occur.

Aeromagnetic surveys are conducted at speeds of approximately 135 kn (155 mph) and at altitudes between 61 and 152 m (200 and 500 ft). Typical operational altitudes for helicopters in the GOM are >229 m (750 ft), except when the aircraft are within the vicinity of platforms. Levels of noise received underwater from passing aircraft depend on the aircraft's altitude, aspect (direction and angle) of the aircraft relative to the receiver, receiver depth, water depth, and seafloor type (Richardson et al., 1995). Because of the relatively high expected airspeeds and these physical variables, aircraft-related noise (including airborne and underwater noise) is expected to be very brief in duration (i.e., few seconds) at any given point. Although projected levels of aircraft noise from G&G operations under the proposed action would increase existing aircraft noise levels within the AOI, this increase is expected to produce a **nominal** incremental increase in impact to marine mammals under the cumulative scenario.

Vessel and Aircraft Traffic

For the purposes of this analysis, it is expected that recent trends showing increases in marine transportation and shipping levels at U.S. Gulf of Mexico coastal ports will continue and that overall vessel traffic within the AOI will increase during the period of interest (Ward-Geiger et al., 2005).

All manner of non-OCS oil- and gas-related 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 2016, approximately 94 percent of human-caused manatee mortalities in Florida were attributed to collisions with watercraft (Florida Fish and Wildlife Conservation Commission, 2016). In addition, the physical presence of vessels and aircraft may disturb individual or groups of marine mammals on or near the sea surface.

As discussed previously, vessel and aircraft traffic associated with Oil and Gas Program activities will originate from selected ports in the CPA and WPA, and will cross State waters to reach fields within the OCS. This discussion of vessel traffic draws from the earlier discussion on vessel noise, with respect to projected and historical Oil and Gas Program vessel traffic levels and other cumulative vessel traffic levels. The physical presence of vessels and aircraft may disturb individual or groups of marine mammals on or near the sea surface. In addition, as discussed in **Chapter 4.2.2.1**, underway vessels could collide with marine mammals, particularly individuals that rest on the sea surface between dives. As discussed in **Chapter 4.2.2.1.6**, ship strikes between vessels and marine mammals are considered accidental and are very unlikely to occur during routine operations.

Table 3.3-3 provides the number of estimated vessels required by survey type and Program Area for the proposed action; it includes 19,689 trips for support vessels and 1,008 trips for survey vessels for cumulative vessel traffic. **Table 3.4-2** provides a summary of projected support vessel operations anticipated for the Oil and Gas Program and estimates that support vessel trips will range from 828,000 to 1,096,000 trips for the 10-year span of the cumulative scenario. **Tables 3.4-7 and 3.4-8** provide vessel trip data for all vessels in the GOM. Exact numbers of cumulative vessel traffic associated with renewable energy and marine mineral support activities are expected to be relatively small as well as spatially and temporally limited, mostly during construction or dredging activities, respectively. Other sources of vessels included in the cumulative scenario are those associated with oil and gas activities in State waters, drilling and production activities (within State and OCS waters), commercial shipping, commercial and recreational fishing, military activities, scientific research, offshore construction activities, maintenance dredging of Federal channels, dredged material disposal, coastal restoration programs, and Mississippi River hydromodification and subsidence issues (**Table 3.4-1**). Vessel traffic data associated with oil and gas activities in State waters were not available for this analysis. Non-OCS Program vessel traffic traveling through the GOM is diverse in vessel type and high in numbers. Available information on commercial vessel traffic (that passes through State waters) from MARAD (**Table 3.4-7**) estimated approximately 27,000 calls in Gulf Coast State ports during 2012. In addition, there were an estimated 309,000 vessel trips recorded by vessels equipped with AIS during 2012 (**Table 3.4-8**). There were approximately 410 to 540 cruise ships departing GOM ports between 2008 and 2011 as well (**Table 3.4-9**). The G&G vessel traffic associated with the proposed action is expected to be concentrated within the WPA and CPA. As vessels pass through State waters, they are expected to be somewhat concentrated in (although not limited to) lanes and channels near major oil and gas service centers such as Port Fourchon, Port of Morgan City, Port of Iberia, and Port of Galveston. Because of the wide distribution of projected vessel activities within the AOI and State waters, it is likely that individuals from all species of marine mammals within the northern GOM may encounter vessel traffic during the 10-year project period. Overall, when compared with cumulative vessel traffic in the GOM, the contribution of G&G vessel traffic to the cumulative scenario is **minor**.

The physical presence of low-flying aircraft can disturb marine mammals, particularly individuals resting on the sea surface. Fixed-wing and rotary-wing (helicopter) aircraft traffic and noise associated with Alternative A are described in **Chapter 4.2.2.1**. For the proposed action, helicopter flights are associated primarily with the installation of the estimated one COST well, airborne and marine gravity surveys, and crew changes during extended deep-penetration seismic airgun surveys. However, as previously described, the helicopter traffic contributed by the proposed action represents 0.1 percent of the cumulative vessel traffic over the 10-year period. All of these operations will originate from heliports along the coast. Other aircraft traffic over the GOM associated with the cumulative scenario includes helicopters associated with oil and gas operations within State waters, survey aircraft near coastal waters, military aircraft, and scientific research (**Table 3.4-1**). Estimates of aircraft traffic were not available for this analysis; however, oil and gas activities are expected to contribute the majority of helicopter traffic in the cumulative scenario (7 to 13 million trips over the 10-year period). Helicopter traffic associated with oil and gas operations in the GOM historically have been concentrated along the continental shelf of the CPA and WPA.

In all cases, helicopters will ascend to service altitudes after takeoff from coastal facilities and maintain altitudes over water until their destination is reached. Typical operational altitudes for helicopters in the GOM are >229 m (750 ft), except when the aircraft are within the vicinity of platforms. Consequently, transits over State and OCS waters likely will only infrequently disturb marine mammals.

Aircraft are not anticipated to affect large numbers of marine mammals, and all interactions are expected to be short term. Projected levels of helicopter traffic from G&G operations under the proposed action would increase existing traffic levels within the AOI. These activities would be concentrated within deepwater areas of the CPA and, to a lesser degree the WPA, because projected G&G activities requiring helicopters (i.e., deep-penetration surveys) are most common there (**Table 3.2-1**). Although projected levels of aircraft traffic from G&G operations under the proposed action would increase existing aircraft traffic levels within the AOI, this increase likely would produce a nominal incremental increase in impact to marine mammals under the cumulative scenario.

Pollution

Discharges and Wastes

Operational waste discharges are generated during offshore oil and gas exploration and development including drilling fluids, drill cuttings, produced water, deck drainage, sanitary wastes, and domestic wastes (refer to Chapter 3.1.5 of the 2017-2022 GOM Multisale EIS). During production activities, additional waste streams include well treatment, workover, and completion fluids. 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).

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). Releases of toxic discharges are regulated by 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 (USDOI, BOEM, 2017a). The impacts from these factors are, therefore, expected to be **nominal** given assumed compliance with existing regulations and permit requirements.

Trash and Debris

Trash and debris (**Chapter 3.3.1.7**) is defined as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally disposed of or abandoned into the marine environment (USDOC, NOAA, 2015a). Derelict nets, ropes, line, or other fishing gear; packing bands; rubber bands; balloon string; six-pack rings; and a variety of other debris can become entangled with marine life, including marine mammals. Marine mammals have been known to ingest trash and debris as well. Entanglement in marine debris can cause decreased swimming ability, disruption in feeding, life-threatening injuries, and death.

Trash and debris may originate from many different activities onshore and offshore. All mariners operating vessels in the GOM are expected to comply with MARPOL 73/78 for management of waste in inland, coastal, and offshore waters (refer to **Chapter 4.2.2.1.8**). Therefore, trash and debris that may be discarded offshore would be only accidental and minimal in volume. However, trash and debris may originate from areas outside of the U.S. and drift into the AOI via local currents. Prior to the development of MARPOL guidelines, as well as USCG and USEPA regulations, it is probable that the volume of trash and debris deliberately discarded into coastal and offshore waters was significant. Overall, discarded trash and debris would result in a **nominal** incremental increase in impact to marine mammals under the cumulative scenario.

Entanglement

Activities associated with the cumulative scenario that may deploy equipment that could pose entanglement risks to marine mammals within the AOI include oil and gas activities in State waters, commercial and recreational fishing, and scientific research. Sources of entanglement include anchors, cables, sensors, fishing gear, or other equipment moored or tethered to the seafloor (permanently or temporarily), as well as any type of line extending from the surface or subsurface to the seafloor. Given the use of the preventive measures, combined with the number of G&G activities in the AOI that involve deployment of line tethered to the seafloor, the incremental increase in the cumulative impacts to marine mammals from seafloor disturbance (i.e., entanglement in lines) during G&G activities are reasonably expected to result in a nominal incremental increase in impacts to marine mammals.

Climate Change

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 (MacLeod, 2009; Evans et al., 2010; Kaschner et al., 2011). Some of the 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). There is also concern that ocean acidification from rising carbon dioxide levels will decrease sound absorption in oceans, thereby causing amplified levels of ambient noise (Gazioglu et al., 2015), which would negatively affect marine mammals. Further, increased sea-surface temperatures likely enhance the magnitude and frequency of harmful algal blooms and their associated toxins, which have shown to negatively impact ecosystem health (O'Neil et al., 2012).

Natural Events and Processes

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. 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.

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).

4.2.2.3.3 Cumulative Impact Conclusions

Based on the analysis of other activities not associated with Outer Continental Shelf G&G activities' impacts discussed in this chapter, the existing baseline conditions, and the proposed action, BOEM has determined that the cumulative effects of all potential impacts to marine mammals are not greatly exacerbated by the proposed action. This determination is justified because the impacts are spread out temporally and spatially in a manner that makes it extremely unlikely that marine mammals will be exposed to multiple stressors simultaneously or sequentially in a manner that would reduce their individual fitness, survival, or reproductive success, or in a manner that would result in an appreciable change in population growth rates.

Activities associated with the proposed action would increase levels of noise and vessel and aircraft traffic within the AOI, resulting in sporadic increases in ambient noise levels during proposed G&G operations. Noise levels of some operations could exceed Level A and Level B harassment thresholds resulting in PTS, TTS, or behavioral changes in marine mammals. Sources of noise associated with the cumulative scenario that may affect marine mammals in the AOI include active acoustic sound, vessel and equipment, and aircraft. Contributions to ambient noise levels associated with two non-seismic sources of sound in the GOM region (i.e., wind and waves and commercial vessel traffic) were considered in modeling of non-action conditions in a chronic effects study (refer to **Appendix K**). Other IPFs that may affect marine mammals include vessel and aircraft traffic, trash and debris, entanglement, and an accidental fuel spill. Many of these IPFs may occur simultaneously during some projected operations under the OCS Program. For example, during deep-penetration seismic airgun, shallow-penetration seismic airgun, and non-airgun HRG survey operations, the IPFs such as active acoustic sound, vessel and equipment noise, vessel traffic, and aircraft noise and traffic (during some survey activities) will occur together. Entanglement of marine mammals in OBC/OBN surveys and the release of trash and debris or fuel into offshore waters are not routine and, therefore, represent accidental occurrences during the 10-year project period.

The spatial distribution of activities projected under the proposed action during the project period are most concentrated within deepwater regions of the CPA and WPA and are less concentrated within continental shelf waters (**Table 3.2-1**). Very little activity is projected to occur within the EPA. Temporally, activity levels associated with the proposed action vary by activity type and year (**Tables 3.2-1 through 3.2-5**). From this analysis, impacts to marine mammals from proposed routine activities include moderate impacts (from active acoustic sound associated with deep-penetration seismic airgun surveys), minor impacts (from active acoustic sound associated with shallow-penetration airgun and non-airgun HRG surveys, as well as vessel and equipment noise), and nominal impacts (from vessel, equipment, and aircraft noise; vessel and aircraft traffic; trash and debris; and entanglement).

The contribution of active acoustic sound under the proposed action to ambient noise levels in the GOM is moderate, specifically within the CPA and WPA. Because these operations may occur within continental shelf and slope waters, individuals from all cetacean species that occur within the AOI may be affected by proposed operations during the 10-year project period. The contribution of project-related vessel and aircraft noise and traffic to the GOM is nominal in all planning areas based on current levels of similar (non-OCS) sources, such as oil and gas activities in State waters and waters of the southern GOM, commercial shipping, commercial and recreational fishing, and military activities throughout the GOM. Although operations associated with the OCS Program are limited to waters of the OCS, there are some IPFs that may occur within adjacent State waters. For example, survey vessels and aircraft will transit through State waters while travelling to and from coastal ports and heliports, and related IPFs (noise and physical presence issues) may impact marine mammals within these waters. In addition, if projected OCS surveys occur near State water boundaries, noise from active acoustic sound sources (primarily deep-penetration seismic airguns) may travel into State waters and impact individual or groups of marine mammals.

Based on the assumption that all operators engaged in OCS Program activities will adhere to current regulations and guidelines regarding the disposal of wastes in the marine environment (**Chapter 4.2.2.1**), potential impacts to marine mammals from entanglement and the release of trash and debris during proposed OCS operations is nominal, and the contribution of this IPF to ambient conditions in the GOM is nominal. Impacts to marine mammals from a potential accidental fuel spill, which are discussed in Alternative A, are described in **Chapter 4.2.2.3** as nominal to minor based on the type (diesel fuel) and volume (small spill classification) of the spill. No information was provided on the location of the accidental fuel spill or season when the accidental spill may occur (**Chapter 4.2.2.2**). The fuel spill presumably would occur within open-ocean conditions of the OCS. Although individuals from all cetacean species that occur within the AOI may encounter the spilled fuel, the fuel likely would rapidly spread and weather, and impacts are nominal to minor. The contribution of impacts from a projected spill to ambient conditions within the GOM is nominal.

When compared with past levels of activities within the GOM, proposed activities do not represent a significant incremental increase to activities under the cumulative scenario. Surveys utilizing active acoustic sound sources have occurred within the GOM for decades, including in State waters and continental shelf and deepwater regions of the OCS. Commercial, military, and recreational vessel traffic has also occurred in the GOM, including the AOI, for many years. In some cases, such as large commercial vessels, traffic is and has been more concentrated along Gulfwide shipping lanes that funnel into major coastal ports. Commercial and recreational fishing vessels have utilized broad areas of the northern GOM, but primarily on the continental shelf and shelf edge. Military vessels are assumed to have traveled through all areas of the GOM, though most, if not all, exercises probably have occurred within the U.S. Navy GOMEX Range Complex OPAREAs, including Panama City, Pensacola, New Orleans, and Corpus Christi (Atlantic Fleet Training and Testing, 2015). Vessel traffic associated with the proposed activity will occur. The projected accidental fuel spill associated with the proposed activity is relatively small and impacts to marine mammals are nominal to minor. When compared with past spill events, the contribution of this projected spill is nominal.

In conclusion, activities associated with Alternative A are more concentrated within deepwater regions of the CPA and WPA, and less concentrated on the continental shelf of these planning areas. In addition, projected levels of activities will vary over the 10-year project period. Combined, the cumulative impacts of Outer Continental Shelf G&G-related operations under Alternative A would be **nominal** to **moderate** to the population, as there could be extensive impacts to marine mammals. The cumulative impacts on marine mammals from all ongoing and reasonably foreseeable future activities in the GOM are expected to be **nominal** to **major**, as described in **Chapter 4.2.2.3.2** above. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which marine mammals could be subject to G&G activity. The relative extent of Outer Continental Shelf G&G activities is considered a stressor to marine mammals in the GOM (especially with respect to low-frequency baleen whales). However, because there is only one species of baleen whale that commonly occurs in the EPA and because the anticipated level of G&G activities in the EPA is low (partly due to the current moratorium), the incremental contribution of the proposed action under Alternative A is expected to be **nominal** to **minor** when considered in the context of cumulative impacts to marine mammal populations. When taking into consideration the breadth of science that has analyzed the impacts of anthropogenic activities to marine mammal populations, impacts from commercial and recreational fishing gear appear to be more conclusively influential on marine mammals than the proposed G&G activities and would still occur without the presence of the proposed G&G activities. Regardless, the incremental impact of a proposed action on marine mammal populations would be **nominal** to **minor**.

4.2.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.2.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on marine mammals. Additional mitigation measures include seasonal seismic restrictions in Federal coastal waters of the GOM, which would temporarily minimize the potential for impacts from active acoustic sources, vessel equipment, and aircraft noise and vessel traffic on individual members of the BSE stocks during their calving season as well as coastal stocks of common bottlenose dolphins, Atlantic spotted dolphins, and individual manatees that may occur in Federal coastal and inshore waters.

4.2.3.1 Impacts of Routine Activities

4.2.3.1.1 Coastal Waters Seasonal Restrictions

Alternative B includes a seasonal restriction on deep-penetration seismic airgun surveys from (1) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath) and (2) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the UME in the northern GOM (**Figure 2.2-1 and Chapter 2.4.3**). No airgun surveys would be authorized within the closure area during these timeframes. This coastal seasonal restriction is designed to protect northern Gulf of Mexico BSE stocks (as well as some coastal stocks) of the common bottlenose dolphin during the time of their reproductive activity peak (**Appendix E, Section 2**). The 32 BSE stocks are listed in **Table 4.2-2**, and their relative distributions along the Gulf Coast are shown in **Figure 4.2-4**. Eleven, year-round BIAs have been within selected bays, estuaries, and sounds that support small and resident populations of BSE common bottlenose dolphins along the Gulf Coast (LaBrecque et al., 2015). Residency patterns of BSE dolphins in the GOM range from transient to seasonally migratory to stable resident communities (LaBrecque et al., 2015). Only the BSE dolphins are known to have small and resident populations that fulfill BIA criteria. In addition, areas in Louisiana, Mississippi, Alabama, and the western Florida Panhandle have been impacted by a

UME of unprecedented size and duration (began February 1, 2010, and closed May 26, 2016) (USDOC, NMFS, 2017).

The seasonal restriction on airgun surveys in Federal coastal waters under Alternative B would temporarily minimize the potential for impacts from active acoustic sound sources; vessel, equipment, and aircraft noise; and vessel traffic on individual members of BSE stocks of common bottlenose dolphins during their calving season, as well as coastal stocks of common bottlenose dolphins, Atlantic spotted dolphins, and individual manatees that may occur in Federal coastal and inshore waters (embayments and estuaries). Geological surveys and non-airgun HRG surveys still would be permitted or authorized within the seasonal restriction area. Thus, this seasonal restriction mitigation measure would not alter the effects from non-airgun HRG or geological surveys, trash and debris, or entanglement that are reasonably foreseeable under Alternative B; therefore, these IPFs are not repeated in this chapter, and the impact analysis for these IPFs are incorporated by reference from Alternative A.

The seasonal restriction of Federal coastal waters to seismic airgun surveys would reduce potential auditory impacts to individual dolphins, manatees, and any other potentially occurring marine mammals within these waters. Overall, the auditory impacts on coastal marine mammals on an annual basis in the seasonal restricted area of the AOI are unlikely to be significantly affected by the implementation of this mitigation measure because the annual number of airgun surveys will not be reduced in coastal waters and, thus, the associated auditory impact level on each species would not be reduced. The key positive benefit associated with this mitigation measure is the removal of a level of environmental stress during a biologically critical period when many BSE and coastal common bottlenose dolphins are reproducing (calving). This protection of their reproductive (calving) environment provides fitness-level consequences to individuals and populations of the potentially occurring coastal species, resulting in a higher probability of success in the reproduction and survival of each species.

Although this measure would not affect (protect) individuals outside the coastal restriction area, it would provide a degree of protection to all marine mammals that may occur within the closure area within the corresponding time-periods and increase the fitness values of the reproducing species (i.e., common bottlenose dolphins, manatees, and Atlantic spotted dolphins), which promotes the survival and reproductive success of the populations as a whole. Because this programmatic analysis considers all survey activities across the AOI and over a 10-year period, and assigns a single impact-level determination for all marine mammals within the AOI, collectively, for each IPF, it is expected that the coastal waters' seasonal restrictions will not reduce the overall impact level discussed in Alternative A (**moderate**) for all marine mammals in the AOI from seismic airgun activities.

The seasonal restriction for Federal coastal waters under Alternative B would not only reduce the number of airgun surveys in the seasonal coastal restriction area but also reduce project-related seismic survey vessel traffic and associated vessel and equipment noise in these restricted coastal areas within the corresponding timeframes. The seasonal coastal restriction is unlikely to affect the total level of survey effort because the survey effort may shift to seasons in which the coastal areas are available for exploration and would likely survey outside these areas during the closed seasons. As discussed in Alternative A (**Chapter 4.2.2.1**), impacts of vessel traffic and noise on marine mammals are expected to be **nominal** to **moderate** (if a collision occurred) and **nominal** to **minor**, respectively. This mitigation measure effectively would remove possible vessel disturbance and vessel strike of marine mammals within the restricted area between January 1 and April 30. However, this mitigation measure only affects marine mammals in Federal coastal waters; the overall reduction in the number of surveys or line miles surveyed during the period of seasonal restriction is not sufficient to reduce the overall impact levels of vessel traffic and noise from Alternative A to all marine mammal species in the AOI. Vessels associated with proposed activities are relatively few in number, are transient within the AOI, and travel at relatively slow speeds. Although individual marine mammals within Federal coastal waters of the AOI likely have been exposed to the sounds and physical presence of recreational and commercial vessel traffic (including oil and gas support vessels), particularly in shipping lanes and near populated areas, whether these prior exposures have resulted in animals being less affected (or reactive) to these sound sources is unknown.

The additional seasonal restriction for Federal coastal waters under Alternative B would not affect scheduling of the potential aeromagnetic survey or the drilling of two shallow test wells and a COST well within the AOI. Support helicopters used for seismic airgun surveys; however, would only transit at operational altitudes in these areas during the season closure time-periods.

As in the case of vessel traffic, individual marine mammals within Federal coastal waters of the AOI likely have been exposed to the sound and physical presence of fixed-wing aircraft and helicopter traffic within the AOI, particularly over inner shelf and coastal waters. However, as with vessel traffic and noise, whether these prior exposures have resulted in animals being less affected (or reactive) to these sound sources is unknown. Impacts to marine mammals from aircraft traffic and noise are expected to remain unchanged from those detailed in Alternative A and would be **nominal** with the seasonal restriction under Alternative B.

4.2.3.1.2 Expanded PSO Program

Under Alternative A, all authorizations for seismic airgun surveys in depths >200 m (656 ft) in the WPA and CPA and in all water depths in the EPA would include the Seismic Airgun Survey Protocol, which specifies mitigation measures for protected species, including ramp-up requirements, an exclusion zone, shutdown requirements, visual monitoring by PSOs, and PAM. For Alternative B, the required use of PSOs and exclusion zone monitoring is expanded to include all water depths throughout the AOI. The expanded PSO Program under Alternative B will also require that all airguns shut down any time a specified “whale” species (including Bryde’s whale, beaked whales, sperm whale, and dwarf and pygmy sperm whales) or manatee is detected entering or is within the exclusion zone in all water depths of the AOI.

Implementation of these operational mitigation measures (i.e., ramp-up requirements, an exclusion zone, shutdown requirements, visual monitoring by PSOs, and PAM) during deep-penetration seismic airgun survey activities may reduce but not eliminate possible injurious exposures (i.e., PTS injuries) to marine mammals because the likelihood of their exposures to impact-producing sound levels would decrease. The effectiveness of these mitigation measures is uncertain; however, reviews of PSO reports from the GOM (Barkaszi et al., 2012) support their success. Manatees may occur within OCS waters, though it is uncommon, as past sightings of this species within the GOM generally have been restricted to coastal waters (Fertl et al., 2005). Furthermore, based on sightings data (as discussed in **Chapter 4.2.1 and Appendix E, Section 2**), whale species selected in Alternative B for shutdown protection are more likely to occur along the continental shelf edge and within deeper waters of the continental slope than on the continental shelf. Therefore, the expansion of shutdown protocols to continental shelf waters of the OCS is not likely to significantly reduce potential injurious exposures to these species.

Expansion of the PSO Program, exclusion zone monitoring (pre-survey search protocols), and sound source ramp-up procedures within continental shelf waters of the AOI may reduce potential injurious exposures to cetaceans that occur within these habitats. These mitigation measures, however, are not likely to significantly reduce behavioral responses, including Level B harassment, of marine mammals. Based on the uncertainties of the effectiveness of these mitigation measures, particularly during nighttime operations as well as periods of poor visibility and inclement weather, and the distributions of protected species listed for added protection in Alternative B, impacts to marine mammals within the AOI from deep-penetration seismic airgun survey noise would not change from that detailed for Alternative A (**moderate**).

The expansion of the requirements for use of PSOs and exclusion zone monitoring in all water depths throughout the AOI and the slow speeds of G&G survey vessels may further protect marine mammals from vessel collisions due to the increase in visual observer effort. However, cetacean species that are regular inhabitants of shelf waters in the GOM include two dolphin species (i.e., common bottlenose dolphin and Atlantic spotted dolphin) that are agile swimmers known to approach moving and stationary vessels. Manatees may receive some additional protection from the added PSO effort, particularly in areas on the continental shelf. The implementation of this mitigation measure under Alternative B would not affect the level of impacts to marine mammals overall within the AOI from vessel collisions as described in Alternative A (**nominal** to **moderate** [if a collision occurred]). The expansion of the PSO Program under Alternative B will include the same mitigation for manatees as provided for specific whale species (Bryde's, beaked, sperm, or dwarf and pygmy sperm whales) and will apply to all deep-penetration seismic airgun surveys in the GOM regardless of water depth (**Chapter 2.4; Appendix B, Section 1.3.2**). Under Alternative B, these mitigation measures (including a shutdown provision) would be expanded into water depths <200 m. Specifically, all airguns would be shut down any time a whale (i.e., Bryde's, beaked, sperm, or dwarf and pygmy sperm whales) or manatee is detected entering or within the established exclusion zone, and, as it is in Alternative A, ramp-up of airguns and recommencement of seismic activities may occur only when the exclusion zone has been visually inspected for at least 30 minutes to ensure the absence of all marine mammals and sea turtles.

Implementation of an expanded PSO Program under Alternative B would reduce the potential for impacts to marine mammals (and sea turtles) from exposure to active acoustic sound sources within the AOI. This preventive measure would apply to all deep-penetration seismic airgun surveys regardless of water depth, resulting in a shutdown of the seismic source and reduced exposure of whale species (Bryde's, beaked, sperm, or dwarf and pygmy sperm whales) or manatees within the exclusion zone. Inclusion of the expanded PSO Program is expected to provide protection for the target whale species (Bryde's, beaked, sperm, or dwarf and pygmy sperm whales) and manatees in addition to the other regularly occurring GOM marine mammal species. Continued implementation of the exclusion zone shutdown measure likely would reduce the localized impacts to all potentially occurring marine mammal species from exposure to the deep-penetration seismic airgun surveys. The potential for impacts to manatees from exposure to airgun noise would be limited to operations conducted in shallower continental shelf or nearshore waters where the species is most likely to occur. Adherence to protocols specified in the expanded PSO Program (**Appendix B, Section 1.3.2**) would likely reduce localized acoustic impacts (primarily behavioral disturbances) to manatees potentially occurring in the survey area only. However, while likely providing localized reduction in sound exposure and associated impacts, those reductions in exposure are not sufficient to alter the overall impacts to marine mammals, including whales (Bryde's, beaked, sperm, or dwarf and pygmy sperm whales) and manatees, throughout the entire AOI from exposure to deep-penetration seismic airgun surveys, and thus, the impact level would not change from that of Alternative A (**moderate**). Implementation of this mitigation measure is not relevant to other IPFs such as vessel and equipment noise, aircraft traffic and noise, trash and debris, and entanglement; therefore, these IPFs will not be discussed further in this marine mammal impact analysis.

4.2.3.1.3 Minimum Separation Distances

Under Alternative B, when operating in the Areas of Concern (**Figure 2.2-1**), simultaneous deep-penetration seismic airgun surveys (separate surveys) must maintain a separation distance of 40 km (25 mi) between active sound sources (airgun arrays). When outside the Areas of Concern, the separation distance would be 30 km (19 mi). This separation requirement does not apply to multiple ships operating in a coordinated survey, such as a WAZ survey, and need not be maintained if unsafe or due to weather conditions.

This measure was designed to mitigate possible effects of multiple man-made underwater sounds from multiple seismic operations on marine mammals, including the effects of interacting and repeated sounds. This mitigation measure, however, would not affect potential impacts from other IPFs such as fixed-wing aircraft noise (during aeromagnetic surveys), drilling noise, trash and debris, and entanglement, as discussed in Alternative A (**Chapter 4.2.2.1**). These IPFs are not discussed further in this chapter.

The separation distance between surveys may be modified based on newly available information and in consideration of any other surveys requested or authorized to operate concurrently. For example, new information suggests that, in some circumstances, airgun noise can be detected at great distances from the sound source, such as across ocean basins (Nieukirk et al., 2012), yet it is unknown if detection of sound at these distances has any effect on marine species. Therefore, BOEM would consider the value of this approach at the site-specific NEPA and environmental analysis level, and with review of new information. Subsequent evaluations also would consider any potential aggregate effects from existing permitted surveys.

Implementing minimum separation distances between concurrent seismic airgun surveys under Alternative B could change the timing of these surveys in certain areas. The specific geographic locations cannot be predicted in advance and would depend on the schedule, planned coverage of individual surveys, and ports to be used for support activities. Under Alternative B and the execution of survey separation distances in certain areas (e.g., Areas of Concern), possible localized decreases in impacts to potentially occurring marine mammals may result as exposure to sound levels are minimized. However, as detailed in **Chapter 2.14.2**, the efficacy of this mitigation measure is not certain due to the complexity of how sound propagates in varying environmental conditions. As discussed under Alternative A (**Chapter 4.2.2.1**), impacts to marine mammals in the AOI from airgun sound sources are estimated to be **moderate**, and this impact level for all marine mammals within the AOI is expected to remain unchanged by implementing this mitigation measure under Alternative B.

Impacts from vessel traffic and the associated vessel and equipment noise are expected to range from **nominal** to **moderate** (if a collision occurred) and **nominal** to **minor**, respectively. Limits, such as maintaining minimum separating distances, on concurrent seismic airgun surveys within the Areas of Concern or other areas or changes in survey timing due to these imposed limits would not alter the overall impacts from active acoustic sound sources, vessel traffic, vessel and equipment noise, or aircraft traffic and noise on marine mammals in the AOI under Alternative B because the effects of this mitigation measure are of limited geographic scope and would not affect all marine mammals throughout the AOI.

4.2.3.1.4 Seismic Restrictions in the Areas of Concern within the EPA

Additional restrictions under Alternative B include the year-round prohibition of deep-penetration seismic airgun surveys within the portion of the Areas of Concern falling within the EPA (**Figure 2.2-1** [portions of Areas 2 and 3, and all of Area 4]) due to the biological importance of these waters to certain species of marine animals (e.g., Bryde's whales). This restriction does not apply to currently leased blocks, any portion of the area encompassed by EPA Lease Sale 226, or OCS lease blocks adjacent to permitted survey areas but within an otherwise off-limit area. This mitigation measure may affect potential impacts to marine mammals from deep-penetration seismic airgun surveys as well as survey-related vessel and aircraft noise. This measure would not affect ratings of impacts from other IPFs such as HRG airgun and electromechanical sound source surveys (**minor**), fixed-wing aircraft noise (during aeromagnetic surveys) (**nominal** to **minor**), drilling noise (**minor**), trash and debris (**nominal**), and entanglement (**nominal**) as discussed in Alternative A (**Chapter 4.2.2**), as the year-round prohibition only applies to deep-penetration seismic airgun surveys. Because the HRG airgun, electromechanical sound, and aeromagnetic surveys still would occur unabated and because this mitigation measure would not affect the amount of drilling noise or trash/debris produced in the AOI, there could be no effect from this mitigation measure in the EPA to the impacts from other IPFs. For this reason, these IPFs are not discussed further in this chapter.

The restriction of seismic airgun surveys within Area of Concern 2 may afford additional protection to the small population of geographically and genetically distinct Bryde's whales in the GOM (Rosel and Wilcox, 2014), as their exposure to sound-producing impact factors will be lessened. However, indirect impacts of sound from surveys in adjacent areas traveling into Area of Concern 2 may affect Bryde's whales and their associated prey to a degree. As discussed in **Appendix E, Section 2**, Bryde's whales found in the northern GOM represent a resident stock that is under consideration for ESA listing. The waters offshore of western Florida and the Florida Panhandle shoreward of the 20-m (66-ft) isobath and a 5-km (3.1-mi) buffer extending seaward from the 20-m (66-ft) isobath (Settlement Area of Concern 3) provide diverse shallow-water habitats for multiple resources such as marine mammals, sea turtles, fishes, and sensitive benthic habitats. This seasonal restriction area will provide protection not only to numerous BIAs, but also potentially occurring BSE stocks of common bottlenose dolphins, individual coastal stocks common bottlenose dolphins and Atlantic spotted dolphins, and manatees in these waters.

Area of Concern 4 is an area west of the Florida Keys and Tortugas, bounded by the 200-m (656-ft) isobath to the north, the 24° N. latitude line to the south, the 83°30' W. longitude to the west, and the 81°30' W. longitude line to the east (**Figure 2.2-1**). Beaked whale and sperm whale numbers may be very dense in this area; therefore, protection will be afforded to those species located within the Area of Concern 4.

Seismic survey restrictions under Alternative B may provide additional protection to potentially occurring marine mammals within the restricted areas from IPFs associated with deep-penetration seismic airgun surveys. One of the positive effects of this mitigation measure, reduced exposure to potentially impactful sound fields, would be significant for Bryde's whales in the AOI (Area of Concern 2), individual marine mammals that move through the inner shelf waters within the coastal restriction area (particularly manatees and individuals from coastal and BSE stocks of common bottlenose dolphins), and individual beaked whales and sperm whales within Area of Concern 4, in addition to all other regionally occurring marine mammals. The designated closure areas represent key habitats for the designated species or stocks. Although deep-penetration seismic airgun surveys still may occur outside the closure areas and expose individuals occurring outside these areas, the implementation of closures likely would afford important protections to key habitat areas and biological behaviors (e.g., calving grounds). Therefore, overall impacts to marine mammals at the stock level from the IPFs associated with active acoustic sources (deep-penetration seismic airgun surveys) are expected to be reduced from the impacts listed in Alternative A (**moderate**). Additionally, although there are restrictions for deep-penetration seismic airgun surveys in the Areas of Concern waters of the EPA, other types of surveys may occur in these waters where Bryde's whales reside, meaning that Bryde's whales still may be exposed to other active acoustic source transmissions. Restrictions in Area of Concern 2 may reduce potential impacts for the Bryde's whale, as the restrictions in this area presumably would prevent or reduce injurious (Level A) and behavioral or TTS (Level B) harassment associated with exposure to deep-penetration seismic sources.

4.2.3.1.5 Use of PAM Required

Alternative B specifies the required use of PAM for all seismic surveys occurring during periods of reduced visibility (as detailed in **Appendix B, Section 1.3.5**) in GOM areas with water depths >100 m (328 ft) to detect vocalizing marine mammals. This is in contrast to Alternative A, in which the use of PAM is optional. The mitigation measure was stipulated to reduce impacts to marine mammals from active acoustic sound sources. The use of PAM allows operators to ramp-up sound sources and start or resume a seismic survey during times of reduced visibility (e.g., darkness, fog, rain) in water depths >100 m (328 ft) if no marine mammals are detected. The use of PAM prior to and during seismic surveys may assist or improve the detection of vocalizing marine mammals within the 180-dB rms (Level A) exclusion zone, particularly under conditions when visual monitoring is not possible. During times of reduced visibility, PAM is an effective protective measure for marine mammals relative to underwater sound IPFs such as active acoustic sources because marine mammals can be detected even when submerged, so long as the animals are vocalizing. Because the overall effect of this measure is that seismic surveys can occur at night or other times when visibility is reduced after PAM has indicated no marine mammals are present, this measure would have no effect or relevance to IPFs such as aircraft traffic and noise, trash and debris, or entanglement; therefore, these IPFs are not discussed further in this chapter. The required use of PAM under Alternative B may affect the vessel traffic or noise IPF because more vessels could be operating at night or during other periods of reduced visibility than would otherwise occur. Thus, under this measure, the impact on vessel traffic and noise may increase in limited areas of the AOI, but the overall impact to marine mammals in the AOI would be unchanged.

An overview of PAM systems may be found in **Chapter 2.14.5**, and information about the effectiveness of acoustic and visual mitigation may be found in **Chapter 2.13**. Because existing PAM systems were not designed specifically for monitoring and mitigation for offshore industrial application, no single technical approach can satisfy all or even most of the marine mammal monitoring and mitigation requirements of the offshore industry; therefore, an integrated approach is necessary. Additionally, PAM systems are unable to simultaneously listen to all species in an area due to the wide range of frequencies of marine mammal vocalizations. The effectiveness of PAM depends on the ability to properly identify species-specific vocalizations in the presence of ambient noise and other noise sources (Ward et al., 2011). In their overview of PAM techniques, Mellinger et al. (2007) noted that acoustic surveys detect 1 to 10 times as many cetacean groups as visual surveys. Although the technology for detecting and locating underwater sounds and their sources in general is well developed, hardware and software systems using passive acoustics specifically designed to locate and track marine mammals as mitigation integrated with seismic airguns are relatively new and have only been commercially available since approximately 2011 (Azem et al., 2011).

As discussed in **Chapter 4.2.2.1** under Alternative A, potential impacts to marine mammals from active acoustic sources are rated as **moderate**, assuming the possibility of some acoustic injury (PTS) in low enough numbers such that the continued viability of the local population or stock is not threatened and the annual rates of recruitment or survival of the local population or stock are not seriously affected. The implementation of PAM during seismic surveys within the AOI under Alternative B could reduce impacts to marine mammals. Although the success of towed PAM as a mitigation tool during seismic surveys is proven, studies point out that, because PAM systems only detect marine mammals that are vocalizing, PAM is not 100 percent effective at detecting all marine mammals that may enter project-specific “acoustic zones of hearing loss, discomfort, or injury” Richardson et al. (1995). Consequently, some individual or groups of cetaceans may experience PTS injuries during surveys conducted within the AOI during the project duration as PAM may not detect all marine mammals in the localized area. It is assumed that PAM surveys would not prevent temporary behavioral alterations, such as displacement of individuals from areas of ensonification. While the use of PAM prior to ramp-up or initiation of seismic surveys during reduced visibility periods would decrease impacts to a portion of any potentially occurring marine mammals in the surveyed area, not all marine mammals may be detected. Even in a localized area, a decrease in potential impacts associated with exposure to active acoustic sources for all potentially occurring marine mammals would not be assured by use of PAM. Therefore, protection provided to marine mammals under Alternative B with the required use of PAM during periods of reduced visibility would not change the impact on all marine mammals within the AOI or alter the overall impact level associated with exposure to airgun sound sources. In addition, the required use of PAM would not alter the overall impact level from the IPFs listed for Alternative A (**moderate**).

4.2.3.1.6 Routine Activities Impact Conclusions

Under Alternative B, G&G activities would include implementation of existing mitigation requirements discussed under Alternative A as well as the following mitigation measure requirements outlined in the Settlement Agreement for Civil Action No. 2:10-cv-01882 dated June 25, 2013 (**Appendices B and C; Figure 2.2-1**):

- required use of PAM for all seismic surveys occurring during periods of reduced visibility in areas with water depths >100 m (328 ft);
- seasonal restriction for airgun surveys in Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath and a 5-km (3.1-mi) buffer extending seaward from the 20-m (66-ft) isobath between January 1 and April 30;
- expanded PSO Program to include same mitigation for manatees as provided for whales for all water depths;
- a 40-km (25-mi) separation distance between simultaneously operating deep-penetration seismic airgun surveys within designated closure areas (Areas of Concern);

- a 30-km (19-mi) separation distance between simultaneously operating deep-penetration seismic airgun surveys outside of the Areas of Concern
- year-round prohibition of deep-penetration seismic airgun surveys in the portion of Areas of Concern falling within the EPA; and
- implementation of the Seismic Airgun Survey Protocol.

As discussed in **Chapter 4.2.3.1**, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to marine mammals from each project-related IPF (including routine activities and accidental fuel spill) is as follows:

- deep-penetration airgun survey noise – **moderate**;
- HRG airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **minor**;
- vessel and equipment noise – **nominal** to **minor**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris – **nominal**; and
- entanglement – **nominal**.

Impacts to marine mammals from routine activities under Alternative B are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Overall, the mitigation measures described under Alternative B may reduce potential impacts from the IPFs listed earlier to individual and groups of marine mammals within the AOI (**Table 2.13-2**). These measures may significantly reduce impacts from certain IPFs (e.g., seismic airgun noise) to selected management stocks of marine mammals within the GOM (e.g., Bryde's whale and sperm whale). Research is limited as to the extent to which these measures would reduce impacts, but these areas are known to have higher aggregations of each of these species. While there may be localized benefits from additional mitigation measures, overall impact ratings by IPF for all marine mammal species across the AOI over a 10-year period would remain the same as Alternative A.

4.2.3.2 Impacts of an Accidental Fuel Spill

Under Alternative B, impacts of an accidental fuel spill on marine mammals would be very similar to those analyzed in **Chapter 4.2.2.2** for Alternative A. The analysis concluded that a small spill at the sea surface would result in **nominal** to **minor** impacts, depending on the number of individuals adversely affected by the spilled fuel and the exposure of federally listed species to the spilled fuel.

Alternative B would change the timing of certain surveys because of seasonal restrictions and limits on concurrent seismic airgun surveys. Additionally, certain surveys would not be allowed within portions of the EPA. Spills from survey and support vessels could occur outside the closure area, and spills from other survey type vessels could occur during the closure period or in the EPA depending on the frequency of the HRG source used. A change in survey timing or type because of limits on concurrent seismic airgun surveys or on survey type would not substantially change the risk of a small fuel spill in the long term. Therefore, the risk of a small fuel spill and its potential impacts on marine mammals within the AOI would be the same as under Alternative A (**nominal** to **minor**), depending on the numbers of individuals adversely affected by the spilled fuel.

4.2.3.3 Cumulative Impacts

4.2.3.3.1 OCS Program G&G Survey Activities

The G&G activities have been ongoing in the GOM for at least the past 30 years, and it is reasonable to assume requests to conduct such activities will continue into the future; however, for the purpose of this Programmatic EIS, the cumulative analysis assesses a 10-year timeframe to coincide with the proposed action because it is expected that most impacts from G&G activities will be of short duration and limited to the time period of the active survey.

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for marine mammals are compared with IPFs from each of the cumulative scenario components in order to focus this cumulative analysis on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The G&G activity IPFs included in the cumulative assessment are the same as those assessed under routine activities and an accidental fuel spill. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI. Impact analyses presented in **Chapters 4.2.3.1 and 4.2.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** to **moderate** impacts to marine mammals, depending on the IPF.

Mitigation measures for the proposed action under Alternative B are described in **Chapter 2.4** and summarized in **Chapter 4.2.3.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.2.3.3**).

Mitigation measures under Alternative B would not change the extent of most activities in the proposed action. Minimum separation distances between concurrent surveys, however, may reduce the potential severity of ensonification from multiple seismic survey sound sources within discrete areas of the AOI. Areas selected for closure from deep-penetration seismic airgun survey activities were designed to focus on mitigation of deep-penetration seismic impacts to a single species or select group of species. Mitigation measures under Alternative B that would change the timing and extent of activities in the proposed action include a seasonal restriction for operating airguns in Federal coastal waters, which was designed to protect coastal stocks of the common bottlenose dolphin during their reproductive peak.

4.2.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.13.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.13.2.3.2**) would remain the same under Alternative B.

4.2.3.3.3 Cumulative Impact Conclusions

The cumulative impact analysis identified **nominal** to **moderate** incremental contributions in impacts from all IPFs under Alternative A compared with the cumulative impact as a whole. Alternative B would implement seasonal restrictions for seismic airgun surveys in Federal coastal waters and exclude certain areas from seismic airgun surveys during the 10-year period of interest. These mitigation measures (including additional or revised procedural measures and spatial restrictions of seismic airgun activities) would reduce potential impacts to specific species or stocks within the AOI as they would restrict surveys in biologically important habitat areas for these species or stocks (e.g., calving grounds). Although survey activities in other areas of the AOI (or in areas adjacent to the closure areas) may continue to potentially impact individual marine mammals during the project period, the closure areas may reduce impacts at key life stages and during critically important biological behaviors. When considering all potential auditory impacts to marine mammals within the AOI from proposed seismic airgun activities along with established impact-level criteria provided in **Chapter 4.2.2**, these mitigation measures will not appreciably change the levels of impacts contributed by Alternative A to all marine mammals within the AOI to the cumulative impact as a whole. The comparative contribution of Alternative B would not differ significantly from that of Alternative A under the cumulative impact assessment even with the addition of the mitigation measures, though there may be slight reductions identifiable in the AOI. Therefore, under Alternative B, when compared with past, present, and future activities, including similar non-OCS Program activities (**Figure 3.4-1**), the cumulative effects of all IPFs to marine mammals within the AOI over the 10-year period would result in **nominal** to **minor** incremental increases in impacts.

4.2.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.2.2**). Additional mitigation measures in Alternative C differ from those in Alternative B and include different months for seasonal restrictions in Federal coastal waters, additional PAM requirements to include PAM operations at night and at all times when in the Mississippi and De Soto Canyons, and non-airgun HRG survey protocols. The following discussion outlines the effects of the additional mitigation measures included in Alternative C on marine mammals.

4.2.4.1 Impacts of Routine Activities

4.2.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

Alternative C includes a seasonal restriction for operation of airguns or airgun arrays in coastal waters of the entire AOI (20-m [66-ft] isobath to shore) from February 1 to May 31. Effects of this seasonal restriction for project-related IPFs result in the same overall level of potential impact to marine mammals in the AOI (**nominal** to **moderate**) as those discussed for Alternative B in **Chapter 4.2.3.1**.

Seasonal Restriction for Coastal Waters

The seasonal restriction for coastal waters (**Figure 2.8-1**) had different effects in the three different coastal modeling zones (Zones 1, 2, and 3; **Appendix D, Figure 110**). Under Alternative B, it is assumed that the levels of survey activities would remain the same as described in Alternative A. Therefore, due to the seasonal restriction, levels would increase outside of the seasonal closure area. Based on distributional data, the common bottlenose dolphin was the only species to show decreased density ratios in all three coastal modeling zones. For all other species, in Zones 1 and 2 (Florida, Alabama, Mississippi, and Louisiana continental shelf), the density ratios were >1.0 (**Table 4.2-6**), indicating a likely overall increase in the exposure estimates (**Appendix D**) as a result of this seasonal restriction, due to the increase in survey activities. In Zone 3 (Texas continental shelf), the closure had varying effects on the other species. The density ratio for Clymene and spinner dolphins decreased the most due to the Seasonal Restriction for Coastal Waters; however, these species are not found within coastal waters, so their densities are very small under both conditions and the difference is not significant. The Atlantic spotted dolphin, false killer whale, Fraser's dolphin, killer whale, and striped dolphin showed increased density ratios (**Table 4.2-6**), indicating a likely overall increase in the exposure estimates (**Appendix D**) as a result of this seasonal restriction. The remaining species exhibited density ratios close to 1.0, which correlates to little or no change from the original density estimate.

4.2.4.1.2 Expanded PSO Program

Alternatives B and C require the use of PSOs and exclusion zone monitoring within all water depths throughout the AOI and require that all airguns shut down any time a specified "whale" species (including Bryde's whale, beaked whales, sperm whale, and dwarf and pygmy sperm whales) or manatee is detected entering or is within the exclusion zone in all water depths of the AOI. Alternative C also includes Non-Airgun HRG Survey Protocol mitigation measures, which include PSO protocols (refer to **Chapter 4.2.4.1.4**).

As discussed in Alternative B (**Chapter 4.2.3.1.2**), implementation of operational mitigation measures during deep-penetration seismic airgun survey activities may reduce but not eliminate possible injurious exposures (i.e., PTS injuries), and expansion of PSOs and exclusion zone monitoring (pre-survey search protocols) within continental shelf waters of the AOI (associated with Alternatives B and C) may reduce potential injurious exposures to cetaceans that occur within these habitats. These mitigation measures, however, are not likely to significantly reduce behavioral responses, including Level B harassment, of marine mammals. Based on the near-coastal distribution of manatees and continental slope distributions of whale species selected for shutdown protection, expanded protocols within continental shelf waters of the OCS associated with Alternatives B and C are not likely to significantly reduce potential injurious exposures to these species. Overall, based on the uncertainties of the effectiveness of these mitigation measures, particularly during nighttime operations and periods of poor visibility and inclement weather, and the distributions of protected species listed for added protection in Alternative C, impacts to marine mammals within the AOI from deep-penetration seismic airgun surveys would not change from that detailed for Alternative A (**moderate**).

The expansion of the requirements for use of PSOs and exclusion zone monitoring in all water depths throughout the AOI and the slow speeds of G&G survey vessels may further protect marine mammals from vessel collisions. However, cetacean species that are regular inhabitants of shelf waters in the GOM include two dolphin species (common bottlenose dolphin and Atlantic spotted dolphin) that are agile swimmers known to approach moving and stationary vessels. Manatees may receive some additional protection by the added PSO effort, particularly in areas on the continental shelf. The implementation of this mitigation measure under Alternative C would not affect the level of impacts to marine mammals within the AOI from vessel collisions as described in Alternative A (**nominal** to **moderate** [if a collision occurred]).

Impacts to marine mammals from aircraft traffic and noise, drilling noise, trash and debris, and entanglement would not be affected by the expansion of seismic survey mitigation measures and the PSO Program associated with Alternative C, and impacts would remain **nominal**.

4.2.4.1.3 Use of PAM Required

Under Alternative C, the use of PAM is required for seismic surveys occurring at night and during periods of reduced visibility in waters deeper than 100 m (328 ft) and required at all times when operating in the Mississippi and De Soto Canyons. The requirement for PAM surveys within the AOI is designed to provide additional means to detect and thus protect diving whale species not visible at all times to visual observers, including endangered sperm whales and Bryde’s whales, during seismic survey mitigation protocols. Sperm whales are concentrated in continental slope waters of the Mississippi Canyon lease block area while Bryde’s whales principally occur in a restricted area of the northeastern GOM between the 100- and 400-m (328- and 1,312-ft) isobaths from approximately 87.5° W. longitude to 27.5° N. latitude and from 100- to 300-m (328- and 984-ft) isobaths farther south off Tampa, Florida (Maze-Foley and Mullin, 2006; Waring et al., 2013; Rosel and Wilcox, 2014) (the middle of “The Elbow” leasing area). Sperm whales are vocally active, making them easy to detect acoustically, particularly during long dives (Mellinger et al., 2003). Their emitted sounds are wideband clicks that usually occur in certain timing patterns (Jaquet et al., 2001), are distinctive, and are easily distinguishable and localized as the clicks have a sharp onset and offset. These characteristics provide good material for determining the time-of-arrival differences used in many acoustic localization methods. Bryde's whales produce low-frequency tonal and swept calls similar to the calls of other balaenopterid mysticetes. Towed PAM equipment likely can detect and determine the location of a calling Bryde's whale (Oleson et al., 2003), but the ability of any PAM system to identify a Bryde's whale is limited by the associated auto-detection software's capability to detect and identify the low-frequency signal emitted by a Bryde's whale and potential masking by the low-frequency seismic signals and vessel noise.

As discussed in **Chapter 2.13**, the use of towed PAM to locate and identify marine mammals has some limitations, such as limited directional capabilities, challenges of sound sources and receivers being mobile, short time coverage, limited detection range, and a tendency towards masking problems from tow vessel noise, flow noise, and seismic source noise, including airgun reverberation in shallow water (Bingham, 2011). While the use of PAM prior to ramp-up or initiation of seismic surveys during reduced visibility periods would decrease impacts to a portion of the marine mammals potentially occurring in the surveyed area, only vocalizing marine mammals would be detected. Thus, even in a localized area, a decrease in potential impacts associated with exposure to active acoustic sources for all potentially occurring marine mammals would not be assured by use of PAM. While the implementation of PAM during seismic surveys within the AOI under Alternative C would reduce but not eliminate impacts to marine mammals, PAM does require additional monitoring, which may lead to additional shutdowns and protections to marine mammals. While the additional measures afford some localized temporal and spatial protections to marine species, it does not alter the overall impact level listed for Alternative A over the entire AOI and 10-year period (**moderate**). Under Alternative C, potential impacts are anticipated to be limited to minor TTS impacts or temporary behavioral changes with no expectation of physical (auditory) injuries anticipated. The expansion of PAM requirements under Alternative C would not affect potential impacts from other IPFs for marine mammals within the AOI. Impact ratings would remain the same as those specified under Alternative A and range from **nominal** to **minor**.

4.2.4.1.4 Non-Airgun HRG Survey Protocol

Non-Airgun HRG Survey Protocol mitigation measures included under Alternative C are discussed together for clarity. Non-airgun HRG surveys in which one or more active acoustic sound sources will be operating at frequencies <200 kHz in all water depths throughout the AOI will require a pre-survey clearance of all marine mammals (and sea turtles) for a period of 30 minutes before start-up or after shutdown for all marine mammals except dolphins. Non-airgun HRG surveys using sound sources <200 kHz must use at least one trained PSO to visually monitor a 200-m (656-ft) exclusion zone during daylight hours. Immediate shutdown of the sound source(s) would occur if any sperm, Bryde's, beaked, or *Kogia* spp. whale(s) or manatee(s) are detected entering or within the exclusion zone. Subsequent restart of the equipment may only occur following confirmation that the exclusion zone is clear of all marine mammals and sea turtles for a period of 30 minutes. The implementation of these mitigation measures are anticipated to reduce potential acoustic injuries (Level A) and behavioral disturbances to potentially occurring marine mammals in proximity of the proposed HRG (<200 kHz) surveys. However, while PSO and visual monitoring methods are effective, they are only efficacious during daylight and periods of good weather and visibility. Thus, while acoustic impacts to potentially occurring localized whale and manatee species associated with non-airgun HRG surveys may be reduced by employing PSOs and visually surveying prior and during the non-airgun HRG surveys, those reductions are only possible in optimal sighting conditions (i.e., daylight and good weather). Also, this mitigation measure provides no protection for other marine species. Therefore, overall impacts to all marine mammals in the AOI associated with exposure to non-airgun HRG sound sources would not change significantly from that already presented for Alternative A (**minor**).

The requirement for visual monitoring surveys by PSOs before and during HRG surveys (<200 kHz) under Alternative C would not affect potential impacts from other IPFs such as vessel and equipment noise, aircraft traffic and noise, trash and debris, and entanglement from Alternative A, and impacts associated with these IPFs would range from **nominal** to **minor**. Visual monitoring by PSOs would provide additional protection to marine mammals from collisions with project-related vessel traffic by notifying vessel crew of potential collisions in a timely manner. However, survey vessels will be operated at relatively slow speeds, and it is unlikely that whales or dolphins will be in danger of collisions. Consequently, the increase in detectability provided by PSOs during non-airgun HRG survey activities will not affect the overall level of impact to all marine mammals within the AOI from active acoustic sound sources.

4.2.4.1.5 Routine Activities Impact Conclusions

Under Alternative C, G&G activities would include implementation of existing mitigation requirements discussed under Alternative A as well as additional mitigation measures for all seismic airgun and non-airgun HRG surveys, including the following:

- expanded PSO Program to include the same mitigation for manatees as provided for whales at all water depths;
- required use of PAM for all seismic surveys occurring during periods of reduced visibility in areas with water depths >100 m (328 ft) and at all times within the Mississippi Canyon and De Soto Canyon lease blocks;
- seasonal closure for airgun surveys in Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31; and
- implementation of the Seismic Airgun Survey Protocol.

Additional mitigation measures for non-airgun HRG surveys include the following:

- non-airgun HRG surveys operating at frequencies <200 kHz in all water depths throughout the AOI will require a pre-survey clearance of all marine mammals (and sea turtles) before start-up or after shutdown; and
- implementation of the Non-Airgun HRG Survey Protocol.

As discussed in **Chapter 4.2.4.1**, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to marine mammals from each project-related IPF (including routine activities and an accidental fuel spill) is as follows:

- deep-penetration airgun survey noise – **moderate**;
- HRG airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **minor**;
- vessel and equipment noise – **nominal** to **minor**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris – **nominal**; and
- entanglement – **nominal**.

Impacts to marine mammals from routine activities under Alternative C are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Overall, the mitigation measures described under Alternative C may reduce potential impacts from the IPFs listed previously to individuals and groups of marine mammals within the AOI (**Table 2.13-2**). The additional mitigation measures analyzed in this alternative would provide localized benefits to marine mammal species. However, from impact-level criteria discussed in **Chapter 4.2.2**, overall impact ratings by IPF for all marine mammal species across the AOI over a 10-year period would remain substantially the same as Alternative A.

4.2.4.2 Impacts of an Accidental Fuel Spill

Under Alternative C, impacts of an accidental fuel spill on marine mammals would be very similar to those analyzed in **Chapter 4.2.2.2** for Alternative A. The analysis concluded that a small spill at the sea surface would result in **nominal** to **minor** impacts, depending on the numbers of individuals adversely affected by the spilled fuel.

4.2.4.3 Cumulative Impacts

4.2.4.3.1 OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for marine mammals are compared with IPFs from each of the cumulative scenario components in order to focus this cumulative analysis on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The G&G activity IPFs included in the cumulative assessment are the same as those assessed under routine activities and an accidental fuel spill. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI. Impact analyses presented in **Chapters 4.2.4.1 and 4.2.4.2** concluded that activities projected to occur under Alternative C would result in **nominal** to **moderate** impacts to marine mammals, depending on the IPF.

Mitigation measures for the proposed action under Alternative C are described in **Chapter 2.5** and summarized in **Chapter 4.2.4.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3**). As discussed in **Chapter 4.2.4.1**, most mitigation measures under Alternative C would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to marine mammals also would not change. Under Alternative C, the mitigation measure that would change the timing and extent of activities in the proposed action is a seasonal restriction for operation of airguns in Federal and State coastal waters between February 1 and May 31. The implementation of mitigation measures outlined in Alternative C (**Chapter 2.5.2**) would reduce potential auditory impacts from proposed activities on individual or groups of marine mammals within the AOI. Specifically, this mitigation measure provides additional protections for coastal stocks of common bottlenose dolphins, which are of particular concern. However, these measures would not significantly reduce the predicted **moderate** (from Alternative A) impact level for all marine mammals within or outside of the AOI, based on impact level criteria (**Chapter 4.2.2**).

4.2.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.2.2.3.2**) would remain the same under Alternative C.

4.2.4.3.3 Cumulative Impact Conclusions

The cumulative impact analysis identified **nominal** to **minor** incremental increases in impacts from all IPFs discussed under Alternative A. The cumulative scenario would remain similar for Alternative C and the associated impacts would likewise be similar. Alternative C would change the timing of seismic airgun surveys in certain areas; however, this seasonal restriction and operational mitigation measures would not appreciably change or contribute to the cumulative impacts expected under Alternative A.

4.2.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.2.2**). Mitigation measures in Alternative D are the same as those discussed in Alternative C, except for additional shutdowns. The following discussion outlines the effects of the additional mitigation measures included in Alternative D on marine mammals.

4.2.5.1 Impacts of Routine Activities

4.2.5.1.1 Expanded PSO Program with Additional Shutdowns

Seismic survey mitigation measures included in Alternative D are modified from Alternative C mitigation measures, which require the use of PSOs and exclusion zone monitoring in all water depths throughout the GOM, required use of PAM for all seismic surveys in water depth >100 m (328 ft) and at all times in the Mississippi Canyon and De Soto Canyon lease blocks, and seasonal coastal restrictions from February 1 to May 31 (**Chapter 4.2.4.1**). Under Alternative D, sound source shutdowns would be required for all marine mammals and sea turtles except for bow-riding dolphins (i.e., dolphins bow-riding or actively approaching G&G operations). The dolphin species in the GOM that bow-ride on the pressure wave of ships include common bottlenose, Fraser's, Risso's, Clymene, rough-toothed, striped, spinner, Atlantic spotted, and pantropical spotted dolphins. Information on the behavioral reactions of bow-riding dolphins is detailed in **Chapter 4.2.2.1**. Visual mitigation with PSOs is implemented for Alternative D, including the associated relevant shutdown procedures as detailed previously.

Overall, mitigation measures described in Alternative D, including the Seismic Airgun Survey Protocol (**Chapter 2.6 and Appendix B, Attachment 1**), are assumed to reduce the extent of, but not prevent, behavioral responses in and potential Level B exposure of marine mammals within the AOI. While the execution of the Alternative D mitigation measures likely would lessen the impacts to localized marine mammals, except bow-riding dolphins, and because additional shutdowns may require additional survey time (ultimately avoiding Level A exposures however increasing the potential for Level B exposures), the overall impacts to marine mammals within the AOI associated with deep-penetration seismic airgun sources would not change significantly from that already detailed for Alternative A (**moderate**). The effects on marine mammals in the AOI due to the addition of shutdowns under Alternative D would not affect potential impact levels from other IPFs (non-airgun HRG acoustic surveys, vessel and equipment noise, aircraft traffic and noise, trash and debris, and entanglement) presented in Alternatives A, B, or C (**Chapter 4.2.4**), which ranged from **nominal** to **minor**, or for vessel traffic which ranged from **nominal** to **moderate** (if a collision occurred).

4.2.5.1.2 Routine Activities Impact Conclusions

Under Alternative D, G&G activities would include implementation of existing mitigation requirements discussed under Alternative C as well as the following additional mitigation measure requirements for seismic airgun and non-airgun HRG surveys:

- expanded PSO Program to include the same mitigation for manatees as provided for whales at all water depths;
- sound source shutdowns for all marine mammals except bow-riding dolphins (i.e., common bottlenose, Fraser's, Clymene's, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso's dolphins);
- required use of PAM for all seismic surveys occurring during periods of reduced visibility in areas with water depths >100 m (328 ft) and at all times within the Mississippi Canyon and De Soto Canyon lease blocks;
- seasonal closure for airgun surveys in Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31; and
- implementation of the Seismic Airgun Survey Protocol.

Mitigation measures for non-airgun HRG surveys include the following:

- non-airgun HRG surveys operating at frequencies >200 kHz in all water depths throughout the AOI will require a pre-survey clearance of all marine mammals (and sea turtles) before start-up or after shutdown; and
- implementation of the Non-Airgun HRG Survey Protocol.

As discussed in **Chapter 4.2.5.1**, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to marine mammals from each project-related IPF (including routine activities and an accidental fuel spill) is as follows:

- deep-penetration airgun survey noise – **moderate**;
- HRG airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **minor**;
- vessel and equipment noise – **nominal** to **minor**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris – **nominal**; and
- entanglement – **nominal**.

Impacts to marine mammals from routine activities under Alternative D are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Overall, the mitigation measures described under Alternative D may reduce potential impacts from the IPFs listed previously to individual and groups of marine mammals within the AOI. However, from impact-level criteria discussed in **Chapter 4.2.2**, the overall impact level by IPF for all marine mammal species within the AOI would remain the same as Alternative A.

4.2.5.2 Impacts of an Accidental Fuel Spill

Under Alternative D, impacts of an accidental fuel spill on marine mammals would be the same as those analyzed in **Chapter 4.2.2.2** for Alternative A. The analysis concluded that a small spill at the sea surface would result in **nominal** to **minor** impacts, depending on the numbers of individuals adversely affected by the spilled fuel.

4.2.5.3 Cumulative Impacts

4.2.5.3.1 OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for marine mammals are compared with IPFs from each of the cumulative scenario components in order to focus this cumulative analysis on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The G&G activity IPFs included in the cumulative assessment are the same as those assessed under routine activities and an accidental fuel spill. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI. Impact analyses presented in **Chapters 4.2.2.2 and 4.2.2.3** concluded that activities projected to occur under Alternative D would result in **nominal** to **moderate** impacts to marine mammals, depending on the IPF.

Mitigation measures for the proposed action under Alternative D are described in **Chapter 2.6** and summarized in **Chapter 4.2.5.1.** A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3**). The mitigation measures are the same as described for Alternative C with the addition of shutdown protocols during seismic operations for all marine mammals except bow-riding dolphins (i.e., common bottlenose, Fraser's Clymene's, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso's dolphins). The addition of shutdown protocols for all marine mammals, except bow-riding dolphins, under Alternative D would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to marine mammals also would not change. Under Alternative D, the mitigation measure that would change the timing and extent of activities in the proposed action is a seasonal restriction between February 1 and May 31 for the operation of airguns in coastal waters (Federal and State) (**Appendix B, Section 1.3.6**).

4.2.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.2.2.3.2**) would remain the same under Alternative D.

4.2.5.3.3 Cumulative Impact Conclusions

The cumulative impact analysis identified **nominal** to **minor** incremental increases in impacts from all IPFs under Alternative A. The cumulative scenario would remain similar for Alternative D, and the associated impacts would remain the same. While Alternative D would change the timing of seismic airgun surveys in certain areas, the seasonal closures and restrictions (which aim at further reducing injury to marine animals) would not appreciably change the contributions to the cumulative impacts noted under Alternative A because portions of surveys may need to be re-shot due to shutdowns (ultimately avoiding Level A harassment with the potential for further Level B harassment).

4.2.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.2.2**). Mitigation measures in Alternative E are the same as those discussed in Alternative C except for reduced activity levels. The following discussion outlines the effects of the additional mitigation measures included in Alternative E on marine mammals.

4.2.6.1 Impacts of Routine Activities

4.2.6.1.1 Reduced Level of Activity

For this mitigation measure under Alternative E, BOEM would authorize a reduced level of activity and would include the mitigation measures described in Alternative C (**Chapter 4.2.4**). There are two options:

- **Alternative E1** – a reduction of deep-penetration, multi-client activities (in line miles) by 10 percent from the estimated levels in a calendar year (**Table 2.7-1**); and
- **Alternative E2** – a reduction of deep-penetration, multi-client activities (in line miles) by 25 percent from the estimated levels in a calendar year (**Table 2.7-2**).

Current projected oil and gas exploration deep-penetration seismic activity levels are provided in **Table 3.2-2**. A 10 percent reduction of deep-penetration, multi-client activities as proposed in Alternative E1 is provided in **Table 2.7-1**, and a 25 percent reduction is provided in **Table 2.7-2** for Alternative E2. Activities could be conducted in any of the planning areas. When the maximum number of exploration survey activities has been authorized for a calendar year, no additional authorization of deep-penetration, multi-client seismic oil and gas exploration activities would be issued for the remainder of the calendar year. In both sub-alternatives, the extent of seismic survey-related sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, and trash and debris would be incrementally reduced within the AOI, thus incrementally decreasing impacts from these IPFs on marine mammals.

Overall, the implementation of either of the two sub-alternatives for the reduction of deep-penetration, multi-client activities would not modify the predicted **moderate** (from Alternative A) impact level for all marine mammals within the AOI from seismic airgun activities even though the area of potential impacts is reduced due to activity reduction. Based on impact-level criteria (**Chapter 4.2.2**), these activity reduction options would reduce but not eliminate potential auditory injury to marine mammals within the AOI annually and over the duration of the proposed action. As with Alternative A, no lethal injuries are expected from exposure to proposed active sound sources. Anticipated numbers of potential auditory injuries (PTS) would remain sufficiently low such that, if actual injuries at this level were to occur, they would not affect the continued viability or annual rates of recruitment or survival of all local populations or stocks of marine mammals. The locations in which the activity reduction levels would occur could not be definitively predicted, but if the reductions occurred in geographic regions within the AOI that are biologically important, such as a closure area, Settlement Areas of Concern, or BIA, then greater fitness benefits may be derived by species in those areas than for other marine mammals in other regions of the AOI. Without being able to predict the locations or time of year in which the reductions may occur in the GOM, the reasonable assumption is that the fitness consequences are similar to those associated with Alternative A.

Reductions of deep-penetration, multi-client activity under Alternative E would not affect potential impacts on marine mammals associated with the other IPFs such as vessel and equipment noise, aircraft traffic and noise, trash and debris, and entanglement, which are the same as those predicted for Alternative A and which range from **nominal** to **minor**.

4.2.6.1.2 Routine Activities Impact Conclusions

Under Alternative E, G&G activities would include implementation of existing mitigation requirements discussed under Alternative C, as well as a reduced level of activity for G&G surveys associated with the Oil and Gas, Renewable Energy, or Marine Minerals Programs. Mitigation measures for seismic airgun surveys under Alternative E include the following:

- expanded PSO Program to include the same mitigation for manatees as provided for whales at all water depths;

- sound source shutdowns for all marine mammals except bow-riding dolphins (i.e., common bottlenose, Fraser's, Clymene's, rough-toothed, striped, spinner, Atlantic spotted, pantropical, and Risso's dolphins);
- required use of PAM for all seismic surveys occurring during periods of reduced visibility in areas with water depths >100 m (328 ft) and at all times within the Mississippi Canyon and De Soto Canyon lease blocks;
- seasonal closure for airgun surveys in Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31; and
- implementation of the Seismic Airgun Survey Protocol.

Mitigation measures for non-airgun HRG surveys include the following:

- non-airgun HRG surveys operating at frequencies >200 kHz in all water depths throughout the AOI will require a pre-survey clearance of all marine mammals (and sea turtles) before start-up or after shutdown; and
- implementation of the Non-Airgun HRG Survey Protocol.

Additional mitigation measures associated with Alternative E include two options: a reduction of G&G activity levels in line miles by 10 percent in a calendar year (Alternative E1) or by 25 percent in a calendar year (Alternative E2).

As discussed previously, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to marine mammals from each project-related IPF (including routine activities and an accidental fuel spill) is as follows:

- deep-penetration airgun survey noise –**moderate**;
- HRG airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **minor**;
- vessel and equipment noise – **nominal** to **minor**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris – **nominal**; and
- entanglement – **nominal**.

Impacts to marine mammals from routine activities under Alternative E are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Overall, the mitigation measures described under Alternative E may reduce potential impacts from the IPFs listed earlier to individual and groups of marine mammals within the AOI depending on where the reduction in activities takes place. Reductions in deep-penetration airgun surveys may lower the impacts to marine mammals; however, from impact-level criteria discussed in **Chapter 4.2.2**, overall impact ratings by all other IPFs for all marine mammal species within the AOI would remain the same as Alternative A.

4.2.6.2 Impacts of an Accidental Fuel Spill

Under Alternative E, impacts of an accidental fuel spill on marine mammals would be very similar to those analyzed in **Chapter 4.2.2.2** for Alternative A. The analysis concluded that a small spill at the sea surface would result in **nominal** to **minor** impacts, depending on the location of the spill and if threatened or endangered species found within the AOI were adversely affected.

4.2.6.3 Cumulative Impacts

4.2.6.3.1 OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for marine mammals are compared with the IPFs from each of the cumulative scenario components in order to focus this cumulative analysis on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The G&G activity IPFs included in the cumulative assessment are the same as those assessed under routine activities and an accidental fuel spill. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI. Impact analyses presented in **Chapters 4.2.6.1 and 4.2.6.2** concluded that activities projected to occur under Alternative E would result in **nominal** to **moderate** impacts to marine mammals, depending on the IPF.

Mitigation measures for the proposed action under Alternative E are described in **Chapter 2.7** and summarized in **Chapter 4.2.6.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3**). The reduction of deep-penetration, multi-client activities by 10 percent (Alternative E1) or 25 percent (Alternative E2) would reduce the extent, severity, and timing of active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, and trash and debris. As discussed in **Chapter 4.2.6.1**, the implementation of either of the two sub-alternatives for the reduction of deep-penetration, multi-client activities would not reduce the predicted **moderate** (from Alternative A) impact level for all marine mammals within the AOI from seismic airgun activities. Based on impact-level criteria (**Chapter 4.2.2**), these activity reduction options would reduce but not eliminate potential auditory injury to marine mammals within the AOI annually and over the duration of the proposed action.

4.2.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.2.2.3.2**) would remain the same under Alternative E.

4.2.6.3.3 Cumulative Impact Conclusions

While the impacts from deep-penetration seismic surveys would decline, impacts from other IPFs would remain unchanged. The cumulative impact analysis identified **nominal** to **minor** incremental increases in impacts from all IPFs under Alternative A. The contributions to cumulative impacts would remain similar for Alternative E, and the associated impacts would remain the same.

4.2.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.2.2**). Mitigation measures in Alternative F are the same as those discussed in Alternative C except for area closures. The following discussion outlines the effects of the additional mitigation measures included in Alternative F on marine mammals.

4.2.7.1 Impacts of Routine Activities

4.2.7.1.1 Closure Areas

Alternative F includes four area closures: Flower Gardens Closure Area, CPA Closure Area, EPA Closure Area, and Dry Tortugas Closure Area (**Figure 2.8-1**). The selection of these closure areas was based on relative densities of target species within the AOI and expert opinion regarding the biological importance of these geographic areas. Target species include the sperm whale (endangered), Bryde's whale (the only resident mysticete within the AOI), and beaked whales, as well as reef and pelagic fishes associated with the FGBNMS.

The Flower Gardens Closure Area was designed to protect marine resources (primarily reef and pelagic fishes) associated with the FGBNMS. This closure area was not selected for additional protection for cetacean species within the AOI; however, it would benefit any marine animal in the closure area. Marine mammals common in this closure area include the beaked whale (*Mesoplodon* sp.), Atlantic spotted dolphin, and common bottlenose dolphin.

The CPA Closure Area was derived by combining Settlement Area of Concern 1 and the western part of Area of Concern 2 (to the boundary of the CPA) and redrawing the southern boundary to encompass additional sperm and beaked whale occurrence records (however, the closure would provide benefit to any marine animal in the closure area). The waters of the CPA Closure Area support relatively high densities of sperm and beaked whales. Satellite tracking studies conducted by Jochens et al. (2008) indicate that the home range of tagged sperm whales within the northern GOM is broad, encompassing waters deeper than 500 m (1,640 ft). Home range is defined as an area over which an animal or group of animals regularly travels in search of food or mates and that may overlap with those of neighboring animals or groups of the same species. By contrast, the composite core area for GOM sperm whales generally includes the Mississippi Canyon, Mississippi River Delta, and, to a lesser extent, the Rio Grande Slope (Jochens et al., 2008). The composite core area is a section of the home range that is utilized more thoroughly and frequently for activities such as feeding. Satellite tagging data of sperm whale movements in the northern GOM show that sperm whales aggregate in the Mississippi Canyon area, including the proposed CPA Closure Area, but regularly move through the waters over the northern GOM continental slope. Movement patterns or seasonal migrations of beaked whales in the GOM are not known, though their distributional patterns likely depend on the movement of mesoscale hydrographic features and their prey (USDOC, NMFS, 2016c).

Bryde's whales that inhabit the northern GOM represent a resident GOM stock and have only been observed in a limited area of the northeastern GOM between the 100- and 400-m (328- and 1,312-ft) isobaths from south of Pensacola, Florida, to 27.5° N. latitude, and between the 100- and 300-m (328- and 984-ft) isobaths from 27.5° N. latitude south to around Tampa, Florida, based on sighting surveys and recent sighting records (Maze-Foley and Mullin, 2006; Waring et al., 2013; Rosel and Wilcox, 2014). Under Alternative F, the EPA Closure Area was refined and expanded from the boundaries of the year-round BIA for the small resident population of Bryde's whales in the GOM (LaBrecque et al., 2015). The boundaries of the EPA Closure Area were expanded from that of the Bryde's whale BIA, where from 87.5° W. longitude to 27.5° N. latitude along the western boundary of the BIA, the EPA Closure Area's boundary was extended to the 400-m (1,312-ft) isobath. While the EPA Closure Area was selected based on the biological importance to the Bryde's whale, it would benefit any marine animal in the closure area. **Appendix K** also estimates chronic and cumulative effects on marine mammals and specifically on Bryde's whale communication area. The study modeled receiver sites specifically in De Soto Canyon to model Bryde's whale effects from chronic sound. These estimates were based on airgun surveys, other OCS activity, and ambient noise.

The Dry Tortugas Closure Area includes waters bounded by the 200- and 2,000-m (656- and 6,562-ft) isobaths (or U.S. EEZ) from the northern border of BOEM's Howell Hook leasing area to 81.5° W. longitude. Sighting data indicate that beaked whale and sperm whale numbers are very dense in this area. In addition, based on unpublished observations and passive acoustic recordings data of calves, sperm whales may use this area for calving (Hildebrand et al., 2012). As with the CPA Closure Area, the Dry Tortugas Closure Area likely supports a segment of the sperm whale stock's home range, or at least represents a separate core area. While the Dry Tortugas Closure Area was selected based on the sightings and densities of beaked whales and sperm whales, it would benefit any marine animal in the closure area.

Closure areas that restrict airgun surveys would provide potential refuge to Bryde's, sperm, and beaked whale species in addition to other deepwater cetacean species of the GOM during the

10-year period. However, except for the Bryde's whale whose distribution appear to be limited to the waters of northeastern GOM, cetacean species regularly move outside of the boundaries of the closure areas. Thus, protection afforded to these individuals by area closures would be limited to biologically important periods and geographic locations (such as feeding behaviors and locations), while their movements would expose them to potential impacts from airgun survey activities. Mitigation provided by the implementation of these closure areas would reduce but not prevent potential injurious auditory impacts (Level A) to marine mammals of the AOI.

Overall, the selection of Alternative F with its associated area closures to seismic surveys during biologically important periods would result in a reduced level of exposure to the active acoustic source IPF, particularly for specific regions of the AOI, thus resulting in an overall incrementally reduced impact to marine mammals within these areas of the AOI from deep-penetration seismic sound sources. Compared with the impact level of Alternative A (**nominal** to **moderate**), the impact level of Alternative F may be incrementally reduced to **nominal** to **minor**.

Quantitative Assessment of Alternative F

The closure areas included in Alternative F were chosen to provide protective measures to the target species identified earlier. The areas were selected based on modified Plaintiffs' Areas of Concern (the original Areas of Concern are described further in Alternative B) and on the basis of expert opinion. To estimate the level of protection provided by the closure areas, a quantitative assessment was conducted. Because the final exposure estimates are the multiplicative product of the modeled exposures and animal density estimates, an extension of this logic was used to assess the effect of the area closures on the predicted exposure estimates. Specifically, animal densities were determined for each modeling area, with and without individual closures, and then cumulatively for instances in which multiple closures exist within a modeling zone (**Appendix D, Figure 110**). Because the Seasonal Restriction for Coastal Waters is not permanent a closure, but includes a temporal dimension, the duration of the Seasonal Restriction for Coastal Waters was also accounted for in the calculations. The ratio of these two density values provides the percentage of impact of that closure on the species-specific exposure estimates. The density ratios (**Table 4.2-6**) provide an indication of the magnitude of the effect of the closure areas on predicted exposure values (**Appendix D**). Density ratios <1.0 indicate there would likely be a reduction in the predicted exposure estimates, whereas density ratios >1.0 indicate there would likely be an increase in the predicted exposure estimates. To fully calculate modified exposure numbers is more involved than simply multiplying these ratios by the final decadal take numbers included in **Appendix D**, as the density ratios are calculated separately for each modeling zone, and the level of effort through the 10-year period is not uniform across zones or time. Therefore, the density ratios indicate the effect of the individual and collective closure areas on exposure estimates, but the density ratios cannot be used in direct multiplication against the decadal exposure estimates.

Implicit in this evaluation is the assumption that the level of exploratory effort (i.e., the number of kilometers of seismic survey effort within a zone) will remain constant, even though the closure areas would not be available. Therefore, more survey effort would occur in non-closure areas within the zone to compensate for the area lost by the closure. Thus, the Alternative F exposure estimates under this analysis represent the minimum mitigative effect of the closures. If the level of survey effort were to be reduced due to the reduction in available area within the modeling zone, then exposure estimates would be reduced below the density ratios included in **Table 4.2-6**. The seasonal coastal restrictions are unlikely to affect the level of survey effort because the survey effort likely would shift to seasons in which the coastal areas are available for exploration. However, permanent closures reduce the total area available for exploration, which might lead to a reduction in survey effort within a modeling zone. If so, then the ratios of zonal areas with and without permanent closures could be used as an additional proxy to estimate the level of survey effort reduction, which ultimately would result in additional exposure reduction.

While the overall take numbers with and without closure areas are informative to this analysis, it is important to understand what protection these areas may provide to a specific species or stock. The closure areas represent important biological habitat, such as for calving and nursing or where high densities of a species or stock generally are found. Although individuals may be exposed outside of these areas, protection within these areas likely is more biologically meaningful to the specific species or stocks than other areas within the AOI. Therefore, the difference in impact levels must be ascertained by looking at reductions in take numbers as well as the value of protection to the species or stock as a whole within the specified closure areas.

Seasonal Restriction for Coastal Waters

The Seasonal Restriction for Coastal Waters (**Figure 2.8-1**) had different effects in the three coastal zones (Zones 1, 2, and 3; **Appendix D, Figure 110**). The common bottlenose dolphin was the only species to show a decreased density ratio in all three coastal zones. For all other species, in Zones 1 and 2, the density ratios were >1.0 (**Table 4.2-6**), indicating an overall increase in the exposure estimates (**Appendix D**) as a result of this seasonal restriction. In Zone 3, the closure had varying effects on the other species. The density ratios for Clymene and spinner dolphins decreased the most due to the Seasonal Restriction for Coastal Waters; however, these species are not found within coastal waters, so their densities are very small under both conditions and the difference is not significant. Because of their general distributions along the outer continental shelf and slope, modeling results for the Atlantic spotted dolphins, false killer whales, Fraser's dolphins, killer whales, and striped dolphins all showed an increased density ratio (**Table 4.2-6**), indicating an overall increase in the exposure estimates (**Appendix D**) as a result of this seasonal restriction. This may be attributed to an increase in survey activity in areas outside of (offshore of) the Seasonal Restriction for Coastal Waters. However, the remaining species within the AOI exhibited density ratios close to 1.0, which correlates to little or no change from the original density estimate.

CPA Closure Area

The CPA Closure Area (**Figure 2.8-1**) occurs in Zones 5 and 7 (**Appendix D, Figure 110**) and focuses on the protection of sperm whales and beaked whales. The sperm whales in Zone 5 exhibited a decrease in density ratio to 0.827 and beaked whales in this area exhibited a decrease in density ratio to 0.982 (**Table 4.2-6**). Spinner dolphins in Zone 5 exhibited the greatest decrease in density ratio to 0.157 (**Table 4.2-6**). All other species in Zone 5 had a decrease or no change in density ratios, except the Atlantic spotted dolphin, Bryde's whale, Clymene dolphin, and short-finned pilot whale (**Table 4.2-6**), indicating no significant change in the exposure estimates as a result of this closure area (**Appendix D**).

The spinner dolphin also had the lowest density ratio in Zone 7 due to the CPA Closure Area. In this zone, all other species had density estimates close to 1.0, which means they were unchanged from the original estimates, indicating no significant change in the exposure estimates (**Appendix D**) from this closure area.

EPA Closure Area

The EPA Closure Area (**Figure 2.8-1**) had a greater reduction on the density ratio in Zone 1 as compared with those in Zone 4 (**Appendix D, Figure 110**). This closure area focuses on restricting activities around Bryde's whales. The Bryde's whale exhibited a decrease in density ratios in Zones 1 and 4 (0.442 and 0.584, respectively) (**Table 4.2-6**). All of the species had a lower density ratio in Zone 1 than in Zone 4, except the common bottlenose dolphin, which showed an increased ratio in Zone 1. The striped dolphin had the lowest density ratio in Zone 1 (0.191), while the common bottlenose dolphin had the highest density ratio (1.051) (**Table 4.2-6**) indicating a wide range of potential changes in the exposure estimates (**Appendix D**) from this closure area. The Atlantic spotted dolphin had an increased density ratio, while the remaining species has decreased or unchanged density ratios as a result of this closure area (**Table 4.2-6**).

In Zone 4, the species with the lowest density ratio was the Bryde's whale (**Table 4.2-6**). Other species with ratios <1.0 include the Atlantic spotted dolphin, common bottlenose dolphin, false killer whale, and Fraser's dolphin. All other species exhibited ratios >1.0, indicating an increase in exposure estimates (**Appendix D**) as a result of this closure area.

Dry Tortugas Closure Area

The Dry Tortugas Closure Area (**Figure 2.8-1**) in Zone 4 (**Appendix D, Figure 110**) focuses on protecting Bryde's whales. The Bryde's whale exhibited a decrease in density ratio in Zone 4 (0.625) (**Table 4.2-6**). This closure produced notable decreases in density ratios for the beaked whale, common bottlenose dolphin, killer whale, *Kogia* spp., pantropical spotted dolphin, pygmy killer whale, Risso's dolphin, short-finned pilot whale, and sperm whale, indicating a decrease in the exposure estimates (**Appendix D**) as a result of this closure area. The striped dolphin showed the greatest increase in density ratio due to this closure area, closely followed by the Bryde's whale and Clymene dolphin (**Table 4.2-6**). All other species had density ratios close to 1.0, and therefore, can be considered unchanged from the original density and likely resulting in unchanged exposure estimates (**Appendix D**) as a result of this closure area.

Mitigative Effects of Closure Areas

In Zone 1 (**Appendix D, Figure 110**), the EPA Closure Area and Seasonal Restriction for Coastal Waters were combined. In this combined case, the Atlantic spotted dolphin is the only species that demonstrates an increase in density ratio (**Table 4.2-6**), likely resulting in an increase in the exposure estimates (**Appendix D**). The common bottlenose and rough-toothed dolphin had density ratios close to 1.0, and therefore, would be unchanged, while all other species showed a decrease in density ratios, likely resulting in a decrease to the exposure estimates (**Appendix D**) resulting from these collective restrictions. Combining these two areas (EPA Closure Area and Seasonal Restriction for Coastal Waters) produces an overall decrease in density ratios, with a likely decrease in the exposure estimates (**Appendix D**) when compared with the Seasonal Restriction for Coastal Waters alone.

In Zone 4 (**Appendix D, Figure 110**), the Dry Tortugas and EPA Closure Areas were combined. With these closure areas combined, the density ratios for the Clymene, melon-headed, and striped dolphins increased dramatically from each closure area implemented separately. The Atlantic spotted dolphin, short-finned pilot whale, and spinner dolphin also showed increased ratios, while the remaining species had unchanging or decreased ratios (**Table 4.2-6**). The combination of these two closure areas resulted in more density ratios (**Table 4.2-6**) consistent with the original density estimate (near 1.0) than if either of the two closure areas were implemented alone, likely resulting in minimal changes in the exposure estimates (**Appendix D**). The estimates due to the EPA Closure Area generally were larger than those resulting from the combined closure areas.

Because an area may be closed based on its biological importance to one or more species, a reduction in not only exposures but also in avoidance of a BIA is an important measure. The reduction of impacts to an area of biological importance may have more benefit to marine animals than may be implied through this quantitative analysis. A reduction of impacts in an area of biological importance may have more benefit to the species than quantified through the number of exposures avoided. Therefore, the benefit to the species may be greater than quantified in this analysis.

4.2.7.1.2 Routine Activities Impact Conclusions

Under Alternative F, BOEM would continue to authorize activities and include the mitigation measures, monitoring, reporting, survey protocols, and guidance that are currently in place (per Alternative A) as well as additional mitigation measures, including the Seismic Airgun Survey Protocol and Non-Airgun HRG Survey Protocol, as applicable (Alternative C), and four area closures (i.e., the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area) to provide additional protection for certain cetacean species and other resources. Under Alternative F, these areas are closed to all activities except non-airgun HRG surveys in which one or more active acoustic sound sources will be operating at frequencies >200 kHz. Mitigation measures for seismic airgun surveys include the following:

- expanded PSO Program to include the same mitigation for manatees as provided for whales at all water depths;
- required use of PAM for all seismic surveys occurring during periods of reduced visibility in areas with water depths >100 m (328 ft) and at all times within the Mississippi Canyon and De Soto Canyon lease blocks;
- seasonal closure for airgun surveys in Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31;
- implementation of the Seismic Airgun Survey Protocol; and
- closure for all new seismic airgun and non-airgun HRG surveys in the CPA, EPA, Dry Tortugas, and Flower Garden Banks Closure Areas.

Additional mitigation measures for non-airgun HRG surveys include the following:

- non-airgun HRG surveys operating at frequencies >200 kHz in all water depths throughout the AOI will require a pre-survey clearance of all marine mammals (and sea turtles) before start-up or after shutdown; and
- implementation of the Non-Airgun HRG Survey Protocol.

As discussed earlier, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to marine mammals from each project-related IPF (including routine activities and an accidental fuel spill) is as follows:

- deep-penetration airgun survey noise – **minor**;
- HRG airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **minor**;
- vessel and equipment noise – **nominal** to **minor**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris – **nominal**; and
- entanglement – **nominal**.

Impacts to marine mammals from routine activities under Alternative F are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Overall, the mitigation measures described under Alternative F may reduce potential impacts from the IPFs listed earlier to individuals and groups of marine mammals within the AOI as discussed previously. In addition, Alternative F, with its associated area closures to seismic surveys during biologically important periods (coastal waters seasonal restrictions), would result in a reduced level of exposure to the active acoustic source IPF, particularly for specific regions of the AOI. This would result in an overall incrementally reduced impact to potentially occurring marine mammals within the AOI from deep-penetration seismic sound sources. Impact ratings for other IPFs would remain about the same as Alternative A.

4.2.7.2 Impacts of an Accidental Fuel Spill

Under Alternative F, impacts of an accidental fuel spill on marine mammals would be very similar to those analyzed in **Chapter 4.2.2.2** for Alternative A, but they could reduce the risk that such a spill would occur in the closure areas because there would be reduced activities in those areas. The analysis concluded that a small spill at the sea surface would result in **nominal** to **minor** impacts, depending on the location of the spill and if threatened and endangered species found within the AOI were adversely affected.

4.2.7.3 Cumulative Impacts

4.2.7.3.1 OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for marine mammals are compared with the IPFs from each of the cumulative scenario components in order to focus this cumulative analysis on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The G&G activity IPFs included in the cumulative assessment are the same as those assessed under routine activities and an accidental fuel spill. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI. Mitigation measures for the proposed action under Alternative F are described in **Chapter 2.8** and summarized in **Chapter 4.2.7.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3**). Mitigation measures under Alternative F are to the same as Alternative C with the addition of area closures in four areas: CPA Closure Area; EPA Closure Area; Dry Tortugas Closure Area; and Flower Gardens Closure Area. Areas selected for closure from deep-penetration seismic airgun survey activities were designed to focus on mitigation of deep-penetration seismic impacts to a single species or select group of species.

Mitigation measures under Alternative F that would change the timing and extent of activities in the proposed action include a seasonal restriction for operation of airguns in Federal and State coastal waters, which was designed to protect coastal stocks of the common bottlenose dolphin during their reproductive peak. As discussed in **Chapter 4.2.7.1**, the implementation of area closures to seismic surveys during biologically important periods (e.g., coastal waters seasonal restrictions) would result in an overall incrementally reduced impact (**nominal** to **minor**) to potentially occurring marine mammals within the AOI from deep-penetration seismic sound sources.

4.2.7.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.2.2.3.2**) would remain the same under Alternative F.

4.2.7.3.3 Cumulative Impact Conclusions

The cumulative impact analysis identified **nominal** to **moderate** incremental increases in impacts to marine mammals from all IPFs described under Alternative A. Because activity level would remain the same in this alternative, the overall cumulative scenario would remain mostly unchanged for Alternative F, and the associated overall impacts would remain similar (**nominal** to **minor**). However, there would be reductions to cumulative impacts within closure areas.

4.2.8 Impacts – Alternative G (No New Activity Alternative)

4.2.8.1 OCS Program G&G Survey Activities

Because Alternative G specifies no new activity for oil and gas G&G activities, any existing permitted activity and ancillary activities would be considered as part of the cumulative activities. Previously permitted activity and ancillary surveys would be conducted under the same mitigation measures as Alternative A. Activity level would slowly decline as previously permitted activities are completed. For this reason, the IPFs and impact-level criteria applied for Alternative G are the same as described under the cumulative activities (**Chapter 4.2.2.3**), except the IPF of entanglement is not included as part of Alternative G because no OBC/nodal surveys would occur.

Active Acoustic Sources

Oil and gas G&G survey activities would slowly decline to zero over a period of several years under Alternative G. No new on-lease G&G activities related to renewable energy development could be conducted, and no new G&G activities related to marine minerals would be authorized by BOEM for survey activities located in Federal waters that require BOEM's authorization. The only survey activities that would continue to occur under this alternative are geophysical surveys associated with drilling activities (VSPs), which puts less acoustic energy in the environment. **Appendix F, Section 1.1.5** provides descriptions of these surveys, which include the use of airgun active acoustic sources. Source characteristics are summarized in **Table 4.1-1**, and detailed characteristics and acoustic modeling assumptions are presented in **Appendix D, Section 5**. The potential impacts of VSPs and SWD surveys are the same as those described in Alternative A (**Chapter 4.2.2.1**), however, at greatly reduced impact levels commensurate with the reduction in survey effort (**Table 2.9-1**). Effects of project-related seismic airgun survey noise on marine mammals within the AOI are expected to be reduced to **minor** and would decline to **no impact** as activities ended. Impacts to marine mammals would be limited to individuals or groups from local populations within the AOI, would not be extensive or severe, and would be limited to behavioral harassment and small (limited) numbers of physical injuries. However, there is a small possibility for onset injury (PTS) to occur. Potential non-injurious impacts would include temporary displacement of individuals, possibly including displacement from preferred habitats. Animals are expected to return to these habitats following the distancing of the sound source or the cessation of survey activities.

Vessel and Equipment Noise

The G&G activities that would continue under the cumulative analysis would generate vessel and equipment noise that could disturb marine mammals. The potential impacts are the same type as those described under Alternative A (**Chapter 4.2.2.1**), however, at greatly reduced impact levels commensurate with the level of ongoing activities (**Table 2.9-1**). Based on existing vessel traffic within the AOI, the effects of project-related vessel and equipment noise on marine mammals within the AOI would be **nominal** to **minor** and would decline to no impact. Impacts to marine mammals from project-related vessel and equipment noise are expected but are not extensive or severe, and would include temporary disruption of communication or echolocation from auditory masking; behavior disruptions of individual or localized groups of marine mammals; and limited, localized, and short-term displacement of individuals of any species, including strategic stocks, from localized areas around the vessels.

Drilling-related noises anticipated under Alternative G include the completion of one possible COST well and up to two shallow test wells in the AOI (**Table 2.9-1**). The potential impacts are the same as those that would occur with Alternative A (**Chapter 4.2.2.1**), with the same impact level (**nominal** to **minor**) due to the low number of proposed drilling operations and the continuous nature of the sounds, but would decline to **no impact** as activities ended.

Vessel Traffic

Although the vessel traffic associated with Alternative G would be greatly reduced, the potential impacts (physical disturbance from or collision with moving vessels) are the same as those that would occur in Alternative A (**Chapter 4.2.2.1**), with the same impact level (**nominal** to **moderate** [if a collision occurred]), and would decline to **no impact**.

Aircraft Traffic and Noise

Although aircraft traffic and associated noise would decrease under Alternative G, the potential impacts (noise and physical disturbance) are the same as those that would occur in Alternative A (**Chapter 4.2.2.1**), with the same impact level (**nominal**), and would decline to **no impact**.

Trash and Debris

The potential impacts from trash and debris are the same as those that would occur in Alternative A (**Chapter 4.2.2.1**), with the same impact level (**nominal**), and would decline to **no impact**.

OCS Program G&G Survey Activities Conclusions

Under Alternative G, BOEM would cease issuing permits or authorizations for new G&G surveys and would not approve G&G surveys proposed under exploration or development plans. However, G&G activities previously authorized under an existing permit or authorization or lease would proceed as part of the cumulative activities. Mitigation measures for the previously permitted and ancillary oil and gas G&G activities that are associated with Alternative G include the following:

- guidance for vessel strike avoidance;
- guidance for marine debris awareness;
- avoidance of sensitive benthic resources;
- guidance for shallow hazards survey and reporting;
- regulations for activities in or near NMSs;
- guidance for avoidance of historic and prehistoric sites;
- guidance for military coordination;
- guidance for ancillary activities (Oil and Gas Program only);
- implementation of PSO Program (Oil and Gas Program only); and
- implementation of the Seismic Airgun Survey Protocol.

As discussed earlier, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to marine mammals from each project-related IPF (including routine activities and an accidental fuel spill) is as follows:

- deep-penetration airgun survey noise – **minor** declining to **no impact**;
- HRG airgun survey noise – **minor** declining to **no impact**;
- non-airgun HRG electromechanical survey noise – **minor** declining to **no impact**;
- vessel and equipment noise – **nominal** to **minor** declining to **no impact**;
- vessel traffic – **nominal** to **moderate** declining to **no impact**;
- aircraft traffic and noise – **nominal** declining to **no impact**;

- trash and debris – **nominal** declining to **no impact**; and
- entanglement – **no impact**.

Impacts to marine mammals from cumulative activities under Alternative G are expected to range from **no impact** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Overall, the removal of all new G&G survey activities within the AOI, as described under Alternative G, would reduce potential impacts from the IPFs listed previously to individual and groups of marine mammals within the AOI. However, G&G activities previously authorized under an existing permit/authorization or lease would proceed under Alternative G. From impact-level criteria discussed in **Chapter 4.2.2**, overall impact ratings by IPF from these surveys for all marine mammal species within the AOI would remain the same as Alternative A but would decline to **no impacts** as G&G activities ended.

4.2.8.2 Impacts of an Accidental Fuel Spill

The accidental fuel spill considered under Alternative A (accidental release of 1.2 to 7.1 bbl of diesel fuel caused by a vessel collision or an accident during fuel transfer; **Chapter 4.2.2.2**) are the same as those that would occur in Alternative G. Although there would be reduced vessel traffic and therefore a reduction in the potential for an accidental fuel spill, the same analysis and impact level (**nominal** to **minor**) would be estimated for Alternative G as for Alternative A, but they would decline to **no impacts** as G&G activities ended.

4.2.8.3 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.2.2.3.2**) would remain the same under Alternative G.

4.2.8.4 Cumulative Impact Conclusions

A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.2.2.3**). The cumulative impact analysis identified **nominal** to **moderate** incremental increases in impacts from all IPFs under Alternative A. The cumulative scenario would remain unchanged for Alternative G, except no additional impacts to the entanglement IPF would occur, and the associated impacts would remain the same. Therefore, there are **nominal** to **minor** changes to the cumulative impacts expected under Alternative A, which would then decline to **no impacts** as G&G activities ended.

4.2.9 Summary Conclusion

In summary, the IPFs that may impact marine mammals within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars); (2) vessel and equipment noise; (3) vessel traffic (i.e., physical disturbance to and risk of collisions); (4) aircraft traffic and noise (e.g., helicopters, fixed-wing aircraft); (5) trash and debris (i.e., ingestion of and entanglement in); (6) entanglement (i.e., with acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines); and (7) accidental fuel spill.

Impacts to marine mammals from deep-penetration seismic airgun surveys result in extensive (i.e., affecting large numbers of individuals), short-term but not severe impacts, with limited physical injury expected. Some of the mitigation measures included in the alternatives provide a level of protection to various target species and afford a reduced level of impacts to those target species, as well as biologically important periods and geographic locations (e.g., seasonal restrictions in coastal waters affords protection to individual members of the BSE stocks during their calving season as well as coastal stocks of common bottlenose dolphins, Atlantic spotted dolphins, and individual manatees that may occur in coastal and inshore waters; the EPA Closure Area provides targeted protection for the Bryde's whale, with protection afforded to other species present in the closure area; the CPA Closure Area provides targeted protection for the sperm whale, with protection afforded to other species within the closure area). However, when impacts to all marine mammals within the AOI during the 10-year timeframe of this Programmatic EIS are considered for the impact-level determination, the overall impact level is **moderate**, depending on the stock, for Alternatives A through D; **minor** to **moderate** for Alternative E; **minor** for Alternative F; and **minor**, declining to **no impact**, for Alternative G due to the minimal level of proposed deep-penetration seismic airgun surveys and eventual phasing out of activities.

Minor impacts are expected for shallow-penetration airgun surveys and non-airgun HRG surveys for Alternatives A through F based on exposure modeling. Impacts under Alternative G are assessed as **minor**, declining to **no impact**. Impacts from vessel and equipment noise are assessed as **nominal** to **minor** for Alternatives A through F because many marine mammal species produce and perceive low- to mid-frequency sounds; furthermore, the effect of increased ambient noise on marine mammals could mask biologically significant sounds. Impacts under Alternative G range from **nominal** to **minor**, declining to **no impact**. Vessel collisions with marine mammals are likely to be avoided; however, if a collision did occur, it could result in the mortality of the individual whale or dolphin. Therefore, depending on whether a collision occurred and the protection status of the species, **nominal** to **moderate** impacts are expected for Alternatives A through F. Impacts under Alternative G range from **nominal** to **moderate**, declining to **no impact**. Potential impacts to marine mammals from an accidental fuel spill are expected to range from **nominal** to **minor**, depending on the number of individuals coming into contact with the spilled fuel and their exposure time, as well as the exposure of federally listed species to the spilled fuel, for all alternatives, except Alternative G (**nominal** to **minor**, declining to **no impact**). Other IPFs affecting marine mammals are assessed as **nominal** for Alternatives A through F, and **nominal** declining to **no impact** under Alternative G.

The behavioral impacts anticipated as a result of the proposed action analyzed in this Programmatic EIS are short-term disruption of behavioral patterns, abandonment of activities, and/or temporary displacement from discrete areas. Due to the extensive mitigations in the proposed action, no serious injuries or mortalities are expected.

Cumulative incremental impacts to marine mammals from the proposed action, when taking into consideration G&G survey activities, OCS oil- and gas-related activities that are not associated with G&G survey activities, the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, the minimization of Outer Continental Shelf G&G-related impacts through stipulations and regulations, and the wide-ranging behavior of marine mammals would be expected to be **nominal** to **minor** with no anticipated population-level impacts.

4.3 SEA TURTLES

4.3.1 Description of the Affected Environment

Five species of sea turtles—loggerhead (*Caretta caretta*), green (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempi*), hawksbill (*Eretmochelys imbricata*), and leatherback (*Dermochelys coriacea*)—occur, at least seasonally, in the northern GOM; all are listed as threatened or endangered under the ESA (**Table 4.3-1**). Detailed information about the distribution, population, life history and natural ecology, threats, and status of the five species of sea turtles may be found in **Appendix E, Section 3**. Under the ESA, NMFS has divided the populations of loggerhead sea turtles into DPSs. A DPS is a population of a species that is discrete from other populations of the species and significant in relation to the entire species. Loggerhead sea turtles that occur in the GOM are assumed to be part of the Northwest Atlantic Ocean DPS, which is listed as threatened under the ESA. Within the most recent Recovery Plan for the Northwest Atlantic population of the loggerhead sea turtle, NMFS has identified five recovery units, four of which are located in U.S. waters (USDOC, NMFS and USDOI, FWS, 2008) (**Figure 4.3-1**). Critical habitat has been designated under the ESA in the GOM for the Northwest Atlantic Ocean DPS of loggerhead sea turtles (*Federal Register*, 2014b). Loggerhead critical habitat is found in the AOI and includes nearshore reproductive habitat, *Sargassum* habitat, breeding habitat, and migratory habitat (**Figure 4.3-2**). Breeding critical habitat in the GOM is restricted to the waters extending from the Florida Strait to the Dry Tortugas. Nearshore reproductive critical habitat is located in the State waters of Mississippi, Alabama, and Florida. *Sargassum* critical habitat is located in the oceanic waters of the AOI (**Figure 4.3-2**). Critical habitat for loggerhead turtles also is designated onshore for nesting beaches in Mississippi, Alabama, and Florida (*Federal Register*, 2014c). On April 6, 2016, NMFS published a final rule to list 11 DPSs of the green sea turtle and to revise current listings under the ESA (*Federal Register*, 2016c). Green sea turtles found in the GOM are part of the threatened North Atlantic DPS.

All five GOM sea turtle species nest on beaches along the coast of at least one State bordering the northern GOM (**Figure 4.3-3; Table 4.3-1**). Except for Florida, sea turtle nesting in the northern GOM often is not systematically documented. Texas beaches support significant nesting by Kemp's ridley sea turtles, mostly on North and South Padre Islands. An average of 136 Kemp's ridley nests per year were documented in Texas from 2010 through 2014 (Lauritsen, official communication, 2015). In Louisiana and Mississippi, no regular surveys are conducted, so nesting reports are anecdotal. Louisiana supports low levels of nesting by loggerhead and possibly Kemp's ridley sea turtles, mostly on Breton and Chandeleur Islands and in Grand Isle. In 2015, two loggerhead sea turtles nested on Grand Isle beach (Lauritsen, official communication, 2015). Mississippi beaches support low levels (0 to 15 nests per year) of loggerhead and possibly Kemp's ridley sea turtle nesting, primarily on Petit Bois and Horn Islands (Lauritsen, official communication, 2015). Alabama has documented an average of 68 loggerhead nests and 1 Kemp's ridley nest per year from 2002 through 2014 (Lauritsen, official communication, 2015). The loggerhead sea turtle is the most widespread sea turtle in the GOM, occurring throughout the GOM and nesting on beaches of nearly every state, but principally in western Florida. As many as 906 loggerhead nests per year were reported for the northern GOM (not including peninsular Florida) from 1995 through 2007 (USDOC, NMFS and USDOI, FWS, 2008). In 2014, 11,050 loggerhead sea turtle nests were reported for western Florida (Florida Fish and Wildlife Conservation Commission, 2015).

Hawksbill, green, and leatherback sea turtle nesting in the northern GOM is very infrequent. Hawksbill nests have been documented on the Atlantic Coast of Florida and in the Florida Keys, as well as once in Texas in 1998. Alabama recorded one green sea turtle nest in 2012, and a single leatherback sea turtle nest was documented in Louisiana in 1989. Although there are no more recent reports of nesting in some states along the GOM, all five species of sea turtles in the AOI occur year-round in the coastal, nearshore, and offshore waters of the GOM in at least one of their life history stages. Each species has a juvenile stage thought to be distributed almost exclusively in offshore pelagic habitats. The juvenile stages, which include post-hatchlings leaving nesting beaches and small oceanic-stage juveniles, most often are found in close association with *Sargassum* drift algae habitats, which they use as developmental habitat before making a transition to shallow-water habitats at 1 to 3 years of age (Bolten, 2003). Witherington et al. (2012) conducted vessel-based transect surveys from five Florida ports from Pensacola to Key West extending up to 120 km (75 mi) offshore to evaluate the abundance, species composition, and behavior of oceanic-stage juvenile sea turtles in the eastern GOM. They found that 89 percent of all sea turtle observations occurred within 1 m (3 ft) of floating *Sargassum* and that sea turtle density estimates in *Sargassum* habitats were nearly 100 times higher than in open-water areas where *Sargassum* was not present. Ninety captures of oceanic-stage juvenile sea turtles revealed a species composition dominated by green (49%) and Kemp's ridley sea turtles (42%) with lower abundances of hawksbill (7%) and loggerhead sea turtles (2%). In addition, large numbers of post-hatchling sea turtles were observed, but only during hatching season (July to October) on adjacent Florida nesting beaches. On a broader scale, Putman et al. (2013) generated predicted distributions for oceanic-stage Kemp's ridley sea turtles throughout the GOM using simulated particle dispersal with ocean circulation models. They found that the highest predicted abundance for Kemp's ridley oceanic-stage juveniles was in the far western GOM, with 50 percent of the individuals expected to remain west of 90° W. longitude.

Following the oceanic stage, sea turtles (with the exception of leatherbacks) transition to shallow coastal waters (generally <30 m [98 ft] depth), where there is appropriate developmental habitat for larger juvenile, subadult, and adult life history stages. In deeper waters, some sea turtles, in particular loggerheads, are often seen associated with man-made structures (e.g., platforms). Eaton et al. (2008) provide a summary of data on sea turtle distribution, abundance, and species composition in nearshore waters from 12 sites on the western coast of Florida. Few in-water studies of sea turtle populations have been conducted in the nearshore waters of the GOM outside Florida. McDaniel et al. (2000) conducted aerial surveys for sea turtles over a broad area of the eastern GOM nearshore zone. Although the aerial surveys were unable to differentiate between species and likely missed smaller individuals, they found a pattern of increasing sea turtle abundance in nearshore waters as they moved from the northern GOM offshore of Louisiana and Mississippi (0.05 to 0.10 sea turtle observations per transect kilometer [obs/km]) to the Florida coastal waters, with the highest abundance recorded in the waters offshore of the Florida Keys (0.35 to 1.0 obs/km). Inwater Research Group, Inc. (2014) conducted 2,300 km (1,429 mi) of vessel-based transect surveys for sea turtles in the near coastal waters of eastern Louisiana. These surveys were able to differentiate between species and estimated overall sea turtle abundance at 0.27 obs/km. Observations were dominated by Kemp's ridley (0.12 obs/km) and loggerhead sea turtles (0.11 obs/km), with considerably lower numbers of leatherback (0.04 obs/km) and green sea turtles (0.006 obs/km). Offshore protected species surveys conducted during seismic operations collected sea turtle sighting data between 2002 and 2008 in the GOM. There were 579 sighting records of sea turtles representing all five species (Barkaszi et al., 2012). The percentage of each species represented in the records was as follows: loggerhead (40.2%); green (22%); leatherback (16.1%); Kemp's ridley (9.5%); hawksbill (3.1%); and unidentified chelonid sea turtle (9.1%). Water depths for these sightings ranged from 13 to 4,380 m (43 to 14,370 ft) with an average depth of 1,366 m (4,482 ft). In 278 (48%) sightings records, the sea turtle was identified as a juvenile.

The *Deepwater Horizon* explosion, oil spill, and response impacted sea turtles that have come into contact with oil and remediation efforts (including use of dispersants). The Final PDARP/PEIS estimates between 4,900 and 7,600 large juvenile and adult sea turtles (Kemp's ridley, loggerhead, and unidentified hard-shelled sea turtles) and between 55,000 and 160,000 small juvenile sea turtles (i.e., Kemp's ridley, green, loggerhead, hawksbill, and unidentified hard-shelled sea turtles) mortalities by exposure to the *Deepwater Horizon* oil spill and response. Necropsy results from many of the stranded sea turtles indicated mortality due to forced submergence, which is commonly associated with fishery interactions (one of the main sea turtle threats). Hatchling sea turtles (i.e., loggerhead, Kemp's ridley, and green sea turtles) and associated habitats also were impacted by response activities (*Deepwater Horizon* Natural Resource Damage Assessment Trustees, 2016).

Data on nearshore and offshore sea turtle distribution in the northern GOM was collected following the *Deepwater Horizon* oil spill in 2010. A summary of the effects of the *Deepwater*

Horizon oil spill on sea turtles of the GOM was documented in the Final PDARP/PEIS (*Deepwater Horizon* Natural Resource Damage Assessment Trustees, 2016).

4.3.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact sea turtles within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars); (2) vessel and equipment noise; (3) vessel traffic (i.e., physical disturbance to and risk of collisions); (4) aircraft traffic and noise (e.g., helicopters, fixed-wing aircraft); (5) trash and debris (i.e., ingestion of and entanglement in); (6) entanglement and entrapment (i.e., with acoustic buoy releases, tethered acoustic pingers, nodal tethering lines, and towed equipment); and (7) accidental fuel spill.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For sea turtles, the following impact-level criteria have been used to evaluate the level of impact for each IPF.

Nominal impacts to sea turtles include those where no measurable impacts to local populations are observed or expected. Nominal impacts are limited to minimal short-term behavioral or other low-level impacts on individuals (low numbers, low severity, and short duration). No mortalities or physical injuries are included, and there are no effects on individual fitness (e.g., reduction in reproductive success or survivorship) or on populations.

Minor impacts to sea turtles include those that are not extensive or severe, and are expected to affect individuals or groups from local populations within the AOI. Minor impacts include limited behavioral harassment and small (limited) numbers of physical injuries. These effects include only a low likelihood of fitness impacts on a low number of individuals. No mortalities are included, and there are no impacts on population rates.

Moderate impacts to sea turtles may be extensive at the local population level (potentially affecting large numbers of individuals within regions of the AOI) but not severe, or they may be severe but not extensive. Moderate impacts include significant behavioral harassment and physical (including auditory) injuries of more than a low number of individuals, including the likelihood of fitness effects on more than a low number of individuals. Moderate impacts include mortality of individuals, including some negative population-level impacts to stable or increasing populations, but not outside of the existing known variation around measured population trends (i.e., the continued viability of the local population is not threatened and the annual rates of recruitment or survival of the local population are not seriously affected). Moderate impacts may include (1) mortalities or mortal injuries (i.e., immediate or delayed death [Popper et al., 2014]) in low enough numbers that the continued viability of the population is not threatened; (2) disruption of critical, time-sensitive behaviors such as nesting, breeding, or the emergence and dispersion of hatchlings; and (3) protracted displacement of individual sea turtles from critical habitat.

Major impacts to sea turtles would be extensive and severe. Major impacts would include extensive levels of life-threatening or debilitating injury or mortality in sufficiently high numbers that the continued viability of the population is threatened, including serious diminishment of annual rates of recruitment or survival. Population rates of declining species would be adversely affected, and population rates of stable or increasing species would be reduced beyond previously measured natural variation as a result of mortality or energetic/health impacts from severe behavioral harassment and/injury. If there is not enough data to assess trends, or populations are unknown, negative population-level effects equate to "major" impacts.

4.3.2.1 Impacts of Routine Activities

4.3.2.1.1 Characteristics of Active Acoustic Sound Sources

Active acoustic sound sources included in the proposed action are airguns and various electromechanical sources such as boomers, subbottom profilers, side-scan sonars, and SBESs and MBESs. Sound source characteristics are summarized in **Table 3.4-2**, and detailed characteristics and acoustic modeling assumptions are presented in **Appendix D, Section 5**.

Airguns would be used as sound sources during the following OCS Oil and Gas Program activities: deep-penetration seismic airgun surveys; VSPs/borehole seismic surveys; and HRG surveys. The HRG surveys using only electromechanical acoustic sources would be used to support projects or surveys in all three Program Areas.

For this Programmatic EIS, one large airgun array and one small airgun are used to represent general configurations and their potential impacts to sea turtles within the AOI (**Appendix D**):

- large airgun array (8,000 in^3) – this array is used to represent sound sources for deep-penetration seismic airgun surveys, including 2D, 3D, 4D, WAZ, VSP, and other variations; and
- small airgun (90 in^3) – a single airgun is used to represent sound sources for some HRG airgun surveys to assess shallow hazards and benthic habitats at oil and gas exploration sites.

Representative broadband source levels are $SPL_{0\text{-peak}}$ 248 dB re 1 μPa at 1 m measured broadside for the large airgun array and $SPL_{0\text{-peak}}$ 228 dB re 1 μPa at 1 m for the small array (**Table 3.3-2**). Although airguns typically have a frequency range between 10 and 2,000 Hz, most of the acoustic energy is <600 Hz.

Non-Airgun HRG Survey Activities

Detailed acoustic characteristics of electromechanical sources, including side-scan sonars, subbottom profilers, and echosounders, are presented in **Appendix D**. Sound from electromechanical sources other than boomer and sparker subbottom profilers are not likely to be detectable by sea turtles. Boomers have an operating frequency range of 300 to 3,000 Hz and may be audible to sea turtles; however, boomers transmit very short pulses of sound (120, 150, or 180 microsecond [μs]) and at very low source levels. The sound transmitted by boomers typically has a 180-dB source level radius of <5 m (16 ft).

Details of each of these electromechanical sound sources and their applications can be found in **Appendix F, Section 1.3**.

Background: Potential Effects of Noise on Sea Turtles

Few studies have examined the role of acoustic cues in relation to sea turtle ecology (Mrosovsky, 1972; Cook and Forrest, 2005; Samuel et al., 2005; Nelms et al., 2016). Sea turtles may use sound for navigation, locating prey, avoiding predators, and environmental awareness (Dow Piniak et al., 2012a). The few vocalizations described for sea turtles are restricted to grunts and gular (throat) pumps of nesting females, which are low-frequency sounds and relatively loud when compared with ambient noise, leading to speculation that nesting females may use these sounds to communicate within species (Mrosovsky, 1972; Cook and Forrest, 2005). There are few data on the extent to which sea turtles use their auditory environment ("soundscape") for navigation, environmental assessment, or identification of predators and prey. The ambient acoustic environment for sea turtles changes with each developmental habitat shift. For example, the inshore ambient biotic environment where juvenile and adult sea turtles generally reside is dominated by low-frequency sound and is noisier than the open ocean environment where hatchlings reside (Hawkins and Myrberg, 1983). Moreover, in highly trafficked inshore areas, nearly constant low-frequency noises from shipping, recreational boating, and seismic surveys increase the potential for acoustic impact (Hildebrand, 2005, 2009) and may prevent an animal from hearing biologically important sounds (Fay, 2009).

Electrophysiological studies on hearing have been conducted on juvenile and subadult green sea turtles (Ridgway et al., 1969; Bartol and Ketten, 2006; Dow Piniak et al., 2012a); post-hatchling, juvenile, and adult loggerhead sea turtles (Bartol et al., 1999; Lavender et al., 2012, 2014; Martin et al., 2012a); hatchling leatherback sea turtles (Dow Piniak et al., 2012b); and juvenile Kemp's ridley sea turtles (Bartol and Ketten, 2006). Available data (detailed in **Appendix I**) indicate that adult sea turtles in water can hear frequencies ranging from 50 to 1,200 Hz, and juvenile sea turtles can hear frequencies up to 1,600 Hz, a range that overlaps with the main energy output from seismic airguns (**Figure 4.3-4**). However, as discussed in **Appendices E and I**, sea turtle hearing thresholds at best sensitivity as reported in the scientific literature range from 93 to 117 dB re 1 μPa at the most sensitive frequencies; by comparison, peak sensitivity thresholds of approximately 30 or 40 dB re 1 μPa are the most sensitive frequencies in some odontocetes (**Appendix H**), and peak sensitivity thresholds of approximately 50 dB are most sensitive frequencies observed in some fish species (Popper et al., 2014). Reported hearing ranges and thresholds differ somewhat among species and life stages but data are too limited to be definitive because of the low numbers of individuals tested.

BOEM concludes that there is incomplete or unavailable information (40 CFR § 1502.22) for all sea turtles with respect to (1) seasonal abundances; (2) stock or population size; (3) population trends, whether they are increasing, stable, or decreasing; (4) hearing range; (5) physiology for underwater hearing; and (6) potential impacts from noise. All of these species-specific and population variables may be relevant to reasonably foreseeable adverse impacts on sea turtles that are subject to active acoustic sound sources (i.e., airguns). However, what is known about the biology and hearing physiology of representative species, in combination with observations of behavioral response to stimuli, allows inferences and conclusions about reasonably foreseeable adverse impacts on sea turtles to be understood with an adequate degree of certainty. Therefore, BOEM has determined that the data or information on sea turtle biology, hearing physiology, seasonal abundances, and population stock in the AOI identified as incomplete or unavailable are not essential to a reasoned choice among the alternatives, including the No Action alternative.

A more complete knowledge base for all types of sea turtles that use the AOI and that bear on the factors listed previously is not available, and such information cannot be acquired without exorbitant cost. Such information certainly cannot be acquired in a timeframe that would make it available for this evaluation. While there will never be complete scientific information on sea turtles that live in OCS waters, biological and physiological data and information about the underwater hearing of representative sea turtles are available. These data are sufficient to draw inferences and conclusions about the types of sea turtles that are less understood. Thus, while BOEM reports where limited data and insufficient knowledge challenge our ability to understand how and when specific types of sea turtle species use the AOI and that bear on the factors listed earlier, incomplete or unavailable information does not affect our ability to understand and assign impacts or design mitigation strategies. BOEM can draw basic conclusions despite incomplete or unavailable information, discuss results using available scientifically credible information, and apply that information using accepted scientific methodologies.

Of the active acoustic sources included in this Programmatic EIS, only airguns, boomers, and sparkers produce sounds expected to be within the hearing range of sea turtles (approximately 50 to 1,200 Hz for adult, and up to 1,600 Hz for juveniles; refer to **Appendix I**). Based on the source levels and reported hearing thresholds of sea turtles in water, these sounds could be audible many kilometers away from the source. Other active acoustic sources such as side-scan sonars, CHIRP subbottom profilers, and MBESs are not expected to be audible to sea turtles and have **nominal** potential for acoustic impacts. Five categories of effects are discussed here: (1) death or auditory injury (including PTS); (2) TTS; (3) auditory masking; (4) behavioral responses; and (5) entanglement risk (gear interaction).

Death or Auditory Injury (Including Permanent Threshold Shift)

Death or injury can occur from exposure to high levels of impulsive sound (Popper et al., 2014). Sea turtle deaths and injuries have been documented in proximity to underwater explosions (Klima et al., 1988; Gitschlag and Herczeg, 1994; Viada et al., 2008), but those impacts are attributed primarily to barotrauma resulting from exposure to the high energy of the shock wave generated by underwater explosions. Based on an extensive review of current scientific literature, no sea turtle deaths or injuries are known to have been caused by seismic airguns or any of the other active acoustic sources analyzed in this Programmatic EIS. Because of their rigid external anatomy, sea turtles may be protected, to some degree, from the impacts of lower-energy impulsive sounds (Ketten et al., 2005; Popper et al., 2014).

When exposed to noise, the ear's sensitivity level will decrease to protect the ear from damage, a process referred to as hearing threshold shift. Hearing threshold shifts are decreases in hearing sensitivity within a certain frequency range (Yost, 2000). Hearing sensitivity normally increases and, unless damage to ear structures has occurred, returns to normal over time after cessation of noise exposure. Threshold shifts can be temporary (TTS) or permanent (PTS) and can consist of a variety of physiological, chemical, and neural phenomena that may or may not recover following noise exposure. Several factors influence the type and magnitude of hearing loss, including exposure level, frequency content, duration, and temporal pattern of exposure. Several mechanical stress or damage (e.g., supporting cell structure fatigue) and metabolic (e.g., inner ear hair cell metabolism such as energy production, protein synthesis, and ion transport) processes within the auditory system underlie TTS and PTS (Kryter, 1994; Ward, 1997; Yost, 2000). Intense sound exposure often results in changes in mechanical processes, whereas prolonged exposure typically results in metabolic changes (e.g., Saunders et al., 1985).

Popper et al. (2014) made a distinction between "mortal injury" and "recoverable injury," with the latter defined as an injury that is not likely to result in mortality, such as sensory hair cell damage or minor internal or external hematoma. Their definition of "recoverable injury" implicitly includes PTS due to permanent inner-ear hair cell damage. Therefore, PTS could be considered a threshold for injury, as it has been used for marine mammals (USDOC, NMFS, 2016b).

There are no data upon which to base mortality or injury criteria for sea turtles exposed to seismic airgun noise. Popper et al. (2014) concluded that sea turtle hearing is better represented by data from fishes than from marine mammals. There are few data on hearing abilities of sea turtles, their uses of sound, and their vulnerability to sound exposure; the rationale of Popper et al. (2014) is that the hearing range for sea turtles much more approximates that of fishes than of any marine mammal, and the functioning of the inner ear of sea turtles (basilar papilla) is dissimilar to that of mammals (cochlea). Popper et al. (2014) used data from fishes exposed to pile-driving (an impulsive source that is not included in this Programmatic EIS) to develop criteria for death or mortal injury of sea turtles exposed to airguns. The dual injury criteria were a peak SPL of 207 dB re 1 μPa or an SEL of 210 dB re 1 μPa^2•s. The SEL criteria proposed by Popper et al. (2014) and Finneran and Jenkins (2012) cannot be directly compared because Popper et al. (2014) did not specify frequency weighting. However, the SPL criterion proposed by Popper et al. (2014) is much lower (more conservative) even though it is intended to represent a more severe impact (i.e., death or mortal injury rather than PTS).

Popper et al. (2014) stated that a "high" risk of recoverable injury in sea turtles would be limited to the near field, within tens of meters of an airgun source. The broadband source levels for the two representative airgun arrays included in this Programmatic EIS are 231 dB re 1 μPa peak SPL for the large airgun array and 210 dB re 1 μPa peak SPL for the small array (refer to **Chapter 3.3.1.1.1**).

Temporary Threshold Shift

The temporary reduction in hearing sensitivity caused by exposure to intense sound is referred to as TTS (Popper et al., 2014). It results from temporary changes in sensory hair cells of the inner ear or damage to auditory nerves innervating the ear (Liberman, 2015). Whether sea turtles are able to regenerate hair cells is unknown (Warchol, 2011). When the hair cells cannot be regenerated, PTS occurs.

There are limited TTS data for sea turtles. Lenhardt (2002) exposed captive loggerhead sea turtles to airgun pulses in a large net enclosure and measured a TTS of >15 dB in one animal, with recovery 2 weeks later. Moein et al. (1995) tested the hearing of 11 loggerhead sea turtles exposed to a few hundred pulses from a single airgun and concluded that 5 sea turtles exhibited some change in their hearing when tested within 24 hours after exposure; hearing had reverted to normal when tested 2 weeks later. The results are consistent with TTS, but unfortunately the received levels of sound to which the sea turtles were exposed were not reported.

Due to the lack of data on sea turtle hearing and auditory impacts, no quantitative TTS criteria have been developed for them. Some previous environmental analyses have applied cetacean TTS criteria to sea turtles (U.S. Dept. of the Navy, 1998, 2001, 2008; USDOI, BOEM, 2014b). Finneran and Jenkins (2012) developed TTS criteria for sea turtles based on criteria for low-frequency cetaceans, with the inclusion of an auditory weighting function for sea turtles. No criteria were developed for airguns; however, for explosives (the only impulsive source considered), dual TTS thresholds for sea turtles consist of a (Type I) weighted SEL of 172 dB re 1 μPa^2•s or a peak SPL of 224 dB re 1 μPa.

As in the case for PTS, Popper et al. (2014) did not adopt marine mammal TTS criteria, instead concluding that sea turtle hearing is better represented by data from fishes. Although Popper et al. (2014) did not define quantitative TTS criteria for sea turtles, they indicated that a "high" risk of TTS in sea turtles would be limited to the near field within tens of meters of an airgun source, based on predictions derived from effects of impulsive sounds as there are no quantified data for the effects of seismic airgun sound on sea turtle hearing.

BOEM concludes that there is incomplete or unavailable information (40 CFR § 1502.22) for all sea turtles with respect to (1) seasonal abundances; (2) stock or population size; (3) population trends, whether they are increasing, stable, or decreasing; (4) hearing range; (5) physiology for underwater hearing; and (6) potential impacts from noise. All of these species-specific and population variables may be relevant to reasonably foreseeable adverse impacts on sea turtles that are subject to active acoustic sound sources (i.e., airguns). However, what is known about the biology and hearing physiology of representative species, in combination with observations of behavioral response to stimuli, allows inferences and conclusions about reasonably foreseeable adverse impacts on sea turtles to be understood with an adequate degree of certainty. Therefore, BOEM has determined that the data or information on sea turtle biology, hearing physiology, seasonal abundances, and population stock in the AOI identified as incomplete or unavailable are not essential to a reasoned choice among the alternatives, including the No Action alternative.

A more complete knowledge base for all types of sea turtles that use the AOI and that bear on the factors listed previously is not available, and such information cannot be acquired without exorbitant cost. Such information certainly cannot be acquired in a timeframe to make it available for this evaluation. While there never will be complete scientific information on sea turtles that live in OCS waters, biological and physiological data and information about the underwater hearing of representative sea turtles are available. These data are sufficient to draw inferences and conclusions about the types of sea turtles that are less understood. While BOEM reports where limited data and insufficient knowledge challenge our ability to understand how and when specific types of sea turtle species use the AOI and that bear on the factors listed earlier, incomplete or unavailable information does not affect our ability to understand and assign impacts or design mitigation strategies. BOEM can draw basic conclusions despite incomplete or unavailable information, discuss results using available scientifically credible information, and apply that information using accepted scientific methodologies.

Masking

Masking is a reduction in the detectability of a given sound (signal) as a result of the simultaneous occurrence of another sound (noise) (Popper et al., 2014). In general, anthropogenic noise “may affect the reception of sound by sea turtles and potentially interfere with their communication, to such a degree that it has a negative effect on hatchling survivorship and adult communication” (Ferrara et al., 2013). However, the potential for masking impacts on sea turtles is difficult to evaluate because the role of sound in their ecology is not known. As described in **Appendix I**, sea turtles can hear low-frequency sounds and have some ability to make sounds. Nunny et al. (2008) hypothesized that the natural sounds of the surf zone may help nesting sea turtles find their nesting site, and Cook and Forrest (2005) hypothesized that grunts made by nesting sea turtles may be for communication. Ferrara et al. (2014) identified four types of sounds in leatherback sea turtle nests during incubation and hypothesized that sounds are used to coordinate group behavior in hatchlings. Recent studies of a freshwater turtle species identified 11 types of sounds used to synchronize behavior among hatchlings and coordinate movements of hatchlings and adult females (Ferrara et al., 2013).

Electromechanical sources such as side-scan sonars, CHIRP subbottom profilers, and MBESs that use frequencies above the estimated hearing ranges of sea turtles are not expected to be audible and are expected to have a **nominal** potential for masking.

Most of the available data on the potential ecological roles of sound for sea turtles are from the nesting environment. It is difficult to measure sea turtle sounds offshore and even more difficult to infer their ecological roles. The usefulness of sound for communication, and therefore the potential for significant masking effects, likely would be limited to areas where multiple individuals are present, such as on nesting beaches, in nearshore waters adjacent to nesting beaches, or in *Sargassum* mats inhabited by hatchlings.

Based on the previous discussion, the potential for masking from airguns or electromechanical sources using frequencies within sea turtle hearing ranges cannot be quantitatively evaluated.

Behavioral Responses

Behavioral responses to seismic airguns, including avoidance, agitation, and diving, have been observed for sea turtles in several studies, and are described in detail in **Appendix I, Section 4**. Popper et al. (2014) provided a qualitative assessment of the behavioral responses of sea turtles to airguns. Based on observations of sea turtle response to impulsive sound, they predicted a "high" risk (likelihood) of behavioral responses in the near field (tens of meters), a "moderate" risk at intermediate distances (hundreds of meters), and a "low" risk in the far field (thousands of meters) of impulsive sound sources.

Experimental studies by O'Hara and Wilcox (1990) and Moein et al. (1995) investigated the use of airguns to repel sea turtles from hopper dredges. O'Hara and Wilcox (1990) reported that sea turtles maintained a distance of 30 m (98 ft) from a single operating airgun. The received level of sound generated by the airguns at a distance of 30 m (98 ft) was not determined; McCauley et al. (2000) later estimated it to be 175 to 176 dB re 1 μPa SPL_{peak}. However, actual sound levels received by the sea turtles may have been slightly <175 to 176 dB because calculations by McCauley et al. (2000) did not consider the shallow airgun depth (NSF and USDOI, GS, 2011). Moein et al. (1995) exposed loggerhead sea turtles to received levels of 175, 177, and 179 dB re 1 μPa, and avoidance behavior was observed upon first exposure; however, after three separate exposures to the airguns, the sea turtles stopped responding (i.e., avoidance behavior was no longer observed).

McCauley et al. (2000) examined the response of caged sea turtles (1 green sea turtle and 1 loggerhead sea turtle) as a single airgun approached and departed. The sea turtles showed a noticeable increase in swimming behavior when the received level was >166 dB re 1 μPa rms and became erratic and increasingly agitated at received levels >175 dB re 1 μPa. Because the animals were caged, avoidance behavior could not be monitored. However, the researchers speculated that avoidance would occur at 175 dB re 1 μPa rms (McCauley et al., 2000).

Lenhardt (2002) exposed loggerhead sea turtles contained within a large net enclosure to airgun pulses. At received levels of 151 to 161 dB re 1 μPa, the sea turtles were found to increase swimming speeds, and an avoidance response was observed near a received level of approximately 175 dB re 1 μPa.

Avoidance of airgun impulsive sound by sea turtles has been inferred from field observations of sea turtle behavior during seismic surveys (Holst et al., 2007; Weir, 2007; DeRuiter and Doukara, 2012). Holst et al. (2007) analyzed monitoring data from 11 seismic surveys and found that, for large-scale surveys, the nearest point of approach for sea turtles was closer during periods of airgun silence (139 m [456 ft]) than when the airguns were firing (228 m [748 ft]). Weir (2007) reported that fewer sea turtles were observed near airgun arrays when they were firing than when they were not firing; however, there was no obvious behavioral avoidance (e.g., swimming away) and the increase in the level of impulsive sound during approach of the vessel may have contributed to the response. DeRuiter and Doukara (2012) observed that basking loggerhead sea turtles exhibited a startle response (rapid dive) at a median distance of 130 m (427 ft) in response to the approach of an airgun array. The maximum distance at which a sea turtle dove was 839 m (2,753 ft), corresponding to a received level of 175 dB re 1 μPa SPL_{peak}. Although the approach of the ship may have been a factor, the analysis strongly suggested that airgun impulsive sound was the cause of the response.

Behavioral responses of sea turtles to airgun pulses may not be limited to the avoidance, agitation, and diving behavior that have been observed so far. The range of behaviors is limited in controlled experiments, and shipboard visual observers during seismic surveys cannot see the movements of submerged sea turtles. DeRuiter and Doukara (2012) speculated that startle responses could have negative fitness consequences for individual sea turtles if it interfered with thermoregulation, caused inhabitual energy expenditures, or excluded sea turtles from optimal habitat. The greatest potential for significant effects of behavioral disruption would be during nesting or hatchling emergence in nearshore reproductive habitat adjacent to nesting beaches.

Based on the best available data, sea turtle behavioral responses to airgun impulsive sound may occur at a received level between 166 and 179 dB re 1 μPa. The broadband source levels of airguns used for sound field modeling to analyze potential impacts to resources are 248 dB re 1 μPa at 1 m $SPL_{0\text{-}peak}$ for a large airgun array (8,000 in^3) and 228 dB re 1 μPa at 1 m $SPL_{0\text{-}peak}$ for a single airgun (90 in^3) (refer to **Table 3.4-2**).

In addition to airguns, boomers are the only other active acoustic source that may be audible to sea turtles. Electromechanical sources such as side-scan sonars, CHIRP subbottom profilers, and MBESs that use frequencies above the estimated hearing ranges of sea turtles are not expected to be audible and are expected to have a **nominal** potential for behavioral effects. Boomers have very short pulse lengths and a low source level (refer to **Appendix D**). Therefore, the potential for behavioral responses, if they occurred, probably would be limited to very near the source.

Entanglement Risk

Albeit small, the risk for gear interaction is present; sea turtles can become entangled in some types of lines associated with G&G activities. The G&G permit applications and site-specific EAs set conditions of approval with each activity that would minimize specific impacts caused by gear interactions. With the implementation of mitigations, impacts are expected to be **nominal**.

4.3.2.1.2 Analysis of Active Acoustic Sound Sources

Deep-Penetration Seismic Airgun Survey Activities

Based on the scope of the proposed action, seismic airgun surveys could affect individuals from all sea turtle species within the AOI. Surveys conducted within Federal coastal waters could affect all species and greater numbers of individuals than deepwater surveys. Deepwater surveys are likely to affect fewer sea turtles, with impacts generally limited to adult leatherback and loggerhead sea turtles as well as hatchlings and oceanic-stage juveniles associated with floating *Sargassum* mats and other flotsam. Surveys conducted during summer sea turtle nesting periods within Federal coastal waters may affect greater numbers of adult sea turtles, particularly loggerhead, green, and Kemp's ridley sea turtles, than surveys conducted during non-nesting periods. Designated critical habitat for hatchling loggerhead sea turtles ("*Sargassum* Habitat") is shown in **Figure 4.3-2** and includes offshore waters of the EPA as well as most of the CPA and WPA. The spatiotemporal distribution and density of *Sargassum* mats and weed lines in the GOM is dynamic and may vary seasonally and annually (*Federal Register*, 2014b). Therefore, it is difficult and impractical to use the entire designated *Sargassum* critical habitat as an area to protect from project-related IPFs.

Subadult and adult sea turtles may more likely be affected by seismic airgun noise than hatchling and juvenile sea turtles because of the greater time that adults and subadults spend submerged and at depth. Hatchling and oceanic-stage juvenile sea turtles generally reside at or very near the sea surface and dive to shallow depths (Salmon et al., 2004; Witherington et al., 2012), so they may be less likely to be injured by the sound field produced by an airgun array during a survey because of the destructive interference of waterborne seismic signals at the sea surface due to the "Lloyd mirror" (image interference) effect (Urick, 1983). However, the reflection of impulsive sound at the sea surface is complex and any sound exposure benefit to animals located near the surface will be hard to accurately predict. The close association of hatchling and oceanic-stage juvenile sea turtles with dense *Sargassum* may provide some absorption and attenuation of impulsive sound.

Alternative A includes operational mitigation measures that, as described in **Chapter 2.3.2 and Appendix B**, would be implemented during seismic airgun surveys. These measures include the establishment of a 500-m (1,640-ft) exclusion zone, visual monitoring by qualified PSOs, and ramp-up requirements (implementation of the PSO Program and Seismic Airgun Survey Protocol). The purpose of the mitigation measures is to prevent serious injury to sea turtles (and marine mammals) by providing a warning and giving animals the opportunity to move from the area where sound levels will be high or to avoid exposing them to high-intensity impulsive sounds when they are present within an established exclusion zone around an airgun array. However, under Alternative A, these measures are required only for seismic airgun surveys in water depths >200 m (656 ft) in the WPA and CPA and in all water depths in the EPA. Most sea turtle species (except leatherback, hatchling loggerhead, and possibly Kemp's ridley sea turtles) within the AOI are distributed within the waters of the continental shelf (i.e., at depths <200 m [656 ft]). This mitigation measure would benefit leatherback sea turtles in areas with depths >200 m (656 ft). It is not likely that hatchling and oceanic-stage juvenile sea turtles would be sighted by PSOs. Therefore, most sea turtles within the WPA and CPA that are distributed on the continental shelf do not benefit from this mitigation measure, but impacts to those life stages may be reduced by their epipelagic habits and close association with *Sargassum* as discussed earlier.

Although the mitigation measures require clearance of the exclusion zone for sea turtles prior to start-up, they do not require shutdown for sea turtles; consequently, some individual sea turtles may be exposed to sound levels that could lead to TTS or PTS. In areas where the measures are used, there will be little potential for deaths or life-threatening injuries from airgun activities. The protocols, however, would not prevent auditory injury or behavioral disturbances to sea turtles at distances beyond the exclusion zone. As noted previously, avoidance reactions by sea turtles to seismic signals have been observed at received SPLs between 166 and 179 dB re 1 μPa (Moein et al., 1995; McCauley et al., 2000).

Under Alternative A, it is estimated that, over the 10-year period (**Table 3.2-1**), a total of 397 to 561 VSP surveys will be conducted within the AOI: 75 to 128 in the WPA (annual mean = 12.8); 322 to 419 in the CPA (annual mean = 41.9); and 0 to 14 in the EPA (annual mean = 1.4). The estimated number of VSP surveys was highest for deepwater areas of the WPA and CPA. Estimates for the number of surveys that might be conducted during a 40-year period were not available for this analysis.

Active acoustic sources used for VSP surveys operate at frequencies between 10 and 2,000 Hz, with most energy generated at frequencies <200 Hz (**Table 3.3-2**). As discussed in **Appendix F, Section 1.1.5**, the defining characteristic of a VSP survey (of which there are several types) is that the energy source is deployed near a borehole that contains seismic receivers. During the survey, the sound source is stationary or operated from a limited number of discrete locations from the borehole and, therefore, the acoustic footprint of a VSP survey is restricted to the area surrounding a borehole. In addition, VSP surveys usually are short in duration and often completed in a few days, the exception being seismic while drilling VSP surveys. It is expected that VSP surveys will contribute to ambient acoustic noise levels encountered by sea turtles in the AOI, although noise from expected G&G operations would be survey- or activity-based, occurring on a transient and intermittent basis over the 10-year period of interest.

Detection of sea turtles by visual monitoring during seismic airgun surveys can be difficult, even for experienced observers. Sighting rates for all sea turtles during seismic mitigation surveys were low (0.003 sea turtle sightings per survey hour), which likely reflects lower densities of sea turtles and sighting difficulty for many of the species (Barkaszi et al., 2012). Most life stages of sea turtles likely to be found in the AOI tend to aggregate in mats or weedlines of floating vegetation (e.g., *Sargassum*) and in other flotsam within or near zones of ocean current convergence; however, because of their small size and cryptic coloration, it is unlikely that their presence would be detected by PSOs during seismic surveys. It is uncertain if sea turtles would move away from an approaching seismic source during a survey or during ramp-up of an array prior to initiation of a survey. Observations of sea turtle behavior in response to impulsive sound generated by seismic airguns off Angola by Weir (2007) were not adequate to draw conclusions about the behavioral response of sea turtles to airgun impulsive sound. There was some indication that fewer sea turtles were seen during full-array survey activity, but there was no obvious behavioral avoidance of the airgun array by sea turtles. Weir (2007) claimed that sea turtles observed basking on the surface may not have been able to move away rapidly (on the sea surface) from approaching airguns even if motivated to do so because their responses to approaching objects while resting on the sea surface normally are slow. From the observer records in Barkaszi et al. (2012), 25 percent of recorded behaviors in sea turtles showed a dive response to the vessel or equipment. A sea turtle's response could include diving to depths below the airgun array, which could increase the likelihood of possible auditory impacts. It has long been assumed that early life history stages of sea turtles associated with *Sargassum* habitats were largely or entirely as passive drifters, with little potential for directed movements towards or away from stimuli. Recent work by Putman and Mansfield (2015) has demonstrated active dispersal of early life stages in the GOM, which demonstrates at least a potential for active swimming to avoid adverse stimuli.

Based on this discussion, the most likely impacts to sea turtles would be short-term behavioral responses of individuals in close proximity to operating airgun arrays. In cases where individual sea turtles cannot or do not avoid airgun arrays and are not detected by visual observers, TTS or PTS auditory injuries could occur, but mortality or life-threatening injuries are unlikely and would be limited to the very near field. Seismic airgun surveys proposed under Alternative A would not be expected to result in long-term or permanent displacement of sea turtles from any areas within the AOI, including open ocean habitats and preferred coastal habitats such as seagrass beds, nearshore or inshore hard substrate habitats, or embayments.

Seismic airgun surveys conducted offshore of heavily used nesting beaches during the nesting season within the AOI (April through July or August) could temporarily displace breeding and nesting adult sea turtles and disrupt time-critical activities. Within the AOI, these include nesting habitats for Kemp's ridley sea turtles along the Texas coast and west coast of Florida, and for loggerhead and possibly Kemp's ridley and green sea turtles along the Mississippi, Alabama, and northwest Florida coasts (WIDECAST, 2015). Critical habitat for hatchling loggerhead sea turtles within the AOI is shown in **Figure 4.3-2** and includes discrete "Nearshore Reproductive Habitats" in Florida (Florida Keys to the Gulf Island National Seashore), Alabama, and Mississippi, and "*Sargassum* Habitat," which includes a large percentage of the AOI. Many adult females linger near the nesting beaches before and between nesting events, resting under rocky ledges and outcrops, or partially burying themselves in soft sediments within inner shelf waters for weeks. Depending on many factors, including (1) the distance of the survey from shore, (2) local factors such as seafloor topography and seafloor substrate that affect the propagation of underwater sound, and (3) the duration and intensity of survey effort in this area, breeding adults, nesting adult females, and hatchlings could be exposed to airgun seismic survey-related sound exposures. Because of the potential for propagation of higher levels of impulsive sound into shallower water, individual sea turtles could be exposed to higher levels of sound. Potential impacts could include auditory injuries to and dispersion of breeding or nesting adults as well as some auditory impacts to hatchlings.

Overall, the potential impacts to sea turtles within the AOI from airgun noise are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Due to limited seismic survey protocols within the AOI (i.e., no protocols required within shelf waters of the WPA and CPA), most impacts likely would consist of behavioral disturbances as well as some TTS- and PTS-level auditory impacts. No lethal or population-level impacts from PTS auditory injuries are likely or expected. Because of the distance of operations from nesting beaches, disruption of critical time-sensitive behaviors such as nesting, breeding, or the emergence and dispersion of hatchlings, and protracted displacement of individual sea turtles from critical habitat are not expected. From this analysis, the mitigation measures that would be implemented, and considering the impact-level criteria (**Chapter 4.3.2**), seismic airgun survey impacts to sea turtles would be **minor**.

Non-Airgun HRG Survey Activities

Non-airgun HRG survey activities associated with Alternative A would use only electromechanical sources such as boomer, sparker, and CHIRP subbottom profilers; side-scan sonar; and MBESs. As discussed in **Appendix F, Section 1.3**, the frequency ranges of these sources used for this analysis are as follows:

- pinger (2,000 Hz);
- sparker (50 to 4,000 Hz);
- boomer (300 to 3,000 Hz);
- CHIRP subbottom profiler (0.5 to 24 kHz);
- side-scan sonar (usually 16 to 1,500 kHz);
- SBES (12 to 240 kHz); and
- MBES (50 to 400 kHz).

According to the ScOT report results (**Appendix G**), acoustic outputs from electromechanical sources other than the boomer and sparker are not likely to be detectable by sea turtles, whose best hearing is below 1,200 Hz for adults and 1,600 Hz for juveniles (**Appendix I**). If these sources are used and operated at a frequency within the hearing range of sea turtles, there could be sound-related impacts (mostly behavioral effects and perhaps some TTS-related impacts). However, the use of these active sound sources with outputs outside of the adult sea turtle hearing range of 50 to 1,200 Hz (up to 1,600 Hz for juvenile sea turtles) during the proposed activity is expected to have **no impact** to sea turtles within the AOI.

Boomer or sparker subbottom profilers have operating frequency ranges of 300 to 3,000 Hz and 50 to 4,000 Hz, respectively, and so may be audible to sea turtles; however, they have very short pulse lengths (120, 150, or 180 μs) and operate at very low source levels. As discussed in **Appendices E and I, Section 3**, the hearing sensitivity of sea turtles is substantially less than that of marine mammals or fishes. Where hearing thresholds of sea turtles are at 93 to 117 dB at their most sensitive frequencies, some odontocetes have peak sensitivity thresholds of approximately 30 or 40 dB, and some fish species have peak sensitivity thresholds of approximately 50 dB. Therefore, even though sea turtles might be able to hear these sources, they are much less susceptible to impacts because of their low sensitivity. Under Alternative A, there are no mitigation measures that include non-airgun HRG survey protocols.

The potential impacts from electromechanical sources operating at frequencies within the hearing ranges of sea turtles are not expected to result in changes to growth, survival, annual reproductive success, or lifetime reproductive success (fitness) of most individuals. Most impacts likely would be limited to behavioral disturbances and TTS-level auditory impacts. Individual sea turtles may experience long-term auditory injuries (PTS), but the animal would have to be very close to the electromechanical source to experience sound levels capable of causing PTS injuries. In the case of non-airgun HRG survey activities using electromechanical sources within the hearing range of sea turtles, no lethal or population-level impacts from PTS auditory injuries are expected. From this analysis, non-airgun HRG survey impacts to sea turtles are expected to range from **nominal** to **minor**.

4.3.2.1.3 Vessel and Equipment Noise

Underwater noise generated by G&G vessels could disturb sea turtles or contribute to auditory masking during the project period. As discussed in **Chapter 3.3.1.3**, vessel noise is a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995). Narrow-band tones typically dominate up to 50 Hz, whereas broadband sounds may extend to 100 kHz. The dominant source of underwater noise generated by vessels is from propulsion gear, primarily propeller operation. The intensity of this noise is largely related to vessel size and speed. Vessel and equipment noise from G&G vessels, including survey and support vessels associated with activities described in the proposed action, would produce low levels of noise. Broadband source levels for most small ships (a category that would include seismic survey vessels and support vessels for drilling of COST wells or shallow test wells) are 170 to 180 dB re 1 μPa at 1 m, and source levels for smaller boats (a category that would include survey vessels for renewable energy and marine minerals sites) are 150 to 170 dB re 1 μPa at 1 m (Richardson et al., 1995).

Vessels associated with various activities under the proposed action are discussed in **Chapters 3.2 and 3.3** and listed in **Table 3.3-3**. Vessels conducting oil and gas G&G deep-penetration seismic airgun surveys (2D, 3D, and 4D surveys) are approximately 100 m (328 ft) in length and would account for most of the proposed survey miles traveled. Other oil and gas activity vessels range from 20 to 100 m (66 to 328 ft) in length. Renewable energy activity vessels range from 20 to 100 m (66 to 328 ft) in length, and marine mineral activity vessels range from 20 to 30 m (66 to 98 ft) in length. Under Alternative A, deep-penetration seismic airgun surveys could occur anywhere within the AOI. Most seismic airgun surveys, however, will occur in deepwater areas of the CPA throughout the project period (**Table 3.2-2**). One to three diesel-powered survey and support vessels are expected to be associated with conventional 2D and 3D NAZ surveys. The WAZ surveys generally involve multiple vessels operating in concert in a variety of vessel geometries, and each WAZ vessel would have several support vessels (**Appendix F, Section 1.1.4**). In general, large seismic vessels will remain offshore for weeks or months, receiving fuel, supplies, and crew via smaller support vessels and helicopters. Traffic associated with support vessels and helicopters is provided in **Table 3.3-3**.

The most likely effects of vessel and equipment noise on sea turtles would include behavioral changes and auditory masking. Vessel and equipment noise is transitory and generally does not propagate great distances from the vessel; furthermore, the source levels are too low to cause death or injuries such as auditory threshold shifts. Based on existing studies on the role of hearing in sea turtle ecology, it is unclear whether masking resulting from vessel and equipment noise would impact sea turtles. Behavioral responses to vessels have been observed but are difficult to attribute exclusively to noise rather than to visual or other cues. Nevertheless, it is conservative to assume that noise associated with G&G survey and support vessels may elicit behavioral changes in individual sea turtles near the vessels. Behavioral changes likely would be limited to evasive maneuvers such as diving, changes in swimming direction, or changes in swimming speed to distance themselves from vessels. Evasive behavior is not expected to adversely affect these individuals or local populations; impacts under Alternative A would be **nominal**.

Geotechnical surveys include measuring conductivity, pressure, and temperature; geologic coring; and grab sampling. Sediment sampling and testing locations for geotechnical surveys are guided by geophysical data and maps generated during HRG surveys. The acoustic characteristics of these sources are discussed in **Appendix D** and expected to be outside the hearing range of sea turtles. Noise produced by these devices is not expected to affect sea turtles in the AOI.

Other sound sources associated with geotechnical surveys under Alternative A include the drilling of potentially up to one COST well and up to two shallow test wells in AOI during the time period of this Programmatic EIS. As discussed in **Chapter 3.3.1.2.2**, noise from drilling operations includes strong tonal components at low frequencies (<500 Hz), including infrasonic frequencies in at least some cases (Richardson et al., 1995). Machinery noise can be continuous or transient and can be variable in intensity. Noise levels vary with the type of drilling rig (as shown here) and water depth (Wyatt, 2008).

Equipment	Bandwidth (kHz)	Source Level (dB re 1 μPa)
Jack-up platform	0.005	119-127
Semisubmersible platform	0.01-10	154
Drillship	0.01-1	125-195

Because of the very low sound frequencies produced by drilling equipment operated from jack-up platforms, drilling activities from these platforms may be inaudible to sea turtles because the drilling equipment is not directly coupled with the water. In contrast, drilling-related sounds from semisubmersible drilling vessels likely would be audible to sea turtles.

Dynamic positioning is a computer-controlled system to automatically maintain a vessel's position and heading by using its propellers and thrusters. Vessel types that employ DP include ships and semisubmersible MODUs. The DP thrusters produce broadband noise (e.g., 137 dB rms at 405 m) at bandwidths between 100 Hz and 10 kHz (McCauley, 1998). Drilling and DP-related noise is continuous, and sound generated by DP may elicit behavioral responses in sea turtles, such as temporary avoidance or displacement of individual sea turtles from some radius around the drilling area. Studies of sea turtles in the proximity of platforms are not conclusive on whether the sea turtles may habituate to the continuous sound source. During the timeframe of this Programmatic EIS, very few drilling activities are anticipated to occur (potentially only 1 COST well and up to 2 shallow test wells). Therefore, impacts to sea turtles from drilling-related noises associated with the proposed activity would be **nominal**.

4.3.2.1.4 Vessel Traffic

As presented in **Table 3.3-3**, 19,689 support vessel trips and 993 survey vessel trips are estimated for proposed operations within the AOI over the 10-year period. Most trips will occur within the CPA and WPA because the highest level of activity is projected there (**Table 3.2-1**). Very few vessel trips are expected to occur within the EPA. The G&G survey vessels could strike and injure or kill sea turtles because it is difficult for PSOs to detect sea turtles under the best observational conditions, much less when the water surface is rough or other conditions occur that inhibit visual detection of smaller animals such as sea turtles. In addition, it is difficult to maneuver a survey vessel towing airgun arrays to avoid sea turtles that may be detected. Propeller and hull collision injuries to sea turtles resulting from interactions with boats and ships are common, and the problem of vessel strikes on sea turtles is an increasing concern, especially in certain areas (such as the southeastern U.S.) where increased development along the coasts is likely to result in increased recreational boat traffic (Hazel and Gyuris, 2006; Hazel et al., 2007). From 1997 to 2005, 14.9 percent of all stranded loggerhead sea turtles in the U.S. Atlantic Ocean and GOM were documented as having sustained some type of propeller or vessel collision injury; the study, however, did not indicate what proportion of observed injuries were post- or ante-mortem (USDOC, NMFS and USDOI, FWS, 2008).

Sea turtles may be able to actively maneuver within the water column to avoid collisions with approaching slow-moving (4.5 kn [5.2 mph]) survey vessels; however, support vessels travel at much faster speeds, and sea turtles may not be able to avoid them. Based on knowledge of their sensory biology (Bartol and Musick, 2003; Levenson et al., 2004; Bartol and Ketten, 2006; Moein-Bartol and Ketten, 2006), sea turtles may detect objects such as vessels, prey, and predators in the water column by means of auditory and visual cues. However, research examining the ability of sea turtles to avoid collisions with vessels shows they may rely more on visual than auditory cues (Hazel et al., 2007). There have been no documented sea turtle collisions with vessels that supported offshore operations during the past 40 years of OCS Oil and Gas operations (USDOC, NMFS, 2007). Collisions with small or submerged sea turtles, or during nighttime or periods of poor visibility, may go undetected and undocumented. Mortalities from vessel collisions outside shallow coastal and inshore waters are poorly documented, as sea turtles are negatively buoyant and remains sinking in deep water are very unlikely to be recovered (Stacy, official communication, 2015). Under Alternative A, all authorizations for shipboard surveys would include guidance for vessel strike avoidance (i.e., NTL 2016-BOEM-G01), which applies to all existing and future oil and gas operations on the Gulf of Mexico OCS. The guidance protocols are discussed in **Appendix B, Section 1**. However, during nighttime and because of the relatively small size of sea turtles, some individuals will go unobserved and may be struck by a vessel. Seismic vessels, which account for most of the project-related vessel traffic associated with Alternative A activities, survey at a speed of approximately 4.5 kn (5.2 mph), a speed at which all life stages of sea turtles present in the AOI, except hatchlings, would have the ability to avoid collision. In addition, waters surrounding survey vessels would be monitored by PSOs during daylight operations for the presence of sea turtles. Collisions between seismic survey vessels (when collecting data) and sea turtles during daylight hours would be unlikely.

Seismic vessels and survey support vessels (e.g., supply vessels and chase boats) usually operate at higher speeds (10 to 12 kn [12 to 14 mph]) during transits than when collecting data during surveys. Collisions between these vessels and sea turtles, particularly at night and during inclement weather, would be unlikely but possible, and a few individual sea turtles are expected to be at risk of injury or mortality over the duration of the action. While mortality from vessel collision frequently is documented in sea turtle stranding data, the issue is most prevalent in shallow inshore and near-coastal waters with high densities of high-speed vessel traffic (Singel et al., 2007). Considering the previous analysis, potential impacts to sea turtles within the AOI from vessel traffic would be **nominal**; however, in the unlikely event a sea turtle is struck and injury or mortality occurs, impacts would be **moderate**.

4.3.2.1.5 Aircraft Traffic and Noise

Aircraft traffic and noise would result from remote-sensing surveys (aeromagnetic surveys) and helicopter support during drilling of COST wells, shallow test wells (**Chapter 3.2.1**), and support and service during deep-penetration seismic airgun surveys. BOEM anticipates that one aeromagnetic survey may be conducted in the AOI during the time period covered by this Programmatic EIS (**Chapter 3.2.1.2**). Helicopter flights will be used to conduct crew changes for larger seismic vessels; the number of anticipated transits is provided in **Table 3.3-3** and discussed in **Chapter 3.3.1.4**. Remote-sensing surveys associated with oil and gas exploration and development activities would include aeromagnetic surveys (**Appendix F, Section 1.5**). The surveys would be conducted by fixed-wing aircraft flying at speeds of approximately 135 kn (155 mph) (Reeves, 2005). Most offshore aeromagnetic surveys are flown at altitudes between 61 and 152 m (200 and 500 ft). A typical aeromagnetic survey may require 1 to 3 months to complete. Potential impacts to sea turtles from aircraft traffic include noise and physical (visual) disturbance.

Noises generated by project-related survey aircraft directly relevant to sea turtles include airborne sounds to individuals on the sea surface and underwater sounds from air-to-water transmission from passing aircraft. Helicopters and fixed-wing aircraft generate noise from their engines, airframe, and propellers. The dominant tones for both types of aircraft generally are <500 Hz (Richardson et al., 1995) and within the auditory range of sea turtles (**Appendix I**). The transmission of aircraft noise into water depends on aircraft altitude, aspect (direction and angle) of the aircraft relative to the receiver, and sea surface conditions. The level and frequency of transmitted sounds propagating through the water column are affected by water depth and seafloor type (Richardson et al., 1995). Because of the expected airspeeds and these physical variables, noise (airborne and underwater) generated by G&G survey aircraft is expected to be brief in duration.

The physical presence of low-flying aircraft can disturb sea turtles, particularly those on the sea surface. Behavioral responses to flying aircraft include diving or abrupt changes in swimming speed or direction. It is projected that 7,497 helicopter trips would occur over the 10-year period. Considering the relatively small number of aeromagnetic surveys, COST wells, and shallow test wells associated with the proposed activity, along with the short duration of potential exposure of aircraft-related noise and physical disturbance to sea turtles because of aircraft airspeed, potential impacts to sea turtles within the AOI from this activity would be **nominal**.

4.3.2.1.6 Trash and Debris

While the release of trash and debris is not considered a routine activity, the potential for release is considered as a part of routine activities. Trash and debris pose two types of negative impacts to sea turtles: (1) entanglement, and (2) ingestion. Entanglement in trash and debris, particularly buoyant trash and debris, can pose a significant hazard to sea turtles. Loggerhead sea turtles have been found entangled in a wide variety of materials, including steel and monofilament line, synthetic and natural rope, plastic onion sacks, and discarded plastic netting (USDOC, NMFS and USDOI, FWS, 2008). From 1997 to 2005, 1.6 percent of stranded loggerhead sea turtles found on Atlantic and GOM beaches were entangled in fishing gear. Monofilament line appears to be the principal source of entanglement for loggerhead sea turtles in U.S. waters (0.9%; 1997 to 2005 average), followed by pot/trap line (0.4%; 1997 to 2005 average) and fishing net (0.3%; 1997 to 2005 average). Less than 1 percent of stranded sea turtles in 2005 were found entangled in other trash and debris (USDOC, NMFS, unpublished data, as cited in USDOC, NMFS and USDOI, FWS, 2008).

In addition, debris item(s) may be mistaken for food and ingested, or ingested accidentally with other food. Debris ingestion may lead to loss of nutrition, internal injury, intestinal blockage, starvation, and death (USDOC, NOAA, 2015a). The habitat association of oceanic phase juvenile sea turtles with *Sargassum* makes them particularly vulnerable to impacts from the ingestion of trash and debris. The oceanic convergence zones that concentrate *Sargassum* also concentrate other buoyant materials, notably including plastics and tar (Thiel and Gutow, 2005). Dietary samples collected by esophageal lavage from 42 oceanic-stage juvenile Kemp's ridley and green sea turtles associated with *Sargassum* in the GOM revealed that 67 percent of the sea turtles sampled contained plastics and that plastics averaged 13 percent of the total dry weight of collected samples (Witherington et al., 2012).

The MARPOL is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL includes regulations aimed at preventing and minimizing pollution from ships (both accidental pollution and from routine operations) and currently includes six technical Annexes. Special Areas with strict controls on operational discharges are included in most Annexes. Annex V (Prevention of Pollution by Garbage from Ships) addresses different types of garbage and specifies the distances from land and the manner in which they may be disposed; the most important feature of Annex V is the complete ban imposed on the disposal of all forms of plastics into the sea. The revised Annex V prohibits the discharge of all garbage into the sea, except as provided otherwise. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste.

The G&G survey operations associated with Alternative A will generate trash made of paper, plastic, wood, glass, and metal. In addition to adherence to the revised provisions of MARPOL Annex V, USCG and USEPA regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. Under Alternative A, all authorizations for offshore G&G activities would include guidance for the handling and disposal of trash and debris (NTL 2015-BSEE-G03).

Taking into account the USCG and USEPA's regulations, as well as BSEE's guidance, trash and debris from G&G activities released deliberately into the marine environment will be eliminated. Any solid material that is released overboard during routine operations is considered accidental and not likely to occur. Debris would consist only of isolated items accidentally lost overboard. Therefore, debris entanglement and ingestion impacts on sea turtles are expected to be **nominal**.

4.3.2.1.7 Entanglement and Entrapment

Sources of entanglement hazards in the proposed action that may impact sea turtles within the AOI include placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor for various activities within the Oil and Gas Program.

Acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines pose an entanglement risk to sea turtles and other marine life. Entanglement is possible with OBC surveys, which are discussed in **Appendix F, Section 1.1.3**. The deployment of nodes and cables is accomplished using an ROV, by dropping nodes on a tether, or by laying cables off the back of a layout boat. According to BOEM, as of 2013, there was only one reported sea turtle entanglement incident during a seismic survey nodal survey (USDOI, BOEM, 2013c).

Risk of entanglement to sea turtles may be reduced by implementing the following measures: (1) shortening acoustic buoy and tethered acoustic pinger lines to the shortest length practical; and (2) replacing tether rope lines <0.25 inches in diameter with a thicker, more rigid tether line or modifying the line by tying knots along its length to increase the diameter and rigidity (USDOI, BOEM, 2013c). Additional measures include having a PSO on board vessels during tethered node retrieval operations. The PSOs will document any entanglement of marine species in the nodal gear, specifically noting the location where entanglement occurred (e.g., pinger tether, acoustic buoy line). The PSO must contact the sea turtle stranding network State coordinator to report the incident and condition of the sea turtle, and request additional instructions to reduce risk of injury or mortality, including rehabilitation and salvage techniques.

Towed seismic equipment for 2D, 3D, 4D and WAZ surveys pose an entrapment risk to sea turtles. Due to the large footprint of the towed equipment and the generally low maneuverability of sea turtles, these configurations could entrap sea turtles who may subsequently be injured or drowned. Entrapment impacts are only applicable to sea turtles. There are no published data regarding actual numbers of sea turtle entrapments in towed gear, and much is speculated regarding the interaction between sea turtles and seismic gear (Nelms et al., 2016). In the GOM, there were no documented cases of sea turtle entrapment in towed gear between the 2002 and 2008 sighting reports (Barkaszi et al., 2012). However, it is highly possible that entrapments go unnoticed and that sea turtles (live or dead) are freed during the recovery process due to the changes in equipment position and tension.

The OBC/OBN (nodal) survey locations and projected levels are not estimated; however, nodal surveys are relatively uncommon and typically used in shallow waters. Given the scope and transitory nature of OBC/OBN surveys associated with Alternative A, and the implementation of risk-reducing measures described previously, debris entanglement and equipment entrapment impacts on sea turtles are expected to be **nominal**.

4.3.2.1.8 Routine Activities Impact Conclusions

This analysis considered the impact-level criteria, AOI, and 10-year timeframe. Mitigation measures associated with Alternative A are outlined in **Chapter 2.3** and detailed in **Appendix B**. As discussed previously, the degree to which these mitigation measures (collectively) will affect the levels of impact to sea turtles from each project-related IPF (including routine activities) is as follows:

- deep-penetration airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **nominal** to **minor**;
- vessel and equipment noise – **nominal**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris – **nominal**; and
- entanglement and entrapment – **nominal**.

Impacts to sea turtles from routine activities under Alternative A are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Implementation of mitigation measures described under Alternative A may reduce potential impacts from the IPFs listed earlier to individuals within the AOI. Impact levels by IPF were determined using impact-level criteria discussed in **Chapter 4.3.2**, and each impact level was determined by considering effects to sea turtles within the AOI as a whole.

4.3.2.2 Impacts of an Accidental Fuel Spill

This analysis considered an accidental release of 1.2 to 7.1 bbl of diesel fuel from a vessel collision or during fuel transfer. As described in **Chapter 3.3.2**, a spill of this size and nature is very unlikely but still reasonably foreseeable. Data from BSEE showed there were 77 petroleum spills, ranging from 1 to 9 bbl, from OCS Oil- and Gas-related activities between 2009 and 2013 (USDOI, BSEE, 2014a). In addition, the NSF and USDOI, GS (2011) noted in their programmatic analysis of impacts associated with seismic research that there has never been a recorded oil/fuel spill during >100,000 km (62,137 mi; 54,000 nmi) of NSF-funded seismic surveys. Due to the extensive network of commercial shipping lanes/fairways in the GOM, traffic coordination and regulation by USCG, and regulation of structures on the OCS under the OCSLA, vessel to-vessel collisions and vessel-to-structure collisions have been minimal compared to the extent of existing vessel traffic and movement. According to BSEE's Incident Statistics and Summary Reporting (USDOI, BSEE, 2014a), from 2007 to 2014, 137 collisions (including a vessel striking another vessel and a vessel striking a stationary vessel or object such as a platform) occurred within the GOM.

As discussed in **Chapter 3.3.2**, diesel fuel spilled at the ocean surface would readily disperse and weather. Diesel fuel most often is a light, refined petroleum product classified by the API as a Group 1 oil based on its specific gravity and density, and is not persistent within the marine environment (API, 1999). When spilled on water, diesel oil quickly spreads to a thin sheen; marine diesel, however, may form a thicker film of dull or dark colors. Because diesel oil is lighter than water (specific gravity is between 0.83 and 0.88, compared with 1.03 for seawater), it cannot sink and accumulate on the seafloor as pooled or free oil unless adsorption with sediment occurs.

However, diesel oil dispersed by wave action may form droplets small enough to be kept in suspension and moved by currents (USDOC, NOAA, 2015b). As diesel spreads on the sea surface, evaporation of the oil's lighter components occurs. Evaporation rates increase in conditions of high winds and sea state as well as high atmospheric and sea surface temperatures (API, 1999; USDOC, NOAA, 2006). Small diesel spills usually evaporate and disperse naturally within a day.

Sea turtles could be affected by an accidental diesel fuel spill during G&G activities. Effects of spilled oil on sea turtles are discussed by Geraci and St. Aubin (1987), Lutcavage et al. (1995, 1997), Milton et al. (2003) and Shigenaka et al. (2010), and are summarized in this chapter. Ingested diesel fuel, particularly the lighter fractions, can be acutely toxic to sea turtles. Oil, including refined diesel fuel, may affect sea turtles through various pathways such as direct contact, inhalation of the fuel and its volatile components, and ingestion (directly or indirectly through the consumption of fouled prey species) (Geraci and St. Aubin, 1987). Several aspects of sea turtle biology and behavior place them at risk, including lack of avoidance behavior, indiscriminate feeding in convergence zones, and inhalation of large volumes of air before dives (Milton et al., 2003). The severity, rate, and effects of exposure to oil varies by life stage. For example, hatchling and oceanic-stage juvenile sea turtles (including juveniles associated with *Sargassum*) exposed to spilled oil or fuel in open ocean environments would be subject to the same oil exposure hazards as adults, which are at risk when they surface to breathe or rest on the sea surface; however, because hatchlings and oceanic-stage juveniles spend a greater proportion of their time at the sea surface, their risk of exposure to floating oil slicks or oiled *Sargassum* is increased (Shigenaka et al., 2010). *Sargassum* is further discussed in **Chapter 4.8**. Oil and diesel fuel can adhere to sea turtle skin and shells. Studies have shown that direct exposure of sea turtle sensitive tissues (e.g., eyes, nares, other mucous membranes) and soft tissues to diesel fuel or volatile hydrocarbons may produce irritation and chemical burns, which may lead to secondary infections. Sea turtles surfacing within or near a diesel release would be expected to inhale petroleum vapors, causing respiratory stress. Ingesting oil or fuel may cause injury to the gastrointestinal tract, which may affect the animals' ability to absorb or digest foods. Toxic chemicals in oil or fuel that are inhaled or ingested may damage organs, impair brain function, cause anemia and immune suppression, or lead to reproductive failure or death (Shigenaka et al., 2010).

A small accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean; small diesel spills usually evaporate and disperse within a day, even in cold water (USDOC, NOAA, 2006). The spilled fuel presumably would rapidly spread to a layer of varying thickness and break up into narrow bands, or windrows, parallel to the wind direction. The rate at which the oil spreads would be determined by the prevailing conditions (e.g., temperature, water currents, tidal streams, wind speeds). The fuel spill is not likely to result in death or life-threatening injury of individual sea turtles or hatchlings, or the long-term displacement of adult sea turtles from preferred feeding, breeding, or nesting habitats or migratory routes. A small diesel fuel spill in the ocean is unlikely to reach sea turtle nests, which usually are positioned above the high tide line. Therefore, potential impacts to sea turtles within the AOI are expected to range from **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick).

4.3.2.3 Cumulative Impacts

4.3.2.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.3.2.1 and 4.3.2.2** determined that activities projected to occur under Alternative A would result in **nominal** to **minor** impacts to sea turtles, with the exception of an accidental strike, which could result in a **moderate** impact, such as injury or death of an individual. The determination of noise-related impacts to sea turtles was made with the assumption that seismic survey protocols and associated impact mitigation measures would prevent the lethal take of any individual turtle. The following analysis considers whether those incremental impacts, when added to or acting synergistically with other impact sources from the cumulative impacts scenario, may result in a significant impact.

Cumulative incremental impacts to sea turtles from the proposed action, when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, the minimization of Outer Continental Shelf G&G-related impacts through stipulations and regulations, and the wide-ranging behavior of sea turtles, would be expected to be **negligible** with no anticipated population-level impacts.

4.3.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes the other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for sea turtles are compared with the IPFs from each of the cumulative scenario components on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). **Figure 3.4-1** shows the spatial distribution of cumulative activities, indicating that most of the cumulative activities are concentrated in shallow shelf waters. Non-OCS G&G-related IPFs that may affect sea turtle populations include (1) Federal and State oil and gas activity; (2) noise from non-OCS G&G-related sources (i.e., from commercial fishing, recreational vessels, military activities, commercial shipping, tourism, construction); (3) vessel and aircraft traffic; (4) entanglement and entrapment (i.e., commercial fishing); (5) habitat disturbance; (6) pollution; (7) natural phenomena including disasters; (8) natural phenomena, disasters, and disease; and (9) scientific research. The factors that may have the largest impacts to sea turtles are outlined below.

Federal and State Oil and Gas Activity

Because of expected mitigations (e.g., BOEM and BSEE proposed compliance with NTLs under the proposed Protected Species Stipulation and COAs on post-lease activities), oil and gas activities (e.g., noise or transportation), and accidental events (e.g., oil spills) related to oil and gas activity 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 the 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 oil and gas activities and accidental events, such as oil spills, 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.

In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (i.e., SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. For more information on impacts from oil and gas activity to sea turtles, refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.9.2 of the 2017-2022 GOM Multisale EIS.

Noise

Primary sources of noise associated with the cumulative scenario that may impact sea turtles include active acoustic sound sources, vessel and equipment, and aircraft. Each source is discussed in separate sections below.

Active Acoustic Sound Sources

Cumulative impacts are assessed in this analysis for the cumulative activities that produce active acoustic sound sources, including State waters oil and gas, commercial fishing, cable installation, military, and scientific research activities (**Table 3.4-1**). Certain oil and gas, renewable energy, and marine minerals activities such as drilling, trenching, pile-driving, and decommissioning are discussed under “Vessel and Equipment Noise” because they are not active acoustic sounds, but rather are related to equipment.

Oil and gas activities in State waters would produce active acoustic sounds in shelf waters, whereas scientific research, military activities, and commercial fishing activities (using sonar) could contribute active acoustic sound throughout the AOI. Activities in the cumulative scenario are not expected to overlap spatially with proposed G&G activities due to spatial avoidance of activities; however, temporal overlap may occur.

The level of proposed activities represent an incrementally significant addition to similar activities within the GOM, especially within deepwater environments of the CPA and WPA. Airgun noise from activities may propagate into and combine with activities occurring in State waters. Due to distance, the intensity of active acoustic source sounds associated with the proposed activity entering State waters would be significantly attenuated from source levels, and effects to sea turtles would range from no observable effect to some behavioral disturbances. The contribution of noise associated with proposed deep-penetration and HRG survey activities to current conditions under the cumulative scenario will result in an increase in active acoustic noise, producing a **nominal** to **minor** incremental increase in active acoustic sound impacts to sea turtles.

Vessel and Equipment Noise

Vessel noise is a major contributor to ambient noise levels within the GOM, particularly in the low-frequency bands (Snyder, 2007). Vessel noise is contributed by many of the cumulative scenario activities (**Table 3.4 1**). As discussed in **Chapter 4.3.2.1**, noise from vessel traffic is generated from vessel propulsion systems and internal machinery (the latter also termed equipment noise), and is the dominant source of underwater noise at frequencies <300 Hz in many areas. Commercial ships and smaller vessels have been increasing in number and size, and generate increasing amounts of underwater noise as a by-product of their operation. The contribution of shipping to ambient noise is especially high near major ports and heavily travelled shipping lanes. **Table 3.3-3** provides the number of estimated vessels required by survey type and Program Area for the proposed action, including 19,689 trips for support vessels and 1,008 for survey vessels. For cumulative vessel traffic, **Table 3.4-2** provides a summary of projected support vessel operations anticipated for the Oil and Gas Program, and estimates that support vessel trips will range from 828,000 to 1,096,000 for the 10-year span of the cumulative scenario. **Tables 3.4-7 and 3.4-8** provide vessel trip data for all vessels in the GOM. Exact numbers of cumulative vessel traffic associated with renewable energy and marine mineral support activities are not known, but they are expected to be relatively small as well as spatially and temporally limited. Oil and Gas Program support vessel traffic projected in the cumulative scenario is expected to be most concentrated within the WPA and CPA, as would the proposed action vessel traffic. Vessel traffic within the AOI is expected to be somewhat concentrated in lanes and channels near major service centers such as Port Fourchon, Louisiana. The amount of vessel and equipment noise generated by the proposed action is very small compared with what exists under the cumulative scenario.

Sources of equipment noise associated with the cumulative scenario include drilling and production activities, pipeline trenching and placement, decommissioning of offshore structures, pile-driving associated with renewable energy installations, dredging noise from marine mineral activities, military activities, channel dredging, and coastal restoration activities. Sources of equipment noise from the proposed action include drilling noise from a limited number of test wells and noise from DP and jack-up vessels (**Chapter 3.3.1.2**).

The most likely effects of vessel and equipment noise on sea turtles would be behavioral changes and auditory masking. Vessel and equipment noise is transitory and generally does not propagate great distances from the vessel, and the source levels are too low to cause death or injuries such as auditory threshold shifts. Based on existing studies on the role of hearing in sea turtle ecology (**Chapter 4.3.2.1; Appendix I**), whether masking would have any ecological effect on sea turtles is unclear. Behavioral responses to vessels have been observed but are difficult to attribute exclusively to noise rather than to visual or other cues. Nevertheless, noise associated with G&G survey and support vessels may elicit behavioral changes in individual sea turtles near the vessels. These behavioral changes presumably will be limited to evasive maneuvers such as diving, changes in swimming direction, or changes in swimming speed to distance themselves from the vessels.

Proposed activities associated with Alternative A would increase levels of vessel and equipment noise within the AOI, resulting in increases in ambient noise levels within discrete geographical areas (primarily the WPA and CPA) during G&G operations. The proposed action would produce a **nominal** incremental increase in equipment noise impacts to sea turtles under the cumulative scenario for Alternative A.

Aircraft Noise

Aircraft traffic and noise would result from remote-sensing surveys (aeromagnetic surveys) and helicopter support during the drilling of a COST well, shallow test wells, and support and service during deep-penetration seismic airgun surveys. BOEM anticipates that one aeromagnetic survey may be conducted in the AOI during the time period covered by this Programmatic EIS (**Chapter 3.2.1.2**). Helicopter flights will be used to conduct crew changes for larger seismic vessels; the number of anticipated transits is provided in **Table 3.3-3** and discussed in **Chapter 3.3.1.4**. Projections for helicopter operations supporting G&G activities within the AOI over the 10-year project period are estimated to be at least 7,497 trips (**Table 3.3-3**). The cumulative scenario estimates that 7.2 to 13.9 million helicopter trips would occur over the 10-year period (**Table 3.4-2**) to support oil and gas activities.

Helicopters and fixed-wing aircraft generate noise from their engines, airframe, and propellers. The dominant tones for both types of aircraft generally are <500 Hz (Richardson et al., 1995) and within the auditory range of sea turtles (**Appendix I**). Aeromagnetic surveys are conducted at speeds of approximately 135 kn (155 mph) and at altitudes between 61 and 152 m (200 and 500 ft). Typical operational altitudes for helicopters in the GOM are higher than 229 m (750 ft), except when in the vicinity of platforms. Levels of noise received underwater from passing aircraft depend on the aircraft's altitude, aspect (direction and angle) of the aircraft relative to the receiver, receiver depth, water depth, and seafloor type (Richardson et al., 1995). Because of the relatively high expected airspeeds and these physical variables, aircraft-related noise (including airborne and underwater noise) is expected to be very brief in duration at any given point.

The physical presence of low-flying aircraft can disturb sea turtles, particularly individuals resting on the sea surface. Impacts from aircraft traffic under Alternative A are expected to be limited to behavioral disruptions. As discussed in **Chapter 4.3.2.1.4**, observations made from low-altitude aerial surveys report that behavioral responses of sea turtles are highly variable, ranging from no observable reaction to diving or rapid changes in swimming speed or direction. Although projected levels of aircraft traffic from G&G operations under Alternative A would increase existing traffic levels within the AOI, the increase would produce a **nominal** incremental increase in impacts to sea turtles under the cumulative scenario.

Vessel and Aircraft Traffic

Vessel traffic is an IPF associated with all components of the cumulative scenario and is included in the proposed action. Aircraft traffic (physical presence) may disturb sea turtles on or near the sea surface; noise impacts were discussed earlier. The G&G survey and support vessel traffic associated with the proposed action under Alternative A is discussed in **Chapter 3.3.1.3**.

As discussed previously, vessel and aircraft traffic associated with the OCS Program activities will originate from selected ports in the CPA and WPA, and will cross State waters to reach fields within the OCS. This discussion of vessel traffic draws from the previous discussion on vessel noise, with respect to projected and historical OCS Program vessel traffic levels and other cumulative vessel traffic levels. As discussed in **Chapter 4.3.2.1**, underway vessels could collide with sea turtles, particularly individuals that rest on the sea surface between dives. In addition, the physical presence of vessels and aircraft may disturb individuals on or near the sea surface.

For cumulative vessel traffic, **Table 3.4-2** provides a summary of projected support vessel operations anticipated for the Oil and Gas Program and estimates that support vessel trips will range from 828,000 to 1,096,000 trips for the 10-year span of the cumulative scenario. **Tables 3.4-7 and 3.4-8** provide vessel trip data for all vessels in the GOM. Exact numbers of cumulative vessel traffic associated with renewable energy and marine mineral support activities are unknown, but they are expected to be relatively small as well as spatially and temporally limited. Other sources of vessels considered under the cumulative scenario include those associated with oil and gas activities in State waters, drilling and production activities (within State and OCS waters), commercial shipping, commercial and recreational fishing, military activities, scientific research, offshore construction activities, maintenance dredging of Federal channels, dredged material disposal, coastal restoration programs, and Mississippi River hydromodification and subsidence issues (**Table 3.4-1**).

As discussed in **Chapter 4.3.2.1.4**, sea turtles may be vulnerable to physical disturbance from collision (ship strike) with moving vessels. Propeller and hull collision injuries to sea turtles, particularly to the most abundant species in the GOM (i.e., loggerhead sea turtle) resulting from interactions with boats and ships are fairly common (Alderson, 2009). The physical presence of low-flying aircraft can disturb sea turtles, particularly individuals resting on the sea surface, although it is difficult to separate effects from physical disturbance and noise. Based on the projected level of G&G activity under Alternative A, impacts to sea turtles from vessel and aircraft traffic are expected to be limited to behavioral disturbances and were classified as **nominal**. Additional vessel and aircraft traffic from G&G operations under the proposed action would be substantive but would not represent a significant increase to existing vessel traffic from cumulative operations within the AOI (**Tables 3.4-7 and 3.4-8**). Therefore, G&G activities associated with Alternative A would produce a **nominal** incremental increase in impacts from vessel and aircraft traffic to sea turtles under the cumulative scenario.

Entanglement and Entrapment

Activities associated with the cumulative scenario that may deploy equipment posing entanglement risks to sea turtles within the AOI include oil and gas activities in State waters, commercial and recreational fishing, and scientific research. Sources of entanglement that may impact sea turtles within the AOI include the placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor. Acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines pose an entanglement risk to sea turtles, particularly deep-diving species such as leatherback sea turtles.

Habitat Disturbance

Activities associated with coastal development, restoration, or maintenance such as dredging channels, shoreline and beach restoration, Mississippi River hydromodification, and remediation of subsidence would occur in State coastal zones and waters, which is outside of BOEM's jurisdiction. These types of activities would impact the quality, at least temporarily, of nearshore habitat critical to sea turtles for reproduction, foraging, and life stage development. Further, 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).

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. 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. Mitigation 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.

Pollution

Trash and Debris

The Federal Oil and Gas Program in the GOM has approximately 2,634 existing structures conducting production activities, including drilling operations. The operation of these structures, including staff, and the activities conducted could generate trash and debris comprising paper, plastic, wood, glass, and metal (**Chapter 3.3.1.7**). Oil and gas operations in the Gulf of Mexico OCS are required to adhere to provisions of MARPOL Annex V as well as USCG and USEPA regulations and NTL 2015-BSEE-G03. By adhering to these requirements, trash and debris impacts, including entanglement and ingestion, from the cumulative scenario activities would be reduced.

Potential impacts from discarded trash and debris associated with Alternative A on sea turtles is discussed in **Chapter 4.3.2.1.6**. Impacts from discarded trash and debris on sea turtles from G&G survey vessels, sampling activities, drilling of shallow test or COST wells, and other activities would result in a **nominal** incremental increase in the impact to sea turtles under the cumulative scenario.

Contaminants

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).

Commercial Fishing

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 GOM 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, 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 reduce fishery impacts to turtles, 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.

Decommissioning

Explosive discharges, such as those used for USACE structure removals or coastal construction, can cause injury to sea turtles (Duronslet et al., 1986), but they are subject to ESA consultation with 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.

Historic Exploitation

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 IPFs described in this chapter (e.g., commercial fishing), 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).

Natural Phenomenon, Disasters, and Disease

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., 2005). 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. 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.

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

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 improved species management.

4.3.2.3.3 Cumulative Impact Conclusions

Overall, activities associated with the proposed action would increase levels of vessel and aircraft noise and traffic within the AOI, resulting in sporadic increases in ambient noise levels during proposed G&G operations. Sources of noise associated with the cumulative scenario that may affect sea turtles in the AOI include active acoustic sound, vessel and equipment, and aircraft. Other IPFs that may affect sea turtles include vessel and aircraft traffic, trash and debris, entanglement and entrapment, and accidental fuel spill. Many of these IPFs may occur simultaneously during some projected operations under the OCS Program. For example, during deep-penetration seismic, shallow-penetration seismic, and non-airgun HRG survey operations, the IPFs such active acoustic sound, vessel and equipment noise, vessel traffic, and aircraft noise and traffic will occur together. Entanglement of sea turtles in OBC or entrapment in towed equipment, and the release of trash and debris or fuel into offshore waters are not routine and, therefore, represent accidental occurrences during the 10-year project period.

The spatial distribution of activities projected under the proposed action during the project period are most concentrated within deepwater regions of the CPA and WPA, and less concentrated within continental shelf waters (**Table 3.2-1**). Very little activity is projected to occur within the EPA. Temporally, activity levels associated with the proposed action vary by activity type and year (**Tables 3.2-1 through 3.2-5**). From this analysis, impacts to sea turtles from proposed routine activities include moderate impacts (from active acoustic sound associated with deep-penetration seismic airgun surveys), minor impacts (from active acoustic sound associated with shallow-penetration airgun and non-airgun HRG surveys, and vessel and equipment noise), and nominal impacts (from vessel, equipment, and aircraft noise, vessel and aircraft traffic, trash and debris, and entanglement and entrapment).

When compared with past levels of activity within the GOM, proposed activities do not represent a significant incremental increase to activities under the cumulative scenario. Surveys utilizing active acoustic sound sources have occurred within the GOM for decades, including within State waters as well as the continental shelf and deepwater regions of the OCS. Commercial, military, and recreational vessel traffic also has occurred in the GOM, including the AOI, for many years. In some cases, such as large commercial vessels, traffic is and has been more concentrated along Gulfwide shipping lanes that funnel into major coastal ports. Commercial and recreational fishing vessels have utilized broad areas of the northern GOM, but primarily on the continental shelf and shelf edge. Military vessels likely have traveled through all areas of the GOM, though most, if not all, exercises probably have occurred within the U.S. Navy GOMEX Range Complex OPAREAs, including Panama City, Pensacola, New Orleans, and Corpus Christi (Atlantic Fleet Training and Testing, 2015).

While the IPFs associated with the proposed action could impact sea turtles if unmitigated, the incremental contribution to cumulative impacts on sea turtles, would be **nominal** to **minor** as a result of the proposed action. This assessment considers 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. Within the GOM, there is a long-standing (>50 years) and well-developed OCS Program, and population-level impacts to sea turtles are not expected.

Combined, the cumulative impacts of Outer Continental Shelf G&G-related operations under Alternative A would be **nominal** to **minor** to the population, as there could be extensive impacts to sea turtles. The cumulative impacts on sea turtles from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.3.2.3.2** above. The incremental contribution of the proposed action under Alternative A is expected to be **nominal** to **minor** because the relative extent of Outer Continental Shelf G&G activities is considered a stressor to sea turtles in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which sea turtles could be subject to G&G activity.

4.3.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.3.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on sea turtles.

4.3.3.1 Impacts of Routine Activities

4.3.3.1.1 Coastal Waters Seasonal Restrictions

Alternative B includes a seasonal restriction on deep-penetration seismic airgun surveys from (a) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath) and (b) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the UME in the northern GOM (**Figure 2.2-1 and Chapter 2.4.3**). No airgun surveys would be authorized within the area during this time. This seasonal restriction was designed to protect the northern Gulf of Mexico BSE stocks of the common bottlenose dolphin, as discussed in **Chapter 4.3.2**. The time period for the area closure from January 1 to April 30 corresponds with the peak calving season for these stocks.

As discussed in **Chapter 4.2.3**, applicable routine IPFs for sea turtles include active acoustic sound sources, vessel traffic and associated vessel and equipment noise, aircraft traffic and noise, trash and debris, and entanglement and entrapment. The seasonal restriction for Federal coastal waters under Alternative B would remove the potential for impacts from active acoustic sound sources from airgun surveys during the closure period. Active acoustic sound sources from non-airgun HRG and geological surveys; survey-related vessel, aircraft, and equipment noise; and survey-related vessel and aircraft traffic on sea turtles within inner shelf and coastal areas during the closure period still would occur. This measure will not influence effects from active acoustic sources from non-airgun HRG and geological surveys drilling noise, disturbance from fixed-wing aircraft during aeromagnetic surveys, and trash and debris. These IPFs are not discussed further in this chapter but are summarized under Alternative A (refer to **Chapter 4.3.2**).

Based on the scope of the proposed action, seismic airgun surveys could affect individuals of all sea turtle species within the AOI. Surveys conducted within Federal coastal waters may affect all species and greater numbers of individuals than surveys conducted in deep water (outer shelf and slope) environments. Deepwater surveys are likely to impact primarily adult leatherback sea turtles and loggerhead sea turtles as well as hatchlings and juveniles associated with mats of floating *Sargassum*, weedlines, and other flotsam. Surveys conducted during summer sea turtle nesting periods within Federal coastal waters may affect greater numbers of adult sea turtles, particularly loggerhead and Kemp's ridley sea turtles, than those conducted during non-nesting periods. Designated critical habitat for juvenile loggerhead sea turtles ("*Sargassum* Habitat") is shown in **Figure 4.3-2** and includes offshore waters of the EPA and most of the WPA and CPA.

Implementation of this seasonal restriction would remove stress and potential auditory injuries from airgun surveys to sea turtles within Federal coastal waters falling within the boundaries of the UME in the northern GOM from January 1 to April 30 and from March 1 to April 30 in the Federal coastal waters outside the UME boundaries. The time period for this restriction coincides with the beginning of sea turtle nesting activities on nesting habitats within the GOM. This measure may be effective for the protection of early nesting activities (e.g., selection and use of nesting areas) and breeding activities in inner shelf waters. However, under Alternative B, seismic activities will be permitted to resume within Federal coastal waters after April 30, which is during peak nesting season. Overall, this measure will not affect sea turtles within outer shelf and slope waters, and may only protect early nesting and breeding activities within Federal coastal waters. Therefore, the measure likely will not reduce the overall impact level (**minor**) for sea turtles in the AOI from seismic airgun activities.

The seasonal restriction would reduce project-related seismic survey vessel traffic and associated vessel and equipment noise in coastal areas during this restriction period. As discussed in **Chapter 4.3.2.1**, impacts of vessel traffic would remain **nominal** to **moderate**, and impacts from vessel and equipment noise on sea turtles are expected to remain **nominal**. This additional mitigation measure may temporarily decrease potential vessel disturbance to and vessel strikes with individual sea turtles in coastal areas during the closure. However, cable laying for OBCs, for example, is not restricted (based on the requirements in the Settlement Agreement); thus, impacts from entanglement would remain **nominal** as described in **Chapter 4.3.2.1**. In addition, non-airgun HRG and geological surveys are not restricted; therefore, the potential for striking a sea turtle is not completely removed. Potential impacts to sea turtles from vessel traffic and noise are expected to remain unchanged with this mitigation measure because the additional closure probably is not of sufficient duration to significantly reduce impact levels. The additional seasonal restriction for Federal coastal waters under Alternative B would not remove the potential aeromagnetic survey or the drilling of two shallow test wells and a COST well within the AOI. In addition, helicopters used for seismic airgun survey support would not operate in these areas during the closure. It is likely that individual sea turtles within Federal coastal waters of the AOI are accustomed to the sounds and physical presence of oil and gas industry helicopter traffic within the AOI. Therefore, it is expected that the impacts from aircraft traffic and noise would remain unchanged (**nominal** under Alternative A) for the additional coastal seasonal restriction under Alternative B.

4.3.3.1.2 Expanded PSO Program

Alternative A includes operational mitigation measures, as described in **Chapter 2.3.2 and Appendix B, Section 1**, that would be implemented during seismic airgun surveys. These measures include the establishment of a 500-m (1,640-ft) exclusion zone, visual monitoring by qualified PSOs, and ramp-up requirements (implementation of the PSO Program and Seismic Airgun Survey Protocol). Under Alternative B, the requirements of the expanded PSO Program require the same mitigation measures for manatees as for whales and are required for all deep-penetration seismic airgun surveys in the GOM regardless of water depth. Mitigation measures for sea turtles remain the same as under Alternative A.

The purpose of this operational measure (i.e., exclusion zone) is to prevent serious injury to sea turtles (and marine mammals) by ensuring they are not present within an established exclusion zone around the airgun array. Under Alternative B, these measures are required for all deep-penetration seismic airgun surveys throughout the AOI. Because this measure is expanded to all water depths, it would benefit subadult and adult stages of all sea turtle species within the AOI during daylight seismic survey operations (these measures are conducted only during daylight hours). Because of their size and cryptic nature within weedlines and mats of flotsam, hatchling sea turtles likely would not be sighted by PSOs during monitoring surveys.

As discussed in **Chapter 4.3.2**, although these mitigation measures require clearance of the exclusion zone for sea turtles prior to start-up, they do not require shutdown for sea turtles; consequently, some individual sea turtles may be exposed to sound levels that lead to TTS or PTS auditory injuries. With ramp-up requirements, there presumably will be no deaths or life-threatening injuries from airgun activities, even at night (based on the assumption that sea turtles would move away from the sound source during ramp-up). Early life history stages of sea turtles associated with *Sargassum* habitats were assumed to be largely or entirely as passive drifters, with little potential for directed movements towards or away from stimuli. Putman and Mansfield (2015) demonstrated active dispersal of early life stages in the GOM, which shows at least a potential for active swimming to avoid adverse stimuli. Most effects from active acoustic sound sources would consist of behavioral alterations (e.g., avoidance, evasive actions, temporary displacement from the area around the sound source), along with some non-life-threatening auditory injuries (e.g., threshold shifts). Overall, effects of this mitigation measure under Alternative B would not reduce potential active acoustic impacts discussed under Alternative A (**minor** for airgun survey activities and **nominal** to **minor** for non-airgun HRG survey activities using boomers and sparkers). This mitigation does not apply to the other project-related IPFs and would not alter the impacts to sea turtles from vessel and equipment noise, aircraft traffic and noise, trash and debris, or entanglement and entrapment; all impacts would remain **nominal**. As discussed in **Chapter 4.3.2.1**, impacts of vessel traffic would remain **nominal** to **moderate** (if a collision occurred).

4.3.3.1.3 Minimum Separation Distances

Alternative B would establish a 40-km (25-mi) separation distance between simultaneously operating, deep-penetration seismic airgun surveys within the Areas of Concern (areas within Mississippi and De Soto Canyons, Federal coastal waters shoreward of the 20-m [66-ft] isobath, and areas west of the Florida Keys and Dry Tortugas) (**Chapter 2.4.2; Figure 2.2-1**). When outside the designated Areas of Concern, the separation distance will be 30 km (19 mi). This minimum separation distance requirement does not apply to operations with multiple vessels in a single survey, such as WAZ surveys, or in conditions of inclement weather or other unsafe conditions. This measure was designed to mitigate possible effects of anthropogenic underwater sounds from multiple seismic operations on resources such as marine mammals and sea turtles, including the effects of interacting and repeated sounds. This measure may affect potential impacts from active acoustic sources as well as survey-related vessel and aircraft noise. This mitigation measure will not affect potential impacts from other IPFs, such as fixed-wing aircraft noise (during aeromagnetic surveys), drilling noise, and trash and debris. These IPFs are discussed further in **Chapter 4.3.2.1**.

Limits on concurrent seismic airgun surveys under Alternative B could change the timing of surveys in certain areas. The specific locations cannot be predicted in advance and would depend on the schedule, planned coverage of individual surveys, and ports to be used for support activities. New information suggests that, in some circumstances, airgun noise can be detected at great distances from the sound source, such as across ocean basins (Nieukirk et al., 2012); however, whether detection of sound at these distances has any effect on marine species is unknown, making this mitigation measure difficult to evaluate. Therefore, specific details regarding potential impacts in certain areas and time periods is not possible for this analysis. BOEM concludes that there is incomplete or unavailable information (40 CFR § 1502.22) for all sea turtles with respect to effects from seismic airgun surveys and concurrent surveys. However, what is known about the biology and hearing physiology of representative species, in combination with observations of behavioral response to stimuli, allows inferences and conclusions about reasonably foreseeable adverse impacts on sea turtles to be understood with an adequate degree of certainty. Therefore, BOEM has determined that the data and information on sea turtle biology, hearing physiology, seasonal abundances, and population stock in the AOI identified as incomplete or unavailable are not essential to a reasoned choice among the alternatives, including the No Action alternative.

A more complete knowledge base for all types of sea turtles that use the AOI and that bear on the factors listed previously is not available, and such information cannot be acquired without exorbitant cost. Such information certainly cannot be acquired in a timeframe to make it available for this evaluation. While there will never be complete scientific information on sea turtles that live in OCS waters, biological and physiological data and information about the underwater hearing of representative sea turtles are available. These data are sufficient to draw inferences and conclusions about the types of sea turtles that are less understood. Thus, while BOEM reports where limited data and insufficient knowledge challenge our ability to understand how and when specific types of sea turtle species use the AOI and that bear on the factors listed earlier, incomplete or unavailable information does not affect our ability to understand and assign impacts or design mitigation strategies. BOEM can draw basic conclusions despite incomplete or unavailable information, discuss results using available scientifically credible information, and apply that information using accepted scientific methodologies.

A change in survey location and timing because of limits on concurrent seismic airgun surveys would not alter the impacts from active acoustic sources on sea turtles within the AOI. Impacts would be similar to those discussed in **Chapter 4.3.2.1** under Alternative A (**minor** for airgun survey activities and **nominal** to **minor** for HRG survey activities using boomers and sparkers). A change in survey location and timing because of limits on concurrent seismic airgun surveys would not alter the impacts to sea turtles from vessel traffic, vessel and equipment noise, aircraft traffic and noise, trash and debris, or entanglement; all impacts would remain **nominal**. As discussed in **Chapter 4.3.2.1**, impacts of vessel traffic would remain **nominal** to **moderate** (if a collision occurred).

4.3.3.1.4 Seismic Restrictions in the Areas of Concern within the EPA

Additional restrictions under Alternative B include prohibiting deep-penetration seismic airgun surveys in the Areas of Concern (**Chapter 2.4.2**) falling within the EPA. This restriction does not apply to surveys related to currently leased blocks, any portion of the area encompassed by EPA Lease Sale 226, or OCS lease blocks adjacent to permitted survey areas but within an otherwise off-limit area. Restricted areas include the portions of Area of Concern 2 within the EPA, waters offshore of western Florida and the Florida Panhandle shoreward of the 20-m (66-ft) isobath, a 5-km (3.1-mi) buffer extending seaward from the 20-m (66-ft) isobath (portions of Area of Concern 3), and an OCS lease block south of the Dry Tortugas and Florida Keys (Area of Concern 4, **Figure 2.2-1**).

Closure of Area of Concern 2 would provide protection from airgun-related impacts to individual sea turtles (e.g., adult loggerhead sea turtles) and hatchling sea turtles (primarily loggerhead and perhaps Kemp's ridley sea turtles) within these offshore waters. Area of Concern 4 would provide protection for individual sea turtles in offshore waters of the Florida Straits. Portions of Area of Concern 3 would provide protection for most sea turtle species in the AOI. However, seismic survey activities associated with Alternative B likely would occur beyond the boundaries of the protected areas and within the majority of the AOI. Although this mitigation measure likely would protect most sea turtles within the Areas of Concern as well as numerous individuals that may occur along the inner continental shelf of western Florida, it would not reduce the overall impacts to sea turtles within the AOI. Therefore, the impacts to sea turtles from seismic airgun activities would remain unchanged from Alternative A (**minor** for airgun survey activities and **nominal** to **minor** for HRG survey activities using boomers and sparkers) for the additional closure areas under Alternative B.

his mitigation measure would remove threats from vessel traffic (e.g., collisions), vessel and equipment noise, and seismic survey-related aircraft noise within areas of the EPA. Overall impacts to sea turtles would be expected to remain **nominal** to **moderate** (if a collision occurred) because the reduction of vessel traffic would be localized and relatively small compared with the AOI. As discussed in **Chapter 4.3.2.1**, impacts of vessel noise would remain **nominal**. Effects of this mitigation measure under Alternative B would not alter the impacts to sea turtles from trash and debris or entanglement and entrapment; impacts would remain **nominal**.

4.3.3.1.5 Routine Activities Impact Conclusions

This analysis considered the impact-level criteria, the AOI, and the 10-year timeframe. Mitigation measures associated with Alternative B are outlined in **Chapter 2.4** and detailed in **Appendix B**. As discussed earlier, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to sea turtles from each project-related IPF (including routine activities) is as follows:

- deep-penetration airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **nominal** to **minor**;
- vessel and equipment noise – **nominal**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris –**nominal**; and
- entanglement and entrapment – **nominal**.

Impacts to sea turtles from routine activities under Alternative B are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Implementation of mitigation measures described under Alternative B may reduce potential impacts from the IPFs listed earlier to individuals within the AOI. Impact levels by IPF were determined using impact-level criteria discussed in **Chapter 4.3.2.1**, and each impact level was determined by considering effects to sea turtles within the AOI as a whole.

4.3.3.2 Impacts of an Accidental Fuel Spill

Under Alternative B, impacts of an accidental fuel spill on sea turtles would be very similar to those analyzed in **Chapter 4.3.2.2** for Alternative A. The analysis concluded that a small spill at the sea surface would result in **nominal** to **minor** impacts, depending on the number of individuals adversely affected by the spilled fuel and the exposure of federally listed species to the spilled fuel.

Alternative B would change the timing of certain surveys because of additional coastal seasonal restrictions and limits on concurrent seismic airgun surveys. Additionally, certain surveys would not be conducted within portions of the EPA. The closure of coastal waters along the west coast of Florida could effectively protect individuals from all species of sea turtles within the AOI, including nesting sea turtles. This closure area and the Dry Tortugas/Florida Keys closure area would protect significant nesting habitats of loggerhead, green, and Kemp's ridley sea turtles within the AOI. However, spills from survey-related vessels could occur within coastal seasonal restriction areas outside of the closure period, and spills from non-airgun HRG survey vessels (except those using boomer or sparker subbottom profilers) could occur during the closure period or in the EPA. A change in survey timing or type because of limits on concurrent seismic airgun surveys or on survey type would not substantially change the risk of a small fuel spill. Therefore, the risk of a small fuel spill and its potential impacts on sea turtles within the AOI would be the same as under Alternative A, i.e., **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick), depending on the numbers of individuals adversely affected by the spilled.

4.3.3.3 Cumulative Impacts

4.3.3.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.3.2.1 and 4.3.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** to **moderate** impacts to sea turtles, depending on the IPF.

The cumulative assessment for Alternative A in **Chapter 4.3.2.3** compared with past, present, and future activities, including similar non-OCS Program activities, evaluated cumulative activities with similar IPFs to the proposed activities, and the spatial and temporal occurrence of other activities and the proposed action. It concluded that the cumulative effects of all IPFs to sea turtles within the AOI over the 10-year period would result in **nominal** to **minor** incremental increases in impacts.

Mitigation measures under Alternative B would not significantly change the extent of activities in the proposed action. Minimum separation distances between concurrent surveys would, however, reduce the potential severity of ensonification from multiple seismic survey sound sources within discrete areas of the AOI. Areas selected for closure from deep-penetration seismic airgun survey activities were designed to focus on impacts to a single species or select group of species. Mitigation measures under Alternative B that would change the timing and extent of activities in the proposed action include a seasonal restriction for operation of airguns in Federal coastal waters. However, survey activities in all other areas of the AOI (or in areas adjacent to the closure areas) may impact individual sea turtles during the project period. When considering all potential auditory impacts to sea turtles within the AOI from proposed seismic airgun activities, along with established impact-level criteria provided in **Chapter 4.3.2**, the mitigation measures included in Alternative B will not appreciably change the levels of impacts contributed by Alternative A within the AOI to the cumulative impact as a whole.

4.3.3.3.2 Activities Other Than OCS Program G&G Survey Activities

An impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.3.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.3.2.3.2**) would remain the same under Alternative B.

4.3.3.3.3 Cumulative Impact Conclusions

When compared with past, present, and future activities, including similar non-OCS Program activities, the cumulative effects of all IPFs to sea turtles within the AOI over the 10-year period would result in **nominal** to **minor** incremental increases in impacts under Alternative B. The cumulative impacts on sea turtles from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.3.2.3.2** above. The incremental contribution of the proposed action under Alternative B is expected to be **nominal** to **minor** because the relative extent of Outer Continental Shelf G&G activities is considered a stressor to sea turtles in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which sea turtles could be subject to G&G activity.

4.3.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.3.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative C on sea turtles. The mitigation measure requiring the use of PAM would provide no benefit for sea turtles because sea turtles do not vocalize; therefore, it is not discussed further in Alternative C.

4.3.4.1 Impacts of Routine Activities

4.3.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

This mitigation measure is described under Alternative B for Federal waters shoreward of the 20-m (66-ft) isobath (**Chapter 4.3.3.1**); airgun surveys are not permitted. Under Alternative C, this seasonal restriction extends to the shoreline and includes Federal waters from the 20-m (66-ft) isobath for a longer season: February 1 to May 31 (**Figure 2.3-1**). Overall, effects of this mitigation measure under Alternative C would not reduce potential active acoustic impacts discussed under Alternative B (**minor** for airgun survey activities and **nominal** to **minor** for non-airgun HRG survey activities using boomers and sparkers). This mitigation would not alter the impacts to sea turtles from vessel and equipment noise, aircraft traffic and noise, trash and debris, or entanglement and entrapment; all impacts would remain **nominal**. Impacts from vessel traffic would remain **nominal** to **moderate** (if a collision occurred). Overall, the chance of impacts would decrease by the reduction of activity within coastal waters by 17 percent for the entire 10-year period.

4.3.4.1.2 Expanded PSO Program

or Alternative C, the expanded PSO Program will apply to manatees as well as whales, requiring all airguns be shut down any time a specific whale species or manatee is detected entering or within the exclusion zone in all water depths. The expansion of this operational mitigation measure would reduce the extent of, but not entirely prevent, potential PTS auditory injuries to a significant population of sea turtles within the AOI. As discussed in **Chapter 4.3.3.1**, this mitigation measure is expanded to include deep-penetration seismic survey operations in all water depths within the AOI and would benefit subadult and adult stages of all sea turtle species within the AOI during daylight seismic survey operations (these measures are conducted only during daylight hours). Because of their size and cryptic nature within weedlines and mats of flotsam, hatchling sea turtles likely would not be sighted by PSOs during monitoring surveys. In addition, although these mitigation measures require clearance of the exclusion zone for sea turtles prior to start-up, they do not require shutdown for sea turtles; consequently, some sea turtles may be exposed to sound levels that lead to TTS or PTS auditory injuries. With ramp-up requirements, there presumably will be no deaths or life-threatening injuries from airgun activities, even during nighttime ramp-ups (based on the assumption that sea turtles would move away from the sound source during ramp-up). Most of the effects from active acoustic sound sources would consist of behavioral alterations (e.g., avoidance, evasive actions, temporary displacement from the area around the sound source) and some non-life-threatening auditory injuries (e.g., threshold shifts). Overall, effects of this mitigation measure under Alternative C would not reduce potential impacts from project-related IPFs discussed under Alternative A (**minor** for airgun survey activities and **nominal** to **minor** for non-airgun HRG survey activities using boomers and sparkers). The expansion of the requirements for using PSOs and exclusion zone monitoring in all water depths throughout the GOM may further protect sea turtles (during daylight hours) from potential vessel collisions due to the increase in visual observer effort. The expansion of PSO monitoring activities to include all water depths within the AOI would reduce potential collisions between project vessel traffic and sea turtles. However, the reduction in impacts is not expected to change the overall level of impacts from vessel strikes (vessel traffic) for the entire AOI, which would remain **nominal** to **minor** (if a collision occurred).

Impacts to sea turtles from vessel and equipment noise, aircraft traffic and noise, trash and debris, and entanglement would not be affected by the expansion of seismic survey mitigation measures and the PSO Program associated with Alternative C; impacts would remain **nominal**.

4.3.4.1.3 Non-Airgun HRG Survey Protocol

Non-Airgun HRG Survey Protocol mitigation measures under Alternative C include pre-survey clearance and shutdowns as well as the use of PSOs and reporting requirements (**Appendix B, Attachment 2**). The measures are linked and discussed together in this chapter.

Under Alternative C, non-airgun HRG surveys in which one or more active acoustic sound sources will be operating at frequencies <200 kHz in all water depths throughout the AOI will require a pre-survey clearance of all sea turtles (and marine mammals) for a period of 30 minutes before start-up or after shutdown for all cetaceans (excluding dolphins) or manatees that are within the exclusion zone. These surveys must use at least one trained PSO to visually monitor an exclusion zone during daylight hours. The exclusion zone would be a 200-m (656-ft) or larger radius area around the sound source. Immediate shutdown of active acoustic sound source(s) would occur if selected marine mammal species (discussed previously) are detected entering or within the exclusion zone. However, sea turtles are not included in the shutdown protocol and therefore could be exposed to the sound levels if seen inside the exclusion zone. Subsequent restart of the equipment after shutting down for a marine mammal may occur following confirmation that the exclusion zone is clear of all sea turtles (and marine mammals) for a period of 30 minutes. Overall, the implementation of these mitigation measures during non-airgun HRG surveys would reduce potential active sound source impacts to sea turtles, particularly during daylight operations. However, these measures are designed to protect sea turtles from the start-up of these sources only (no shutdowns for sea turtles are required).

As discussed in **Chapter 4.3.2**, results from the ScOT report (**Appendix G**) indicate that acoustic outputs from electromechanical sources other than the boomer and sparker are not likely to be detectable by sea turtles, whose best hearing is below 1,200 Hz for adults and 1,600 Hz for juveniles (**Appendix I**). If these sources are used and operated at a frequency within the hearing range of sea turtles, there could be sound-related impacts (mostly behavioral effects and perhaps some TTS-related impacts). Active sound sources with outputs beyond the sea turtle hearing range of 50 to 1,200 Hz for adults and up to 1,600 Hz for juveniles (refer to the previous list) are not expected to impact sea turtles within the AOI. Boomer or sparker subbottom profilers have operating frequency ranges of 300 to 3,000 Hz and 50 to 4,000 Hz, respectively, and so may be audible to sea turtles; however, they have very short pulse lengths (120, 150, or 180 μs) and very low source levels. Because of expected small 180-dB radius area from the source, potential impacts from non-airgun HRG surveys of electromechanical sources using frequencies within the hearing ranges of sea turtles would be expected to affect only a few individuals. Impacts would include behavioral disturbances and TTS-level auditory impacts. Individual sea turtles may experience long-term auditory injuries (PTS), but they would have to be very close to the electromechanical source. No lethal or population-level impacts from PTS auditory injuries are expected. From this analysis, the effects of the Non-Airgun HRG Survey Protocol are not expected to reduce overall potential impacts to sea turtles from active acoustic sound sources due to daylight limitations and no shutdown protocols. Therefore, non-airgun HRG survey impacts to sea turtles are expected to remain the same under Alternative C (**nominal** to **minor**) and airgun survey impacts would remain **minor**.

The requirement for a Non-Airgun HRG Survey Protocol under Alternative C would not affect potential impacts from other IPFs such as vessel and equipment noise, aircraft traffic and noise, trash and debris, and entanglement and entrapment; all impacts would remain **nominal**. The presence of PSOs on board survey vessels could provide additional protection to sea turtles from collisions with project-related vessel traffic during daylight hours (PSOs would notify vessel operators if a collision is possible). However, PSOs are not expected to maintain watches for sea turtles or marine mammals when vessels are not actively collecting data (such as transits), and PSOs are not required or effective during nighttime transits or operations. Overall, the increase in detectability provided by PSOs during non-airgun HRG surveys will not affect the overall level of impact to sea turtles within the AOI from vessel traffic, as discussed under Alternative A (**nominal** to **moderate** [if a collision occurred]).

4.3.4.1.4 Routine Activities Impact Conclusions

This analysis considered the impact-level criteria, the AOI, and the 10-year timeframe. Mitigation measures associated with Alternative C are outlined in **Chapter 2.5** and detailed in **Appendix B**. As discussed previously, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to sea turtles from each project-related IPF (including routine activities) is as follows:

- deep-penetration airgun survey noise – **minor**;
- non-airgun HRG electromechanical survey noise – **nominal** to **minor**;
- vessel and equipment noise – **nominal**;
- vessel traffic – **nominal** to **moderate**;
- aircraft traffic and noise – **nominal**;
- trash and debris – **nominal**; and
- entanglement and entrapment – **nominal**.

Impacts to sea turtles from routine activities under Alternative C are expected to range from **nominal** to **moderate**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

Implementation of mitigation measures described under Alternative C may reduce potential impacts from the IPFs listed earlier to individuals within the AOI. Impact levels by IPF were determined using impact-level criteria discussed in **Chapter 4.3.2**, and each impact level was determined by considering effects to sea turtles within the AOI collectively.

4.3.4.2 Impacts of Accidental Fuel Spills

Under Alternative C, impacts of an accidental fuel spill on sea turtles would be very similar to those analyzed in **Chapter 4.3.2.2** for Alternative A. The analysis concluded that a small spill at the sea surface would result in **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick) impacts.

4.3.4.3 Cumulative Impacts

4.3.4.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.3.2.1 and 4.3.2.2** concluded that activities projected to occur under Alternative B would result in **nominal** to **moderate** impacts to sea turtles, depending on the IPF.

The cumulative assessment for Alternative A in **Chapter 4.3.2.3** compared with past, present, and future activities, including similar non-OCS Program activities, evaluated cumulative activities with similar IPFs to the proposed activities, as well as spatial and temporal occurrence of other activities and the proposed action. It concluded that the cumulative effects of all IPFs to sea turtles within the AOI over the 10-year period would result in **nominal** to **minor** incremental increases in impacts.

4.3.4.3.2 Activities Other Than OCS Program G&G Survey Activities

An impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.3.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.3.2.3.2**) would remain the same under Alternative C.

4.3.4.3.3 Cumulative Impact Conclusions

Mitigation measures under Alternative C would not change the extent of activities in the proposed action. One measure would change the timing of activities in the proposed action by means of a seasonal restriction for operation of airguns in Federal and State coastal waters. Alternative C would change the timing of seismic airgun surveys in certain areas; however, the seasonal restriction and operational mitigation measures would not appreciably change the cumulative impacts expected under Alternative A, resulting in **nominal** to **minor** incremental increases in impacts. The cumulative impacts on sea turtles from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.3.2.3.2** above. The incremental contribution of the proposed action under Alternative C is expected to be **nominal** to **minor** because the relative extent of Outer Continental Shelf G&G activities is considered a stressor to sea turtles in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which sea turtles could be subject to G&G activity.

4.3.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.3.2**). The additional mitigation measure under Alternative D would not reduce potential active acoustic impacts discussed under Alternatives A and C (**Chapters 4.3.2.1 and 4.3.4.1**).

4.3.5.1 Impacts of Routine Activities

The additional mitigation measure under Alternative D, exclusion of bow-riding dolphins from shutdown protocols, would not change the extent, severity, or timing of IPFs outlined in Alternatives A and C for sea turtles. Impacts would remain as under Alternatives A to C, i.e., **nominal** to **minor** for non-airgun HRG survey activities and **minor** for airgun survey activities. This mitigation would not alter the impact levels to sea turtles from vessel and equipment noise, aircraft traffic and noise, trash and debris, or entanglement and entrapment, and would remain **nominal**, while impacts from vessel traffic would remain **nominal** to **moderate** (if a collision occurred).

Overall, impacts to sea turtles from routine activities under Alternative D are expected to range from **nominal** to **moderate**.

4.3.5.2 Impacts of an Accidental Fuel Spill

Under Alternative D, impacts of an accidental fuel spill on sea turtles would be similar to those analyzed in **Chapter 4.3.2.1** for Alternative A. The risk of a small fuel spill and its potential impacts on sea turtles within the AOI would be the same as under Alternative A, i.e., **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick), depending on the numbers of individuals adversely affected by the spill.

4.3.5.3 Cumulative Impacts

4.3.5.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.3.5.1 and 4.3.5.2** concluded that activities projected to occur under Alternative D would result in **nominal** to **moderate** impacts to sea turtles, depending on the IPF.

The cumulative assessment for Alternative A in **Chapter 4.3.5.3** compared with past, present, and future activities, including similar non-OCS Program activities, evaluated cumulative activities with similar IPFs to the proposed activities, and the spatial and temporal occurrence of other activities and the proposed action. It concluded that the cumulative effects of all IPFs to sea turtles within the AOI over the 10-year period would result in **nominal** to **minor** incremental increases in impacts.

4.3.5.3.2 Activities Other Than OCS Program G&G Survey Activities

An impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.3.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.3.2.3.2**) would remain the same under Alternative D.

4.3.5.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative D are the same as described for Alternative C, with the addition of shutdown protocols during seismic operations for all marine mammals except bow-riding dolphins. The addition of shutdown protocols for all marine mammals except bow-riding dolphins under Alternative D would not change the extent, severity, or timing of activities in the proposed action, resulting in **nominal** to **minor** incremental increases in cumulative impacts to sea turtles under Alternative D. The cumulative impacts on sea turtles from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.3.2.3.2** above. The incremental contribution of the proposed action under Alternative D is expected to be **nominal** to **minor** because the relative extent of Outer Continental Shelf G&G activities is considered a stressor to sea turtles in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which sea turtles could be subject to G&G activity.

4.3.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.3.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative E on sea turtles.

4.3.6.1 Impacts of Routine Activities

4.3.6.1.1 Reduced Level of Activity

Alternative E includes a reduction of G&G activity levels by 10 percent (Alternative E1) or 25 percent (Alternative E2). This measure is not restricted to any specific area of the AOI; therefore, it is not practicable in this analysis to assess areas that maximize impact mitigation for sea turtles (e.g., areas offshore of known coastal nesting habitats for certain species). The overall reduction in activities would proportionately reduce impacts to sea turtles from active acoustic sound sources, but the impact levels in the AOI over the 10-year period would not be significantly reduced.

Alternative E1 specifies a 10 percent reduction and Alternative E2 specifies a 25 percent reduction of deep seismic activities; both would proportionately reduce potential impacts from seismic survey IPFs to sea turtles in the AOI. This would reduce the extent, severity, and timing of seismic survey-related sound sources, vessel and equipment noise, vessel traffic, support helicopter traffic and noise, and trash and debris within the AOI, as well as impacts from these IPFs on sea turtles. However, with no information regarding the area(s) where activity would be restricted, proposed deep-penetration survey activities may occur within open areas of the AOI, and individual sea turtles may still be at risk from potential impacts from these IPFs. Impacts to sea turtles within the AOI under Alternatives E1 and E2 from project-related IPFs range from **nominal** to **minor** for airgun survey activities (**minor**) and non-airgun HRG survey activities using boomers and sparkers (**nominal** to **minor**), **nominal** to **moderate** (if a collision occurred) for vessel traffic, and **nominal** for vessel and equipment noise, aircraft traffic and noise, trash and debris, and entanglement and entrapment.

Overall, impacts to sea turtles from routine activities under Alternative E are expected to range from **nominal** to **moderate**.

4.3.6.2 Impacts of an Accidental Fuel Spill

Under Alternative E, impacts of an accidental fuel spill on sea turtles would be very similar to those analyzed for Alternative A in **Chapter 4.3.2.2**. The risk of a small fuel spill and its potential impacts on sea turtles within the AOI would be the same as under Alternative A, i.e., **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick), depending on the numbers of individuals adversely affected by the spill.

4.3.6.3 Cumulative Impacts

4.3.6.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.3.6.1 and 4.3.6.2** concluded that activities projected to occur under Alternative E would result in **nominal** to **moderate** impacts to sea turtles, depending on the IPF. The cumulative assessment for Alternative A in **Chapter 4.3.2.3** compared with past, present, and future activities, including similar non-OCS Program activities, evaluated cumulative activities with similar IPFs to the proposed activities, and the spatial and temporal occurrence of other activities and the proposed action. It concluded that the cumulative effects of all IPFs to sea turtles within the AOI over the 10-year period would result in **nominal** to **minor** incremental increases in impacts.

4.3.6.3.2 Activities Other Than OCS Program G&G Survey Activities

An impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.3.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.3.2.3.2**) would remain the same under Alternative E.

4.3.6.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative E would reduce the extent, severity, and timing of active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and entanglement and entrapment; therefore, impacts for these IPFs would be proportionately decreased under Alternative E. The reduction in survey line miles would not appreciably change the cumulative impacts noted under Alternative A and would result in **nominal** to **minor** incremental increases in impacts. The cumulative impacts on sea turtles from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.3.2.3.2** above. The incremental contribution of the proposed action under Alternative E is expected to be **nominal** to **minor** because the relative extent of Outer Continental Shelf G&G activities are considered stressor to sea turtles in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which sea turtles could be subject to G&G activity.

4.3.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.3.2**). Some mitigation measures associated with Alternative F, such as PAM requirements and the expanded PSO Program to include protective measures for manatees, do not apply to sea turtles (as discussed in **Chapter 4.3.4**) and are not discussed in this analysis. The following discussion outlines the effects of the additional mitigation measures included under Alternative F that may affect sea turtles.

4.3.7.1 Impacts of Routine Activities

4.3.7.1.1 Closure Areas

Alternative F includes four area closures: CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area (**Figure 2.8-1**). Survey data collected along the continental shelf edge and slope of the GOM suggest that adults of a few sea turtle species occur within these environments, primarily leatherback and loggerhead sea turtles (Lohoefener et al., 1990; Davis et al., 2000). These areas also support hatchling sea turtles.

This mitigation measure would provide an ancillary benefit to individual sea turtles within the closure areas, as effects on sea turtle hearing and behavior (discussed in detail in **Appendices E and I**) will be reduced following a reduction in active acoustic sound sources (e.g., seismic airgun and electromechanical sounds) and vessel and equipment noise. However, while there may be some reduction of impacts to sea turtles within the closure areas, the additional mitigation measures under Alternative F would not change the extent or severity of the IPFs in the majority of the AOI. Consequently, the effects of this mitigation measure would not reduce potential active acoustic impacts (i.e., **minor** for airgun survey activities and **nominal** to **minor** for non-airgun HRG survey activities using boomers and sparkers). Impacts from vessel traffic would remain **nominal** to **moderate** (if a collision occurred). This mitigation would not alter the impacts to sea turtles from vessel and equipment noise, aircraft traffic and noise, trash and debris, or entanglement and entrapment; impacts would remain **nominal**.

Overall, impacts to sea turtles from routine activities under Alternative F are expected to range from **nominal** to **moderate**.

4.3.7.2 Impacts of an Accidental Fuel Spill

Under Alternative F, impacts of an accidental fuel spill on sea turtles would be similar to those analyzed in **Chapter 4.3.2.2** for Alternative A. The risk of a small fuel spill and its potential impacts on sea turtles within the AOI would be the same as under Alternative A, i.e., **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick), depending on the numbers of individuals adversely affected by the spill.

4.3.7.3 Cumulative Impacts

4.3.7.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.4.7.1 and 4.4.7.2** concluded that activities projected to occur under Alternative F would result in **nominal** to **moderate** impacts to sea turtles, depending on the IPF. The cumulative assessment for Alternative A in **Chapter 4.3.2.3** compared with past, present, and future activities, including similar non-OCS Program activities, evaluated cumulative activities with similar IPFs to the proposed activities, and the spatial and temporal occurrence of other activities and the proposed action. It concluded that the cumulative effects of all IPFs to sea turtles within the AOI over the 10-year period would result in **nominal** to **minor** incremental increases in impacts.

4.3.7.3.2 Activities Other Than OCS Program G&G Survey Activities

An impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.3.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.3.2.3.2**) would remain the same under Alternative F.

4.3.7.3.3 Cumulative Impact Conclusions

Mitigation measures under Alternative F are similar to Alternative C with the addition of area closures in four areas: CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area. Alternative F would change the timing of seismic airgun surveys in certain areas (the coastal seasonal restrictions) and restrict new airgun and non-airgun HRG surveys in portions of the AOI; however, these restrictions would not appreciably change the cumulative impacts noted under Alternative A, resulting in **nominal** to **minor** incremental increases in impacts. The cumulative impacts on sea turtles from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.3.2.3.2** above. The incremental contribution of the proposed action under Alternative F is expected to be **nominal** to **minor** because the relative extent of Outer Continental Shelf G&G activities is considered a stressor to sea turtles in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which sea turtles could be subject to G&G activity.

4.3.8 Impacts – Alternative G (No New Activity Alternative)

Alternative G specifies no new activity; however, existing permitted and ancillary activities would continue, and the mitigation measures would be the same as for Alternative A. Activity level would slowly decline over a period of several years. For this reason, the IPFs for continuing permitted and ancillary activities and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.3.2**), except that the IPF of entanglement and entrapment is not included as part of Alternative G because no OBC/OBN surveys are part of the alternative.

The only airgun survey activities that would occur under Alternative G are VSP and SWD surveys. **Appendix F, Section 1.1.5** provides descriptions of these surveys, which include the use of airgun active acoustic sources. Sound source characteristics are summarized in **Table 3.4-2**, and detailed characteristics and acoustic modeling assumptions are presented in **Appendix D**. The potential impacts of zero-offset and walkway VSP and SWD surveys are the same as those that would occur with Alternative A (**Chapter 4.3.2.1**), however at greatly reduced impact levels commensurate with the reduction in survey effort (**Table 2.9-1**). No impacts to local populations are expected; impacts would be limited to minimal short-term behavioral or other low-level impacts on individuals (low numbers, low severity, and short duration). Therefore, effects of project-related seismic airgun survey noise on sea turtles within the AOI are expected to be reduced from Alternative A (**nominal** to **minor**) to **nominal** declining to **no impact** under Alternative G.

The continuance of permitted and ancillary G&G activities that would occur under Alternative G would generate vessel and equipment noise that could disturb sea turtles. The potential impacts are the same as those that would occur under Alternative A (**Chapter 4.3.2.1**), however at greatly reduced impact levels commensurate with the level of ongoing activities (**Table 2.9-1**). Based on the existing vessel traffic within the AOI, effects of project-related vessel and equipment noise on sea turtles within the AOI would be **nominal** declining to **no impact**. As described previously, minimal drilling related to G&G activities is projected to occur under Alternative G and would include possibly drilling only one COST well; therefore, minimal to no equipment noise impacts will occur from drilling.

The potential impacts (physical disturbance from or collision with moving vessels) are the same as those that would occur under Alternative A (**Chapter 4.3.2.1**), with the same impact level (**nominal** to **moderate**) that would decline to **no impact**.

The potential impacts (noise and physical disturbance) are the same as those that would occur under Alternative A (**Chapter 4.3.2.1**), with the same impact level (**nominal**) but would then decline to **no impact**.

The potential impacts from trash and debris are the same as those that would occur under Alternative A (**Chapter 4.3.2.1**), with the same impact level (**nominal**) that would decline to **no impact**.

Overall, the removal of all new G&G survey activities within the AOI, as described under Alternative G, would reduce potential impacts from the IPFs listed previously to sea turtles within the AOI. However, G&G activities previously authorized under an existing permit/authorization or lease would proceed under Alternative G. Impacts from active acoustic sound sources are reduced from Alternative A to **nominal** declining to **no impact** due to the reduction in activities. Impact levels from vessel traffic would remain **nominal** to **moderate** (if a collision occurred) and would then decline to **no impact**. The impact levels for vessel and equipment noise, aircraft traffic and noise, and trash and debris would remain **nominal**. The impact level for entanglement and entrapment would be reduced to **no impact**. These determinations are further outlined and compared against other alternatives in **Table 2.13-1**.

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.3.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.3.2.3.2**) would remain the same under Alternative G. The cessation of G&G activities would result in the loss of an important tool for exploration to identify the location and size of oil and gas prospects, for the development of renewable energy projects, and exploration for non-energy marine minerals such as sand and gravel (or other sediment) for beach nourishment, coastal restoration, and public works projects. Such a loss would result in increased environmental risk to industry and could potentially lead to a dramatic reduction in oil and gas activity in the GOM.

4.3.9 Summary Conclusion

In summary, the IPFs that may impact sea turtles within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; and side-scan sonars); (2) vessel and equipment noise; (3) vessel traffic (i.e., physical disturbance to and risk of collisions); (4) aircraft traffic and noise (e.g., helicopters, fixed-wing aircraft); (5) trash and debris (i.e., ingestion of and entanglement in); (6) entanglement and entrapment (i.e., with acoustic buoy releases, tethered acoustic pingers, nodal tethering lines, and towed equipment); and (7) accidental fuel spill.

Impacts to sea turtles are assessed as **minor** for airgun surveys for Alternatives A through D and Alternative F because they are not expected to result in substantial changes to behavior, growth, survival, annual reproductive success, or lifetime reproductive success (fitness). Due to the reduced level of proposed activities under Alternative E, the impact level is expected to range from **nominal** to **minor**. The minimal level of proposed deep-penetration seismic airgun surveys and eventual phasing out of survey activities under Alternative G reduces the impact level to **nominal**, declining to **no impact**. In addition, some protection is afforded to sea turtles in Alternatives B through F through implementation of the expanded PSO Program, but not enough to change the overall impact level. For Alternatives A through F, **nominal** to **mino**r impacts are expected for non-airgun HRG surveys. However, for Alternative G, because the level of non-airgun HRG surveys would be significantly reduced and eventually phased out, the impact to sea turtles would be **nominal**, declining to **no impact**. Impacts to sea turtles from vessel traffic would range from **nominal** to **moderate** (if a collision occurred) for Alternatives A through F because the support vessels associated with G&G activities travel at higher speeds and the potential for collisions increases at night and at times of reduced visibility. For Alternative G, the impact to sea turtles would be **moderate**, declining to **no impact**. Potential impacts to sea turtles from an accidental fuel spill are expected to range from **nominal** (if the fuel does not contact individual sea turtles) to **minor** (if individual sea turtles encounter the dispersed windrows of the surface slick) for all alternatives, except Alternative G (**nominal** to **minor** declining to **no impact**). Impacts from entanglement and entrapment would be **nominal** for all alternatives except Alternative G, which would be reduced to **no impact** over time as survey activities are phased out. Other IPFs affecting sea turtles are assessed as **nominal** for Alternatives A through F and **nominal,** declining to **no impact** under Alternative G.

4.4 FISH RESOURCES AND ESSENTIAL FISH HABITAT

4.4.1 Description of the Affected Environment

The AOI covers a broad geographic and bathymetric region, ranging from the shoreline to the open ocean, and features a mix of fish resources that includes estuarine, coastal, and oceanic species associated with demersal (defined in **Appendix E, Section 4**) and pelagic (the open water environment) habitats. Distributions vary by species relative to environmental factors such as water depth, salinity, temperature, and habitat type. Fish resources covered in this chapter include threatened and endangered species managed by NMFS and FWS as part of the ESA as well as

EFH and species managed under the Magnuson-Stevens Fishery Conservation Act by the Gulf of Mexico Fishery Management Council (GMFMC) and NMFS' Highly Migratory Species Division of the Office of Sustainable Fisheries. Some federally managed fish resources occurring in the AOI receive further protection and management from Federal, State, territorial, Tribal, and/or local laws/regulations. Many federally managed fish species spend all or part of their life cycle in the AOI, resulting in the majority of the AOI designated as EFH. The EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (16 U.S.C. § 1801(10)). "Fish" includes "finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds," whereas "spawning, breeding, feeding or growth to maturity" covers the complete life cycle of those species of interest. The EFH is further described in detail in **Appendix E, Section 4**.

The proposed AOI includes critical habitat for the endangered smalltooth sawfish (*Pristis pectinata*) and threatened Gulf sturgeon (*Acipenser oxyrinchus desotoi*), which are two fish species that are managed by NMFS and FWS as part of the ESA (**Figure 4.4-1)**. The majority of smalltooth sawfish (*Federal Register*, 2003c) distribution in the AOI is limited to the waters of southwest Florida and Florida Bay, primarily within the jurisdictional boundaries of Everglades National Park (Simpfendorfer and Wiley, 2005; USDOC, NMFS, 2009; Wiley and Simpfendorfer, 2010; Waters et al., 2014) (**Figure 4.4-1**). Gulf sturgeon (*Federal Register*, 2003d) reside primarily in estuaries and rivers, and enter the AOI only seasonally in western Florida (**Figure 4.4-1**). Nassau grouper (*Epinephelus striatus*) (*Federal Register*, 2016d) is listed as threatened and, although occurring in the AOI, typically is replaced by red grouper (*Epinephelus morio*) north of Key West; it is considered transient or rare in the northern and northwestern GOM. Species that are candidates for becoming listed as threatened or endangered species include the dusky shark (*Carcharhinus obscurus*) (*Federal Register*, 2013b) and great hammerhead shark (*Sphyrna mokarran*) (*Federal Register*, 2013c). Species of concern, as defined under the ESA, in the AOI include the Alabama shad (*Alosa alabamae*), dusky shark, sand tiger shark (*Carcharias taurus*), speckled hind (*Epinephelus drummondhayi*), and Warsaw grouper (*Epinephelus nigritus*) (USDOC, NMFS, 2015b).

The demersal or bottom-dwelling fish fauna of the continental shelf separate broadly into soft bottom and hard bottom assemblages. The EPA (west Florida shelf) shelf has vast areas of soft bottom composed of mostly carbonate sediment interspersed with stands of seagrasses and macroalgae, which attract diverse assemblages of fishes, including herrings, pipefishes, snappers, grunts, porgies, drums, gobies, smooth puffers, and filefishes. In the CPA and WPA, sedimentary bottom covers most of the shelf and upper slope. Sediments are muddy on the inner shelf, particularly in the CPA, and coarse along the outer shelf. Soft bottom fish assemblages in these areas are characterized by croakers, drums, sea robins, porgies, and flatfishes. Soft bottom habitats are designated EFH for penaeid shrimps (**Chapter 4.5.1**) and red drum (*Sciaenops ocellatus*) by the GMFMC (2004).

Hard bottom habitat is most extensive in the EPA, where relatively low-relief (<1 m [3 ft]) rock characterizes much of the west Florida shelf, and is composed of a mosaic of coral reefs and epibenthic communities (Jaap, 2015). Low-relief hard bottom on the inner shelf of the CPA and

WPA is very limited compared with that of the EPA. Inner shelf reefs, which exist in water depths ranging from nearshore to approximately 30 m (98 ft), support snappers, porgies, grunts, damselfishes, groupers, sea basses, and other reef fish species. In water depths >30 m (98 ft), where reduced light penetration excludes most plants and herbivores, a distinctive "mesophotic" hard bottom assemblage occurs (Koenig et al., 2000; Weaver et al., 2002, 2006). Mesophotic reef systems colonized by sponges, hydrozoans, soft corals, and tunicates are found in all planning areas. Fish assemblages on mesophotic reefs are composed of snappers, groupers, sea basses, wrasses, bigeyes, butterflyfishes, angelfishes, jacks, and other reef-dwelling species, and are found on the continental shelf edge of all planning areas (Dennis and Bright, 1988; Koenig et al., 2000; Continental Shelf Associates, Inc. and Texas A&M University, 2001; Weaver et al., 2002). **Table 4.4-1** provides information on hard bottom species with EFH identified within the AOI. Hard bottom habitats represent EFH for members of the reef fish management unit (snappers, groupers, tilefishes, jacks, triggerfishes, and wrasses) overseen by the GMFMC. The GMFMC also manages corals and coral EFH, which are discussed in **Chapter 4.5.1**.

Fishes that inhabit hard bottom in the GOM (e.g., red snapper) may also associate with artificial habitat, including oil and gas structures, artificial reefs, shipwrecks, and other debris (refer to Szedlmayer and Lee, 2004; Gallaway et al., 2009). Artificial structures create an environment conducive to the settlement (and attraction) of shallow-water tropical reef fishes in the upper water column and mesophotic species in depths >30 m (98 ft) (Stanley and Wilson, 2000). While these are not considered EFH, they present habitats where fish can concentrate near structures and be impacted by IPFs under the proposed scenario.

The primary water column fish assemblage found in coastal and shelf waters of the GOM is termed coastal pelagic. Major coastal pelagic fishes occurring in the GOM are sharks, rays, ladyfish, anchovies, herrings, mackerels, little tunny, jacks, mullets, bluefish, and cobia. Individual species (e.g., king mackerel [*Scomberomorus cavalla*], Spanish mackerel [*Scomberomorus maculatus*], cobia [*Rachycentron canadum*]) managed jointly by the GMFMC and South Atlantic Fishery Management Council (SAFMC) are termed coastal migratory pelagic species. In addition to these species, coastal sharks managed by NMFS' Highly Migratory Species Division of the Office of Sustainable Fisheries have EFH designated within the AOI. **Tables 4.4-2 and 4.4-3** provide information on coastal migratory pelagic species with EFH identified within the AOI.

Epipelagic fishes inhabit the upper 200 m (656 ft) of the water column and include several sharks, billfishes, tunas, dolphins, flyingfishes, halfbeaks, opahs, oarfishes, jacks, remoras, pomfrets, butterfishes, molas, and triggerfishes. Some epipelagic fishes, including sharks, tunas, swordfish, and other billfishes, are managed by NMFS' Highly Migratory Species Division of the Office of Sustainable Fisheries. **Tables 4.4-3 and 4.4-4** provide information on highly migratory and shark species, respectively with EFH identified within the AOI. Several highly migratory species such as dolphinfish (*Coryphaena hippurus* and *C. equisetis*), sailfish (*Istiophorus platypterus*), white marlin (*Kajikia albida*), blue marlin (*Makaira nigricans*), and tunas (*Thunnus* spp.) are important to commercial and/or recreational fisheries. Most of these species associate with offshore structures in a transient fashion, usually in response to the availability of prey. Floating *Sargassum*, jellyfishes, siphonophores, and logs and other debris attract juvenile and adult epipelagic fishes. Most fish associated with *Sargassum* are temporary residents, such as juveniles of species that reside in shelf or coastal waters as adults (e.g., jacks, triggerfishes, and filefishes). However, several larger species of recreational or commercial importance, including dolphinfish [*Coryphaena hippurus*], yellowfin tuna [*Thunnus albacares*], blackfin tuna [*Thunnus atlanticus*], skipjack tuna [*Katsuwonus pelamis*], Atlantic bonito [*Sarda sarda]*, little tunny [*Euthynnus alletteratus*], and wahoo [*Acanthocybium solandri*], feed on the small fishes and invertebrates attracted to *Sargassum* (Dooley, 1972; Bortone et al., 1977; Wells and Rooker, 2004a, 2004b).

Below the epipelagic zone, the water column may be layered into the mesopelagic (200 to 1,000 m [656 to 3,280 ft]) and bathypelagic (>1,000 m [3,280 ft]) zones, known as the midwater area. Lanternfishes, which are small silvery fishes, can be extremely abundant. No EFH is designated for any members of the mesopelagic group, but many are important prey for other managed species.

Demersal fishes are those that are in direct contact with the substrate or hover above it from the shelf-slope transition down to the abyssal plain. The deepsea demersal fish fauna in the GOM includes approximately 300 species.

4.4.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact fish resources and EFH within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars); (2) vessel and equipment noise; (3) trash and debris; (4) seafloor disturbance; (5) drilling discharges; (6) entanglement (i.e., with acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines); and (7) accidental fuel spill.

There is little specific information on any of these IPFs in relation to fish resources or EFH in the AOI. However, based on studies of fish (individual and population) from other waterbodies, members of the regional fish community discussed in **Chapter 4.1** may be affected to some degree by G&G activities. Thus, impact levels were developed based on available literature and studies on the effects of the IPFs to individual fish and populations of fish from other waterbodies.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For fish resources and EFH, the following impact-level criteria have been used to evaluate the level of impact for each IPF.

- **Nominal** impacts to fish resources and EFH would include those where little to no measurable impacts are observed or expected. There would not be any adverse effects on a federally managed fish species or EFH.
- **Minor** impacts to fish resources and EFH would include those that are detectable but neither severe nor extensive. Minor impacts to fish resources and EFH would include temporary displacement or disruption of important behavioral patterns of federally managed fish species, physical injuries or mortalities of a small (limited) number of individuals, and spatially limited impacts to EFH.
- **Moderate** impacts to fish resources and EFH would be detectable and extensive but not severe. Moderate impacts to fish resources and EFH would include some degree of population-level physiological/anatomical damage to, population-level mortality to, or extended displacement of large numbers of (i.e., population-level) a federally managed fish species. Moderate impacts also would include extensive damage (quantifiable loss depending on the habitat type) to EFH and extensive disruption of behavioral patterns (including spawning, feeding, or ontogenetic [age-related] migrations) that may adversely affect a species.
- **Major** impacts to fish resources and EFH would be detectable, extensive, and severe. Major impacts to fish resources and EFH would include a high level of physiological/anatomical damage to, mortality to, or long-term displacement of a federally managed fish species. Major impacts would also include extensive, long-term damage (quantifiable loss depending on the habitat type) to EFH, or extensive, chronic disruption of behavioral patterns (including spawning, feeding, or ontogenetic migrations) that would adversely affect a species.

4.4.2.1 Impacts of Routine Activities

4.4.2.1.1 Background: Potential Effects of Noise on Fishes

There are no studies on the impacts of sound to species of fish, fish populations, or EFH in the AOI. There are studies that investigate the effects of sound on species from other waterbodies, and these studies are discussed in this chapter in order to provide a framework for inferring impacts expected in the AOI. Many of the studies were conducted in a laboratory setting; thus, the response of fishes to anthropogenic sounds in the AOI is not well understood (Popper and Hastings, 2009; Hawkins et al., 2014; Popper et al., 2014). This chapter focuses on the most common and likely direct effects from active acoustic sound sources. Before considering these direct effects, it is important to realize that sound plays a major role in the lives of all fishes and is used to perform, or be integral to, many life-sustaining functions (e.g., prey capture and foraging, predator avoidance, mating, spawning, and territorial disputes) (Zelick et al., 1999). Fish utilize the soundscape and components of sound in their environment to perform these functions (Fay, 2009). Depending on their hearing anatomy and peripheral sensory structures, which vary among species, fishes hear sounds using pressure and particle motion sensitivity capabilities and detect the motion of surrounding water (Popper et al., 2008). Information on the physics of underwater sound, mechanics of fish hearing, and auditory anatomy and physiology is discussed in **Appendix J**.

Hearing has been measured in <100 of the >32,000 species of fish, with mostly freshwater fish species having been studied, although several elasmobranchs (i.e., sharks and rays) have been researched as well. Very little hearing research has been conducted on the >1,100 species of fish that occur in the GOM. Fish appear to be most sensitive to low-frequency sounds below 1,000 Hz. For the majority of fish for which data are available, the region of best hearing ranges from 100 to 200 Hz up to 800 Hz, with most species able to detect sounds to below 100 Hz and some species even capable of detecting infrasound, i.e., sounds below 30 Hz (Karlsen, 1992a, 1992b; Knudsen et al., 1992; Ross et al., 1995). Flatfish (Pleuronectiformes), of which numerous species occur in the GOM, have relatively narrow-band hearing, from 30 to 300 Hz (Casper and Mann, 2009). The GOM species such as the bay anchovy (*Anchoa mitchilli*) can detect sounds at frequencies of approximately 100 to 1,000 Hz (Mann et al., 2001). Popper (2005) reported that studies measuring responses of the ear using physiological methods propose that a species of sturgeon likely is capable of detecting sounds from <100 Hz to approximately 1 kHz, suggesting that sturgeon should be able to localize or determine the direction of origin of sound. Meyer and Popper (2002) recorded auditory-evoked potentials of varying frequencies and intensities for lake sturgeon (*Acipenser fulvescens*) and found that lake sturgeon can detect pure tones from 100 to 2,000 Hz, with best hearing sensitivity from 100 to 400 Hz. Lovell et al. (2005), using a combination of morphological and physiological techniques, determined that lake sturgeon were responsive to sounds ranging in frequency from 100 to 500 Hz, with the lowest hearing thresholds acquired between 200 and 300 Hz; lake sturgeon were not sensitive to sound pressure. Data on shark hearing are limited, but elasmobranch species generally are able to detect low-frequency sounds (approximately 20 to 1,000 Hz), with similar thresholds for all measured species >100 Hz (Casper and Mann, 2009), and sound appears to be sensed solely through particle motion (Myrberg, 2001). Nelson and Gruber (1963) reported that free-ranging sharks, including hammerheads, were attracted to low-frequency sounds (<60 Hz) that were rapidly and irregularly pulsed, as these sounds likely represented the vibrations caused by struggling prey. Some actively swimming, fish-eating sharks such as lemon sharks (*Negaprion brevirostris*) and Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) have best hearing below 100 Hz, suggesting that hearing may be more important than other senses in the detection of prey for some species (Casper et al., 2012). Very sparse data on hearing in hammerhead sharks are available; Olla (1962) observed that hammerhead sharks were able to detect sounds below 750 Hz, with best sensitivity from 250 to 275 Hz.

In summary, fishes hear within a frequency range of 25 Hz to 3 kHz; sharks and rays (including smalltooth sawfish) are at the lower end of this range, and herrings, which have specialized anatomy (connection between gas-filled swim bladder and the inner ear) that enhances their ability to hear high frequencies, are at the higher end of the range. This hearing range overlaps with the frequency ranges of several G&G-related noise sources; seismic airguns range from 1 to 100 Hz. A fish's ability to detect a biologically relevant sound will decrease in the presence of background noise in the same frequency range. The potential direct effects depend not only on this overlapping frequency range, but also on the distance of an organism from a sound source; water depth of exposure; and species-specific hearing sensitivity, anatomy, and physiology. In order of increasing likelihood with decreasing distance from a sound source, key impacts include the following:

- behavioral responses;
- masking;
- TTS (hearing loss);
- barotrauma (pressure-related injuries); and
- mortality.

Behavioral responses (e.g., fleeing,and avoidance) to active acoustic sound sources are the most likely direct effects for the majority of fish resources exposed to sound within the AOI. Fewtrell and McCauley (2012) found that fish exhibited alarm responses to airgun noise at levels exceeding 147 to 151 dB re 1 μPa^2•s SEL. Wardle et al. (2001) also noted that fish elicited an alarm response to seismic airgun sounds, but no overall change in fish behavior was observed. The reaction of fish to seismic airguns is not species specific but may depend on the physiological state of the fish, past exposures, motivation (e.g., feeding, spawning, migration), and many other environmental factors. Although several studies have demonstrated that anthropogenic sounds might affect the behavior of some fishes, potentially impacting foraging opportunities or increasing energetic costs, Peña et al. (2013) noted schools of feeding herring did not react to seismic airgun sounds. However, field studies by Engås et al. (1996) reported a significant, short-term decline in commercial fishing catch rate of haddock (*Melanogrammus aeglefinus*) and Atlantic cod (*Gadus morhua*) during and for up to 5 days after seismic survey operations; the catch rate subsequently returned to normal. Slotte et al. (2004) found that pelagic species, including blue whiting (*Micromesistius poutassou*) and Norwegian spring-spawning herring (*Clupea harengus*), descended to greater depths after exposure to airgun sounds. During the seismic activities, the abundance of fish 30 to 50 km (19 to 31 mi) from the area of airgun ensonification increased, suggesting that fish avoided the zone of seismic activity. Other studies found minor responses during or following seismic surveys, using a 28-airgun array, such as a small decline in the abundance of lesser sand eels (*Ammodytes marinus*), with the abundance quickly returning to pre-seismic levels (Hassel et al., 2004), or no response in the behavior of the fish (Wardle et al., 2001). Wardle et al. (2001) used underwater video and an acoustic tracking system to examine the behavior of reef fishes in response to emissions from a single seismic airgun. Startle responses and some changes in the movement patterns of fish were observed during exposure. Startle responses have been observed in several fish species exposed to airgun sounds (Pearson et al., 1992; Santulli et al., 1999; Hassel et al., 2004). The Santulli et al. (1999) study used a

16-airgun array with a total volume of approximately 2,500 in^3, while the Pearson et al. (1992) study used a single 100-in^3 airgun.

Auditory masking occurs when sounds in the environment are in the same frequency range as a sound of biological relevance to or within the hearing range of fishes. The potential for masking or behavioral response may exist many kilometers from a sound source, depending on the ambient sound level and the frequency and amplitude characteristics of the propagated sound. Fish species in the candidate and non-listed categories described in **Chapter 4.4.1 and Appendix E, Section 4**, including some federally managed species, utilize sound to some extent for sensing their environment (which includes other sound-producing species), calling to mates, sensing predators, or warding off aggressors (Rountree et al., 2006). Demersal soft bottom species best known for their use of sound in reproductive signaling are the drums (Sciaenidae), including the federally managed red drum. Because most species of this family (e.g., weakfish [*Cynoscion regalis*], black drum [*Pogonias cromis*], silver perch [*Bairdiella chrysoura*], and Atlantic croaker [*Micropogonias undulates*]) engage in species-specific chorusing during spawning periods, passive acoustic instruments have been used to identify spawning areas inside bays and estuaries (Mok and Gilmore, 1983; Rountree et al., 2006; Luczkovich et al., 2008). It is reasonable to assume that some sciaenid taxa use sound to coordinate spawning activities in coastal and shelf waters of the AOI (Holt, 2008). Other demersal families known to produce sounds include stargazers, cusk-eels, and hakes. Several hard bottom demersal taxa such as groupers, drums, grunts, porgies, squirrelfishes, damselfishes, toadfishes, grenadiers, and gobies produce sounds that may be ecologically important (Myrberg and Fuiman, 2002; Rountree et al., 2006). Some pelagic species, particularly herrings, have a very broad range of hearing, which may allow them to detect the ultrasonic clicks from cetacean predators (Mann et al., 1997).

The TTS occurs following overstimulation from sound, which results in damage to auditory hair cells and decreased hearing sensitivity. Fish are more susceptible to TTS impairment within their most sensitive hearing range (refer to **Appendix J**). In some cases, the sensory cells lining the auditory system of fishes have been damaged by sounds produced by airguns. McCauley et al. (2003) found that exposure to sounds from a 20-in^3 airgun (i.e., peak to peak SPL of approximately 223 dB re 1 μPa; exposure to 600 pulses) produced observable anatomical damage to the auditory maculae (region containing specialized cells) of pink snapper (Sparidae). In most fish species, hair cells in the ear continuously regenerate, and loss of auditory function likely is restored when damaged cells are replaced with new cells. Impacts would be most severe when the individual fish is close to the source and when the duration of exposure is long. Popper (2005) and Wardle et al. (2001) noted that the potential for pathological damage (i.e., to hearing structures) depends on the energy level of the received sound, its rise time, and the specific hearing characteristics of the species of interest. In studies of seismic exposure, fish were exposed to 5 or 20 shots from an 8-airgun seismic array (total volume = 730 in^3), with a received sound level of >195 dB re 1 μPa (peak-to-peak) (Popper et al., 2005; Song et al., 2008). After exposure, some temporary hearing loss occurred in two species of fish, but no evidence of tissue damage to the swim bladder, other non-auditory tissues, or ear tissue was found (Song et al., 2008). Popper et al. (2005) suggested that the differences in tissue damage between their study and that of McCauley et al. (2003) may have been due to the very different acoustic environments of the studies. No mortality occurred to fish in any of these seismic studies. In an evaluation of the behavior of free-swimming fishes to noise from an 8-airgun seismic array (total volume = 730 in^3) in the Mackenzie River in Northwest Territories, Canada, fishes did not exhibit a noticeable response even when SELs (single discharge) were on the order of 175 dB re 1 $\mu Pa^2 \cdot s$ and $SPL_{0\text{-peak}}$ were >200 dB re 1 μPa (Jorgenson and Gyselman, 2009; Cott et al., 2012).

Barotrauma caused by decompression is the mechanism of injury. Injuries can range from slight to severe and can cause death if the organism's fitness is compromised. Refer to **Appendix J** for a detailed explanation of barotrauma and the effects of decompression to fish. Several controlled, impulsive pile-driving studies (a proxy for airgun signals) showed swim bladder damage in Chinook salmon [*Oncorhynchus tshawytscha*] and documented barotrauma injuries in other species (Halvorsen et al., 2012a, 2012b; Casper et al., 2013a). However, Casper et al. (2012, 2013a, 2013b) showed recovery rates of approximately 10 days for multiple species held in the laboratory. If injury were to occur, fish with swim bladders or other gas-filled chambers would be more susceptible to barotrauma and mortality from G&G activities than fish without swim bladders. Additionally, with increasing depth and range from the source, a pressure change caused by sound poses less risk of barotrauma to fish (refer to **Appendix J, Section 5.4**). In most seismic airgun surveys, the sound source is constantly moving. Adult or juvenile fish presumably would not be exposed to sounds intense enough to cause physiological or anatomical damage because they would swim away from the sound source during its approach. During typical seismic airgun surveys, source vessels travel at 4.5 to 6 kn (5.2 to 7 mph) so that the towed airgun array moves on the order of 37 to 49 m (121 to 161 ft) between seismic pulses, assuming that the airgun array is fired every 10 to 15 seconds (Richardson et al., 1995). Thus, given the assumed fish avoidance behavior, the ramp-up protocols for airgun surveys, the mobile nature of the seismic surveys, the potential for regeneration of damaged hair cells, and the low likelihood of conditions for barotrauma, impulsive sound from airguns would cause a **minor** impact to fish at the population level.

Mortality may occur in close proximity to a sound source (e.g., seismic airguns) when there is a rapid rise and the peak pressures (positive or negative) differ substantially from the ambient pressure at the receiver's location. Beyond the near vicinity of seismic sound sources at shallower depths, the potential for barotrauma and mortality decreases. There are limited data on mortality in response to anthropogenic noises, particularly from airguns, and it is not clear whether death or injury only occurs in close proximity to a sound source (Hawkins et al., 2014). Overall, fish likely will experience sublethal impacts that potentially increase the possibility for delayed mortality (Hawkins et al., 2014). Because G&G sound sources produce low-frequency sounds within the sensitive hearing range of most fish, the likelihood of fish experiencing TTS, masking, and behavioral impacts is high.

Few studies have investigated the effects of airgun noise on fish eggs and larvae, and the results are equivocal (Popper and Hastings, 2009). Eggs and larvae are passive or have limited motion, and so may be considered stationary objects with regard to a moving sound source. Results indicate that mortality to eggs may occur close to airguns (within 1.4 m [4.6 ft]) but that effects of seismic airgun noise on fish eggs and larvae were indistinguishable from natural variability (Booman et al., 1996; Sætre and Ona, 1996). Cox et al. (2012) indicated that mortality of trout eggs to a single airgun exposure was 100 percent at 0.1 m (0.3 ft) but not significantly different than the control group at 2.7 m (8.6 ft). Bolle et al. (2012) found that common sole (*Solea solea*) larvae exposed to impulsive pile-driving sounds did not experience a significant increase in mortality.

The effects of sound on pelagic invertebrates (cephalopods) are also included in this discussion. Cephalopods have a specialized structure inside the cephalic (head) region called a statocyst (specialized sensory organ) that may help an animal determine its position in space (orientation) and maintain balance (Budelmann, 1992). Available data suggest that cephalopods are capable of sensing the particle motion of sounds and detect low frequencies up to 1,000 to 1,500 Hz, depending on the species (Kaifu et al., 2008; Hu et al., 2009; Mooney et al., 2010; Samson et al., 2014). Packard et al. (1990) showed that three species of cephalopods were sensitive to particle motion, not sound pressure, with the lowest thresholds reported as 0.002 to 0.003 meters per second squared [m/s^2] at 1 to 2 Hz. Mooney et al. (2010) demonstrated that squid statocysts (sensory organs found in a wide range of aquatic invertebrates) act as an accelerometer through which particle motion of the sound field can be detected. Mooney et al. (2010) measured acceleration thresholds of -26 dB re 1 m/s^2 between 100 and 300 Hz, and a pressure threshold of 110 dB re 1 μPa at 200 Hz.Hearing thresholds at higher frequencies have been reported, e.g., 134 dB re 1 μPa and 139 dB re 1 μPa at 1,000 Hz for the oval squid (*Sepioteuthis lessoniana*) and the common octopus (*Octopus vulgaris*), respectively (Hu et al., 2009). McCauley et al. (2000) reported that exposure of caged squid to seismic airguns showed behavioral response, including inking. Wilson et al. (2007) exposed two groups of squid (*Loligo pealeii*) in a tank to 199- to 226-dB killer whale echolocation clicks, which resulted in no apparent behavioral effects or any acoustic debilitation. However, both the McCauley et al. (2000) and Wilson et al. (2007) experiments used caged squid, so it is unclear how unconfined animals would react. André et al. (2011) exposed four cephalopod species (i.e., *Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*) to 2 hours of continuous sound from 50 to 400 Hz at received levels of 157 ± 5 dB re 1 μPa and reported lesions occurring on the statocyst's sensory hair cells of the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low-frequency sound. Similar to André et al. (2011), Solé et al. (2013) conducted a low-frequency (50 to 400 Hz) controlled exposure experiment on two deep-diving squid species (i.e., *Illex coindeti* and *Loligo vulgaris*), which resulted in lesions on the statolyst epithelia. Solé et al. (2013) described their findings as "morphological and ultrastructural evidence of a massive acoustic trauma induced by…low frequency sound exposure." In experiments conducted by Samson et al. (2014), cuttlefish exhibited escape responses (inking and jetting) when exposed to sound frequencies between 80 and 300 Hz with sound levels above 140 dB re 1 μPa rms and 0.01 m/s^2; the cuttlefish habituated to repeated 200-Hz sounds. The response intensity of the cuttlefish depended on the amplitude and frequency of the sound stimulus, suggesting that cuttlefish possess loudness perception with a maximum sensitivity of approximately 150 Hz (Samson et al., 2014).

4.4.2.1.2 Analysis of Active Acoustic Sound Sources

Active acoustic sound sources in the proposed action include two general types: airgun sources and non-airgun HRG (electromechanical) sources (**Chapter 3.3.1.1**). Operating frequencies and sound source levels for airguns and electromechanical sources are presented in **Table 3.3-2**.

Deep-Penetration Seismic Airgun Survey Activities

Airguns are used as the seismic source for deep-penetration seismic airgun surveys and HRG surveys for oil and gas exploration. Non-airgun HRG surveys use boomers, sparkers, CHIRP subbottom profilers, side-scan sonar, and MBESs. The HRG and VSP activities are expected to have the highest number of events, whereas deep-penetration 3D and 4D surveys are expected to have the longest durations and scale of activity (**Table 3.2-7**). For example, 3D and 4D surveys cover large areas during relatively long operational periods (2 to 12 months); HRG surveys focus on individual or groups of OCS lease blocks. Thus, with HRG surveys, the area exposed to airgun noise would be smaller, survey trackline density would be higher, and survey duration would be shorter (days rather than months) than deep-penetration surveys. Longer duration, deep-penetration surveys over large areas would have a high likelihood of temporarily exposing fishes to impulsive seismic sound. Depending on water depth, these fish would include coastal pelagic, epipelagic, and demersal hard bottom species. The HRG surveys using airguns that are focused on smaller areas could expose a smaller number of fishes to higher levels of sound than could deep-penetration surveys. Long duration but widespread versus short duration over small areas presents different sound exposure situations, both of which could result in adverse impacts to fishes. Repeated passes by a seismic survey vessel conducting an HRG site-specific survey could displace or disrupt spawning behavior of federally managed grouper and snapper species, as well as other fishes. According to Slabbekoorn et al. (2010), no studies have been conducted to assess the effect of seismic sound on fish spawning. Some data exist on the effect of approaching vessel traffic on spawning behavior for some fish species and are discussed in **Chapter 4.4.2.1**.

Fishes exposed to sound might move away from the sound source, experience TTS (hearing loss), experience masking of biologically relevant sounds, or show no obvious direct effects. Mortality from decompression injuries is possible in close proximity to a sound (**Appendix J**), but only limited data on mortality in response to airguns are available (Hawkins et al., 2014). Surveys using towed airgun arrays move through an area relatively quickly, limiting the exposure of fishes to multiple impulsive sounds. For large deep-penetration airgun surveys, exposure would be highest in terms of the level and number of impulsive sounds; conversely, for HRG surveys using smaller airguns or non-airgun sound sources, transect lines would be more closely spaced and shorter, so fishes might experience exposure to more sequences of impulsive sound. During VSP surveys where the sound source remains in a single location or is moved short distances, sound exposure could be high for fishes that do not leave the survey location but low for those that avoid the sound. In all cases, sound levels would return to ambient once a survey ends and the noise source is shut down. When exposure to sound ends, behavioral responses by fishes are expected to end also (McCauley et al., 2000). While accounting for the potential to disrupt spawning aggregations or schools of important prey species, the mobile and temporary nature of most surveys using active sound sources, the small area of the seafloor (relative to the overall AOI) affected during the surveys, and the possibility of fishes to temporarily move away from noise that is affecting them suggest that the impacts from airguns to fish resources and EFH would be **minor** under Alternative A.

No data are available for the hearing of smalltooth sawfish; however, the hearing of other elasmobranchs (sharks and rays) has been studied. In elasmobranchs (and most likely smalltooth sawfish), hearing is limited to a low-frequency range (600 to 800 Hz) and relies on water particle motion to sense these sounds (Myrberg et al., 1976; Myrberg, 2001; Casper et al., 2003; Casper and Mann, 2006). Therefore, sounds from airguns are likely within the hearing range of the smalltooth sawfish, but probably only very near the source where the particle motion component of a sound would be more intense. With the exception of boomer and sparker subbottom profilers, electromechanical sound sources generate sound much higher in frequency than do airguns (**Table 3.3-2**) that are outside the hearing range of smalltooth sawfish. The behavioral response of smalltooth sawfish to G&G sound would be of most concern if it affects the behavior of individuals involved in reproduction or foraging. Sound particle motion is greatest very close to a sound source and attenuates rapidly with increasing range from a source (**Appendix J**; Normandeau Associates, Inc., 2012). Smalltooth sawfish distribution in the AOI is limited to the waters of southwest Florida and Florida Bay (**Figure 4.4-1**). Seismic surveys are not expected within shallower waters where smalltooth sawfish may be present. Because of the rapid attenuation of sound particle motion with distance from a sound source and the expectation that higher-energy sound sources will not be operated in the proximity of smalltooth sawfish, impacts of active acoustic sound on smalltooth sawfish are expected to be **nominal** under Alternative A.

Little is known about the hearing of Gulf sturgeon. Studies of other sturgeon species indicate that their hearing is most sensitive at very low frequencies (<800 Hz) (Lovell et al., 2005; Meyer et al., 2010). Some sturgeon species produce sounds prior to reproduction at frequencies (2 kHz) above their known hearing range (Johnston and Phillips, 2003). Gulf sturgeon may communicate using sounds produced by jumping during spawning (Sulak et al., 2002). The frequency range of sound heard by Gulf sturgeon likely includes that of the impulsive sound generated by airguns and subbottom profilers. The severity of impacts caused by airguns (i.e., sound pressure and particle motion) would depend on the level of sound produced by the airgun or airgun array and the distance of exposed fish from the source. The most likely effects of active acoustic sound on Gulf sturgeon would be temporary hearing loss, masking, and behavioral changes. Because most individual Gulf sturgeon reside primarily within estuaries and rivers beyond the AOI, any effects would be limited in space and time. A small portion of the Gulf sturgeon population seasonally enters into the coastal ocean in western Florida (**Figure 4.4-1**). Seismic airgun surveys conducted in shallow-water areas close to critical habitat have the highest potential to impact Gulf sturgeon. However, the extent of seismic surveys within shallower waters where Gulf sturgeon may be present is expected to be small relative to the overall seismic survey effort. Therefore, the effect of active acoustic sound sources noise on Gulf sturgeon is expected to be **nominal** under Alternative A.

Non-Airgun HRG Survey Activities

Electromechanical sources, with the exception of sparker and boomer subbottom profilers, are considered mid- or high-frequency sources. For these sources, the acoustic energy emitted outside a main operating frequency band is **nominal**; therefore, these are considered narrow-band sources (refer to **Table 3.4-2** for frequency and source levels). High-frequency electromechanical sources can be highly directive, with transmit beam widths as narrow as a few degrees or less.

Very little information is available for the direct effects of mid- and high-frequency sound sources on fishes, and available studies that have been conducted are for species and in environments that differ from the AOI. Nevertheless, noise from non-airgun HRG surveys may temporarily affect the behavior of some fish species within the AOI, particularly those capable of hearing in the high-frequency range (25 to 135 kHz) such as herrings, menhaden, and anchovies (Mann et al., 1997; Popper et al., 2004). The ability to perceive high-frequency sounds is thought to have evolved as a means of sensing the presence of echolocating predators such as common bottlenose dolphins, which are primary predators of these fish in coastal oceans (Popper et al., 2004). Experimental tests conducted with blueback herring in the Savannah River (Georgia-South Carolina border) confirmed avoidance reactions to high-frequency sound (Nestler et al., 1992). Results determined a maximum avoidance response to sounds ranging from 124.6 to 130.9 kHz at 187 to 200 dB re 1 μPa emitted by a single electromechanical transducer positioned 60 m (197 ft) from the fish. Comparative trials using lower-frequency sounds resulted in limited or no reaction from test subjects (Nestler et al., 1992).

The direct effects of mid- to high-frequency sonar on the physiology and hearing abilities of fish also are not well understood. Halvorsen et al. (2012a) tested the effect of mid-frequency sonar on the hearing of two fish species. Rainbow trout (*Oncorhynchus mykiss*) and channel catfish (*Ictalurus punctatus*) were exposed to sweeps of 2.8 to 3.8 kHz sonar and 3.3 kHz tones for a cumulative exposure of 220 dB re 1 $\mu Pa^2 \cdot s$ SEL_{cum}. Cumulative exposure did not cause a shift in the hearing threshold of rainbow trout. However, channel catfish hearing shifted by 4 to 6 dB at 2.3 kHz, a frequency that overlaps with the upper end of the species' hearing threshold. The catfish recovered from TTS within 24 hours. Other studies tested the effect of low-frequency sonar on hearing thresholds and found that results vary by species (Popper et al., 2007; Halvorsen et al., 2013). Popper et al. (2007) found that rainbow trout exposed to sonar had a TTS of approximately 20 dB at 400 Hz. Halvorsen et al. (2013) found no TTS in largemouth bass (*Micropterus salmoides*) and yellow perch (*Perca flavescens*). Very small threshold shifts (9 dB or less) were found in channel catfish, and the threshold shift returned to normal after 24 hours. In both studies, fishes were exposed to high intensities (193 and 195 dB re 1 μPa SPL_{rms}), considerably higher than the fish are expected to be exposed to during G&G activities. Popper et al. (2007) and Kane et al. (2010) found no evidence of physiological damage to auditory and non-auditory body tissues from sonar.

These results confirm that high-frequency sounds emitted by active electromechanical acoustic operations in the AOI could noticeably affect the behavior of herrings and other high-frequency sensitive fish resources. Changes in behavior, particularly in spawning fish, could affect reproductive potential or feeding activity. In addition, temporary displacement of prey species could indirectly affect feeding activities of predatory fishes. Because the use of electromechanical sources for HRG surveys would be mostly from moving vessels and because individual surveys would be temporary and spatially limited, the impacts on these fishes and populations are expected to be **nominal** under Alternative A.

4.4.2.1.3 Vessel and Equipment Noise

Most of the G&G survey activity described in **Chapter 3.3.1.1** would be conducted from vessels. Vessel noise is a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995). Frequency ranges and source levels for vessels and other machinery are described in **Chapter 3.3.1.2**. Drilling from fixed platforms and artificial islands produces predominantly low- to mid-frequency noise (700 to 1,400 Hz) at maximum source levels of 184 dB re 1μPa at 1 m (Blackwell et al., 2004). Noise of these levels falls within the general range of hearing in fishes (Amoser et al., 2004; **Appendix J**).

Research indicates that the direct effects of vessel and equipment noise will not cause mortality or barotraumatic injuries in adult fish (Hawkins et al., 2014). Vessel and equipment sound source levels have been shown to cause several different effects in behavior, TTS, auditory masking, and blood chemistry. The most common behavioral responses are avoidance, alteration of swimming speed and direction, and alteration of schooling behavior (Vabø et al., 2002; Handegard and Tjøstheim, 2005; Sarà et al., 2007; Becker et al., 2013). Laboratory and field studies have demonstrated several other behaviors influenced by vessel noise. For example, several studies have noted changes in time spent burrowing or using refuge, time spent defending or tending to nests and eggs (Picciulin et al., 2010; Bruintjes and Radford, 2013), intraspecific aggression and territoriality interactions (Sebastianutto et al., 2011; Bruintjes and Radford, 2013), foraging behavior and predator-prey relationships (Purser and Radford, 2011; Bracciali et al., 2012; Voellmy et al., 2014a, 2014b; Simpson et al., 2015, 2016), vocalization patterns (Picciulin et al., 2008, 2012), and overall frequency of movement (Buscaino et al., 2009). These studies also demonstrated that the behavioral changes generally were temporary. Some studies noted changes in the blood chemistry or metabolic rates of several fish species (e.g., European sea bass, gilthead seabream, red drum, spotted sea trout, European eels, Ambon damselfish [*Pomacentrus amboinensis*]) in response to vessel noise (Buscaino et al., 2009; Spiga et al., 2012; Simpson et al., 2015, 2016).

Auditory masking and TTS in fish exposed to vessel noise has been demonstrated in a few studies. Auditory thresholds have been shown to increase by as much as 40 dB when fish are exposed to vessel noise playbacks (Wysocki and Ladich, 2005; Vasconcelos et al., 2007; Codarin et al., 2009). The degree of auditory masking or TTS depends on the hearing sensitivity of the fish, the frequency, and the noise levels tested (Wysocki and Ladich, 2005). The impact of auditory masking and TTS indicate that vessel sounds can lower the ability of fish to detect biologically relevant sounds. However, the effects were found to be temporary and hearing abilities returned to normal.

Very little is understood regarding the effect of vessel noise on the eggs and larvae of fish. Bruintjes and Radford (2014) demonstrated that egg hatching success and larval development of the cichlid *Neolamprologus pulcher* was not affected by exposure to vessel noise playback. Holles et al. (2013), however, reported that the behavior of coral reef larvae could be disrupted by the sound of vessel noise, indicating that the noise could decrease the ability of coral reef larvae to navigate and settle on suitable adult habitat. Nedelec et al. (2015) found no difference in larval fish length at 16 days between individuals exposed to control and vessel sounds. However, fish exposed to vessel sound had a lower body-length ratio, and these fish were easier to catch in predator-avoidance trials. These studies indicate that developmental success and survival could be impacted from vessel noise but the impacts (e.g., positive, negative, and neutral) vary widely.

Currently, there are G&G activities being conducted throughout the AOI. As such, vessel and equipment noise would continue in the AOI as a result of the proposed action scenario. Negative effects on fish behavior are expected to be short term and localized to areas where activity is concentrated. In many cases, effects (e.g., TTS) are temporary as fish hearing abilities recover. For these reasons, the impacts of vessel and equipment noise on fish resources and EFH are expected to be **minor** under Alternative A.

The G&G activities would introduce vessel and equipment noise throughout the AOI. Smalltooth sawfish could be adversely affected by vessel and equipment noise, but because of limited geographical distribution and abundance within the AOI as well as the fact that they are bottom dwellers situated away from the source, exposures to such noise would be rare. The impacts of vessel and equipment noise on smalltooth sawfish individuals in the AOI would be **nominal** under Alternative A.

Gulf sturgeon could be adversely affected by vessel and equipment noise generated by G&G operations if individuals were concentrated in areas of G&G vessel activity. However, Gulf sturgeon likely would not be subjected to vessel and equipment noise associated with the G&G activity scenario because of their distribution and habitat preference. The species generally occurs in estuaries and rivers adjacent to, and occasionally in, the coastal and shelf waters of the AOI. Gulf sturgeon is a bottom dweller; individuals would be far from vessel and equipment noise produced by G&G vessels and, therefore, in the far field of the sound sources. Given these factors, impacts of vessel and equipment noise on Gulf sturgeon would be **nominal** under Alternative A.

4.4.2.1.4 Trash and Debris

All survey vessels performing work within U.S. jurisdictional waters are required to comply with Federal regulations and MARPOL 73/78. Within MARPOL Annex V, “Regulations for the Control of Pollution by Garbage from Ships,” as implemented by 33 CFR part 151, are requirements designed to protect the marine environment from various types of garbage generated on board vessels. In addition, all authorizations for shipboard surveys would include guidance for marine debris awareness (NTL 2015-BSEE-G03).

Plastic lines, cables, rope, and other trash and debris generated by survey vessels during the proposed G&G activities (**Chapter 3.3.1.7**) could directly impact individual smalltooth sawfish if accidentally lost overboard. Because of their long, toothed rostrum, smalltooth sawfish are susceptible to entanglement in various discarded material (Seitz and Poulakis, 2006). In compliance with existing Federal regulations, the amount of trash and debris dumped offshore would be minimal as only accidental loss of trash and debris is anticipated, some of which could sink to the seafloor. Because of the disposal restrictions in place to reduce trash and debris and because the species is very sparsely distributed in the AOI, impacts to smalltooth sawfish from trash and debris would be **nominal**. Trash and debris is not expected to be a concern for Gulf sturgeon, other fish resources, or EFH under Alternative A. Overall, in analyzing all fish and EFH resources, potential impacts would be **nominal** for Alternative A.

4.4.2.1.5 Seafloor Disturbance

Sources of seafloor disturbance that may result from G&G activities are bottom sampling (cores and grabs); placement of anchors, nodes, cables, or other bottom-founded equipment; COST and shallow test well drilling; and placement of anchored monitoring buoys (**Table 3.2-7**). The primary concern is the potential for direct physical damage to demersal hard bottom fish resources. Similarly, EFH (i.e., coral, coral reefs, and live/hard bottom habitats) and federally managed species such as spiny lobster and members of the snapper/grouper complex could be directly affected by physical damage to hard bottom. Placement of equipment on the seafloor could damage areas where direct contact with the seafloor occurs. On soft bottom, the damage can mean loss of small patches of epifauna (living on the seafloor surface) and infauna (living in seafloor sediment); on hard bottom, contact can crush epibiota (organisms that live on the surface of other organisms) and damage the structure of the founding hard bottom. Due to existing regulatory protective requirements that review identified sensitive benthic habitats and the relatively small annual number of seafloor-disturbing activities in BOEM’s three Program Areas, seafloor disturbance would affect a relatively small amount of EFH-related seafloor and associated demersal EFH species. Most demersal fish will be able to move to avoid direct impact from seafloor-disturbing activities. Damage to unknown or unseen hard bottom could occur, but because of the relatively small area covered by most bottom-founded equipment and small overall reduction of the seafloor-habitat (**Chapter 4.5.2.1.3**) associated demersal EFH fish in all three Program Areas and existing protective regulations (**Chapter 4.5**), such impacts are expected to be **nominal**. Soft bottom areas where deployments are made could lose benthic organisms (because of burial and crushing), and bottom-feeding fishes would be temporarily displaced from feeding areas.

The projected area of seafloor disturbance from G&G activities is an extremely small area (refer to **Table 3.2-7**) over a 10-year period. Given these estimates of minimal seafloor disturbance by projected G&G activities and existing requlatory protective requirements and reviews, the impacts to fishery resources and EFH are expected to be **nominal** under Alternative A. For the threatened and endangered fishes, seafloor disturbance could affect bottom-feeding species (smalltooth sawfish and Gulf sturgeon) by displacing individuals from feeding areas and reducing the available benthic prey organisms. These potential impacts would be **nominal** under Alternative A for smalltooth sawfish and Gulf sturgeon because the species mainly occur outside of the AOI.

4.4.2.1.6 Drilling Discharges

Discharges from COST and shallow test wells consist of drilling fluids and cuttings that would affect limited portions of the water column and seafloor surrounding individual wells. Releases of toxic discharges are regulated by 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 (USDOI, BOEM, 2017a). Drilling discharges can temporarily affect infaunal communities through alteration of benthic community structure, similar to impacts associated with seafloor disturbances noted previously. **Chapter 3.3.1.9** indicates the types of drilling discharges and the total volumes generated from exploratory drilling. The projected area of seafloor disturbance from G&G activities is an extremely small area (refer to **Table 3.2-7**). Because of the small areas affected by proposed G&G well drilling activities, impacts to fish resources and EFH, including smalltooth sawfish and Gulf sturgeon, from drilling discharges are expected to be **nominal** under Alternative A.

4.4.2.1.7 Entanglement

Sources of entanglement hazards in the proposed action that may impact fish resources within the AOI include placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor for OBC/OBN (nodal) surveys within the Oil and Gas Program.

Acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines pose an entanglement risk to fish and other marine life. Entanglement is possible with OBC surveys, which are discussed in **Appendix F, Section 1.1.3**. The deployment of nodes and cables is accomplished by using an ROV, by dropping nodes on a tether, or by laying cables off the back of a layout boat. Risks of entanglement to marine life are reduced by the application of mitigations and conditions of approval. BOEM and cooperating agencies, using an applied adaptive management philosophy, have developed several standard mitigations and conditions to protect marine resources, including (1) shortening acoustic buoy and tethered acoustic pinger lines to the shortest length practical, (2) replacing tether rope lines <0.25 inches in diameter with thicker, more rigid tether line, and (3) modifying the line by tying knots along its length to increase diameter and rigidity. The OBC/OBN (nodal) survey locations and projected levels are not estimated; however, nodal surveys are relatively uncommon and typically performed in shallow waters (<300 m). As of 2013, there was only one reported manta ray entanglement incident during a tethered nodal seismic survey. Given the scope and transitory nature of OBC/OBN surveys associated with Alternative A and the implementation of risk-reducing measures described previously, entanglement impacts on fish resources and EFH are expected to be **nominal**.

4.4.2.1.8 Routine Activities Impact Conclusions

This analysis considered the impact-level criteria, the AOI, and the 10-year timeframe. Mitigation measures associated with Alternative A are outlined in **Chapter 2.3** and detailed in **Appendix B**. As discussed previously, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to fish resources and EFH from each project-related IPF (including routine activities) is as follows:

- deep-penetration airgun survey noise – **nominal** to **minor**;
- non-airgun HRG electromechanical survey noise – **nominal**;
- vessel and equipment noise – **nominal** to **minor**;
- trash and debris – **nominal**;
- seafloor disturbance – **nominal**;
- drilling discharges – **nominal**; and
- entanglement – **nominal**.

Overall, impacts to fish resources and EFH from routine activities under Alternative A are expected to range from **nominal** to **minor**. Implementation of mitigation measures described under Alternative A may reduce the potential impacts from the IPFs listed earlier to individuals within the AOI. Impact levels by IPF were determined using impact-level criteria discussed in **Chapter 4.2.2.1**, and each impact level was determined by considering effects to fish resources and EFH within the AOI as a whole.

4.4.2.2 Impacts of an Accidental Fuel Spill

An accidental event could result in the release of fuel or diesel by a survey vessel. Based on USCG spill statistics, a spill scenario was developed in **Chapter 3.3.2** that assumes a diesel spill volume of 1.2 to 7.1 bbl. Diesel is acutely toxic to algae, invertebrates, and fishes, and any contact with a diesel spill can result in death. However, small spills in open water, such as the one described in **Chapter 3.3.2**, rapidly disperse and volatile components evaporate, making fish kills rare events. For the duration of such a spill, species and life stages residing in the upper water column are most at risk for contact with the spilled fuel. Coastal pelagic and epipelagic adults, including Spanish mackerel, king mackerel, little tunny, and yellowfin tuna (**Chapter 4.4.1 and Appendix E, Section 4**), that forage at the sea surface would be most likely to encounter a surface spill and have the highest risk of exposure, but they would likely swim away from a small diesel spill. Planktonic early life stages (i.e., eggs of demersal and pelagic species) would be unable to avoid a spill and, therefore, are most vulnerable to toxic properties of diesel (Mos et al., 2008).

Numerous federally managed species described previously (refer to **Chapter 4.4.1 and Appendix E, Section 4**) have pelagic eggs and larvae that would be at risk if they encountered a diesel spill. The EFH most at risk from a small diesel spill would be pelagic *Sargassum* habitat.

Drifting in windrows or mats, *Sargassum* supports two fish species permanently (Sargassumfish and *Sargassum* pipefish) and several fish species as juveniles (e.g., jacks, triggerfishes, filefishes). Additionally, larger species of recreational or commercial importance feed on the small fishes and invertebrates attracted to *Sargassum* habitat (Dooley, 1972; Bortone et al., 1977; Wells and Rooker, 2004a and 2004b) (**Chapter 4.8**). Exposure of spilled diesel fuel on early life stages of fish and on *Sargassum* habitat is expected to last for less than a day and have limited spatial extent. Furthermore, if an accidental fuel spill occurs, the spill size likely would be relatively small and the area of impact would be a small portion of the AOI; the type and severity of impacts to pelagic fish, as well as buoyant eggs and larvae in localized areas, would depend on the location of the event but are expected to range from **nominal** to **minor** under Alternative A.

Because of their life histories, neither smalltooth sawfish nor Gulf sturgeon would have sensitive eggs or larvae in the water column of the AOI where they would be exposed to accidentally spilled diesel fuel. Therefore, the expected impact of an accidental diesel fuel spill is expected to be **nominal** for both species under Alternative A.

4.4.2.3 Cumulative Impacts

4.4.2.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.4.2.1 and 4.4.2.2** determined that activities projected to occur under Alternative A would result in **nominal** to **minor** impacts to fisheries resources and EFH, with the level of impact dependent upon the specific IPF being considered. The following analysis considers whether those incremental impacts, when added to or acting synergistically with other impact sources from the cumulative impacts scenario, may result in a significant impact. Implementation of mitigation measures described under Alternative A may reduce the potential impacts from the routine activities IPFs listed earlier to individuals within the AOI. Exposure of spilled diesel fuel on early life stages of fish and on *Sargassum* habitat is expected to last for less than a day and have limited spatial extent and are expected to range from **nominal** to **minor** under Alternative A.

Therefore, cumulative incremental impacts to fish resources and EFH from the proposed action, when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, the minimization of Outer Continental Shelf G&G-related impacts through stipulations and regulations, and the wide-ranging behavior of fish resources and EFH, would be expected to be **minor** with no anticipated population-level impacts.

4.4.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for fish resources and EFH are compared with the IPFs from each of the cumulative scenario activities on those activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The IPFs for the cumulative activities that have the potential to affect fisheries resources and EFH include (1) Federal and State oil and gas activity; (2) increased anthropogenic noise in the ocean, including underwater noise from sonars, explosives, and other active sound sources and vessel and equipment noise; (3) pollution; (4) seafloor disturbance; (5) commercial and recreational fishing; (6) entanglement (7) habitat modification; and (8) climate change. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI.

The G&G activities have been ongoing in the GOM for at least the past 30 years, and it is reasonable to assume they will continue into the future; however, for the purpose of this Programmatic EIS, the cumulative analysis assesses a 10-year timeframe to coincide with the proposed action because it is not expected that G&G activities will have lasting effects or extend beyond the 10-year period of this Programmatic EIS.

Federal and State Oil and Gas Activity

The impacts from oil and gas activities, excluding infrastructure emplacement, would be expected to be **nominal** or **minor** due to short-term localized effects. The installation of 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, infrastructure is expected to be decommissioned and sites restored to natural habitat. 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 **minor**. The potential for fuel spills from vessels involved in the OCS Program would be higher than that expected under the proposed action because of the magnitude of vessel activity in the AOI and the high number of vessel transits.

In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. For more information on oil and gas activities and their impacts to fish and invertebrate species, refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.7 of the 2017-2022 GOM Multisale EIS.

Noise

Active Acoustic Sound Sources

Active acoustic sound sources related to oil and gas development have been ongoing in the GOM for decades and are likely to be used in the future. As discussed in **Chapter 4.4.2.1**, such sounds may impact fish resources and EFH, but only temporarily and in localized areas around the sound sources.

The G&G activities associated with the proposed action will not be conducted within State waters. However, other agencies can permit G&G activities that can include active sound sources (e.g., seismic airguns and side-scan sonars for oil and gas activities in State waters). Behavioral responses or masking are possible impacts to fish or invertebrates if the sound source is loud enough and in the hearing range of the organism, or the organisms may exhibit no response (**Chapter 4.4.2.1**).

Other major factors that contribute active acoustic sound sources are shown in **Table 3.4-1**. Impacts from similar sound sources (e.g., seismic airguns) under the G&G proposed action are discussed in **Chapter 4.4.2.1**. Studies have shown that military sonars do not cause mortality or physiological damage to auditory and non-auditory tissues (Popper et al., 2007; Kane et al., 2010), and they are not likely to lead to population consequences for Atlantic herring (Sivle et al., 2015). Active acoustic sound sources from G&G activities considered in cumulative impacts assessment have been ongoing in the AOI for decades and are likely to continue in the future. Anthropogenic sounds levels in the marine environment are increasing, and impacts like masking and behavioral changes to fish and invertebrates are likely (Slabbekoorn et al., 2010; Radford et al., 2014). However, assessing overall increases in sound is difficult because of the lack of baseline data from individual sound sources and the ambient sound conditions (Hawkins et al., 2014). Therefore, a **nominal** to **minor** incremental increase in impacts to fish resources and EFH is expected from active acoustic sound sources under Alternative A.

Vessel and Equipment Noise

The impacts from vessel and equipment noise under the proposed action are discussed in **Chapter 4.4.2.1**. Overall, **Chapter 4.4.2.1** concluded that there would be **nominal** to **minor** impacts to smalltooth sawfish, Gulf sturgeon, and all other fish resources and EFH.

Support vessel traffic, drilling, and other development activities are key parts of most OCS Program activities; as such, vessel and equipment noise is generated (**Chapter 3.4**). Very little drilling will occur as part of the proposed activities and, therefore, will add little to the cumulative impacts (**Table 3.2-7**). Vessel and equipment noise in the AOI may negatively affect the behavior of fish resources (**Chapter 4.4.2.1**). Offshore facility decommissioning, including platform and caisson removal, typically use one of two primary methods to sever structures attached to the seafloor: mechanical severance or explosive severance. Explosive charges generally are placed inside the platform legs or conductors 4.6 to 7.6 m (15 to 25 ft) below the seafloor. Structure-removal permit applications and numbers of structures removed in the GOM between 2002 and 2013 are summarized in **Tables 3.4-3 and 3.4-4**. The underwater detonation of explosives results in a shockwave and acoustic energy that can kill or harm fish. Gitschlag et al. (2000) found that the most severely impacted fish species at explosive structure removals (in order of abundance) were Atlantic spadefish (*Chaetodipterus faber*), blue runner, red snapper, and sheepshead (*Archosargus probatocephalus*). Govoni et al. (2008) indicated that explosives can cause mortality to fish larvae but are unlikely to affect fishes at the population level. Proposed activities would increase levels of vessel noise within the AOI, resulting in increases in ambient noise levels within discrete geographical areas during G&G operations (primarily the WPA and CPA).

Other major factors that contribute vessel and equipment noise are shown in **Table 3.4-1**. Most of the noise-producing activities result in continuous sound (e.g., vessel and dredging noise) that may result in impacts such as behavioral responses and masking in fish and invertebrates (**Chapter 4.4.2.1**). Pile-driving sounds are impulsive and likely to have similar impacts to seismic airguns. Mortality or physiological damage may be possible within a very small range of the sound source; behavioral responses and impacts to hearing are more likely throughout the AOI. Vessel and equipment noise from G&G activities considered in cumulative impacts assessment have been ongoing in the AOI for decades and are likely to continue in the future. Anthropogenic sound levels in the marine environment are increasing, and impacts like masking and behavioral changes in fishes are likely (Slabbekoorn et al., 2010; Radford et al., 2014). However, assessing overall increases in sound is difficult because of the lack of baseline data from individual sound sources and the ambient sound conditions (Hawkins et al., 2014).

Overall, compared with the combined vessel noise within the GOM, a **nominal** incremental increase in impacts to fish resources and EFH from vessel and equipment noise is expected under the proposed action.

Pollution

Trash and Debris

Certain types of trash and debris could be accidentally lost overboard, some of which could sink to the seafloor and potentially cause entanglement of smalltooth sawfish (**Chapter 4.4.2.1**). However, there are no reports of smalltooth sawfish or other fish resources being entangled from the OCS Program or oil and gas activities in State waters. In compliance with existing Federal regulations, the amount of trash and debris dumped offshore would be minimal, as only accidental loss of trash and debris is anticipated. All authorizations for shipboard surveys would include guidance for marine debris awareness (NTL 2015-BSEE-G03). Because of the disposal restrictions in place to reduce trash and debris, guidance for marine debris awareness, and the fact that smalltooth sawfish are very sparsely distributed in the AOI and are limited to State waters in the EPA, impacts to smalltooth sawfish from entanglement in trash would be **nominal**. Considering the small contribution of trash and debris from activities under the proposed action, a **nominal** incremental increase in impacts from trash and debris is expected.

Drilling Discharges

The Oil and Gas Program's activities over the next 10 years are projected to include drilling that will result in discharges from several activities (refer to **Table 3.4-2**). Drilling discharges can temporarily increase turbidity, bury soft bottom communities, and exclude bottom-feeding fishes from small areas of the seafloor (**Chapter 4.4.2.1**). Activities that produce drilling discharges under the proposed action can be found in **Table 3.2-7**. Wells drilled under the OCS Program and those drilled under Alternative A likely would not be close enough in time or space for drilling discharges from one well to contribute to the possible impacts from another.

Oil and gas activities in State waters will contribute drilling discharges and impacts to fish and EFH. It is extremely unlikely that IPFs from the proposed action will enter State waters and result in additional incremental impacts to similar activities.

Drilling discharges will not occur homogenously over the entire AOI or over the 10-year period; thus, they are spatially and temporally limited and their impacts are not likely to increase over time. Therefore, a **nominal** incremental increase in impacts to fish resources and EFH from drilling discharges is expected under Alternative A. Potential impacts of drilling discharges to benthic resources, including corals, spiny lobster, and shrimp, are considered in **Chapter 4.5**.

Seafloor Disturbances

Impacts from seafloor disturbances during the proposed action are discussed in **Chapter 4.4.2.1**. Overall, **Chapter 4.4.2.1** concluded that there would be **nominal** impacts to smalltooth sawfish, Gulf sturgeon, and all other fish resources and EFH.

Seafloor-disturbing activities associated with the proposed action over the 10-year period are included in **Table 3.2-7**. The cumulative scenario includes activities that disturb the seafloor by anchoring, trenching, coring, trawling and bottom sampling from OCS Program activities, decommissioning, and activities of the Renewable Energy and Marine Minerals Programs. In addition, other activities in the AOI such as State waters oil and gas, commercial fishing, dredging and material disposal activities, cable installation, military activities, and scientific research can cause seafloor disturbances (**Table 3.4-1**). Seafloor-disturbing activities may affect fish resources and EFH temporarily by disrupting feeding of soft bottom species or elevating turbidity that would impair feeding by visually oriented plankton feeders. The projected area of seafloor disturbance is a very small fraction of the AOI and represents a limited area compared with projected seafloor disturbance from Oil and Gas Program activities during the 10-year period (**Table 3.4-2**). Because of the likely wide separation, the risk of cumulative impacts associated with the proposed action with similar cumulative activities will be **nominal**. While small numbers of seafloor samples may be clustered in an area, the seafloor disturbed by each sample is small and the areas investigated using seafloor samples likely will be widely spaced. In addition, the time required for each sample is very short. Potential impacts of seafloor disturbance to benthic resources, including corals, spiny lobster, and shrimp, are considered in **Chapter 4.5**.

The number of seafloor disturbances expected under the proposed action do not occur homogenously over the entire AOI or over the 10-year period; thus, they are spatially and temporally limited and their impacts are not likely to increase over time. Considering the small contribution of seafloor disturbance from activities under the proposed action, a **nominal** incremental increase in impacts is expected.

Commercial and Recreational Fishing

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. 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 **nominal** for most non-targeted species to **moderate** for species that are overfished or experiencing overfishing (e.g., hogfish spp., gray triggerfish, and greater amber jack [*Seriola dumerili*]).

Entanglement

Chapter 4.4.2.1 concluded that there would be **nominal** impacts to smalltooth sawfish, Gulf sturgeon, and all other fish resources and EFH from the proposed action under Alternative A. The EFH for corals, spiny lobster, and shrimp are considered in the analysis of benthic resources in **Chapter 4.5**.

Other major factors that contribute to entanglement are shown in **Table 3.4-1**. Such activities could cause entanglement from trash and debris, fishing gear, or sampling gear. Entanglement risk of sawfish is highest for active or discarded commercial and recreational fishing gear, and the risk of entanglement by other debris is very low (Seitz and Poulikis, 2006). The OBC/OBN (nodal) surveys locations and projected levels are not estimated; however, nodal surveys are relatively uncommon and are typically performed in shallow waters. Given the scope and transitory nature of OBC/OBN surveys associated with Alternative A and the implementation of risk-reducing measures described previously, entanglement impacts on fish resources and EFH are expected to result in a **nominal** incremental increase in impacts under the cumulative scenario.

Habitat Modification

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, 2010). 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). 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). Therefore, the cumulative adverse impact of coastal development on fishes and invertebrate resources is expected to be **minor**.

Climate Change

A review of climate change is presented in Chapter 4.2.1 of the Five-Year Program EIS (USDOI, BOEM, 2016b).

4.4.2.3.3 Cumulative Impact Conclusions

The spatial distribution of activities projected under the proposed action during the project period are most concentrated within deepwater regions of the CPA and WPA, and less concentrated within continental shelf waters (**Table 3.2-1**). Very little activity is projected to occur within the EPA. Temporally, activity levels associated with the proposed action vary by activity type and year (**Tables 3.2-1 through 3.2-5**). Impacts to fish resources from sound are likely to be minimal, temporary, and localized. Seismic surveys and activities that generate vessel and equipment noise are not conducted homogenously over the entire AOI or over the 10-year period; thus, they are spatially and temporally limited and their impacts are not likely to increase over time.

When compared with past levels of activities in the GOM, proposed activities do not represent a significant incremental increase to activities under the cumulative scenario. Surveys utilizing active acoustic sound sources have occurred within the GOM for decades, including within State waters and the continental shelf and deepwater regions of the OCS. Commercial, military, and recreational vessel traffic also has occurred in the GOM, including the AOI, for many years. In some cases, such as large commercial vessels, traffic is and has been more concentrated along shipping lanes that funnel into major coastal ports. Commercial and recreational fishing vessels have utilized broad areas of the northern GOM, but primarily on the continental shelf and shelf edge. Military vessels likely have traveled through all areas of the GOM, though most, if not all, exercises presumably have occurred within the U.S. Navy GOMEX Range Complex OPAREAs.

When compared with past, present, and future activities, including similar non-OCS Program activities (**Figure 3.4-1**), the cumulative effects of all IPFs to fish resources and EFH within the AOI over the 10-year period would result in **nominal** to **minor** incremental impacts. The cumulative impacts on fish resources and EFH from all ongoing and reasonably foreseeable future activities in the GOM, including other similar BOEM Program activities (**Figure 3.4-1**), are expected to be nominal to moderate as described in **Chapter 4.4.2.3.2** above. The incremental contribution of the proposed action under Alternative A is expected to be minor. Although the proposed action represents a small portion of these activities, it contributes to potential IPFs and extends the area over which fish resources and EFH could be subject to G&G-related stressors.

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 nominal 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 Akins, 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 IPFs, 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.

4.4.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.4.2.1**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on fish resources and EFH.

4.4.3.1 Impacts of Routine Activities

Additional mitigation measures under Alternative B, including the expansion of NTL 2016-BOEM-G02 (inclusion of manatees and application to all deep-penetration seismic airgun surveys in all water depths) and the expanded use of PAM, are not relevant to fish resources and EFH and, therefore, would not change the level of impact to fish resources and EFH. As such, those mitigation measures will not be addressed in the following discussion.

4.4.3.1.1 Coastal Waters Seasonal Restrictions

Seasonal restrictions for airgun operations in coastal waters under Alternative B would change when active acoustic sound sources and vessel equipment and noise could occur in Federal coastal waters of the GOM compared with Alternative A. Seismic airgun usage associated with the surveys would not be authorized from (a) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath) and (b) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the UME in the northern GOM (**Figure 2.2-1 and Chapter 2.4.3**). The impacts of active acoustic sound sources and vessel and equipment noise from seismic airgun surveys would be reduced, but only within coastal waters during the restricted time periods. The purpose of this mitigation measure is to protect marine mammals within the seasonally restricted areas from IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some coastal fish species (**Tables 4.4-1, 4.4-2, and 4.4-4**), as the effects on fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced in the seasonally restricted areas. However, seismic surveys will still occur outside this area, the closure timeframe is temporary, and the closure area is small compared with the AOI. Therefore, the overall impacts from the IPFs in Alternative B will not change. The impacts of active acoustic sound sources from seismic airguns are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH under Alternative B. The mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will remain **nominal** for fish resources and EFH under Alternative B. Impacts of vessel equipment and noise are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH under Alternative B. This mitigation does not apply to the other project-related

IPFs and would not alter the impacts to fish resources and EFH from trash and debris, seafloor disturbance, drilling discharges, or entanglement; impacts would remain **nominal**.

4.4.3.1.2 Minimum Separation Distances

Alternative B would establish a 40-km (25-mi) separation distance between simultaneously operating deep-penetration seismic airgun surveys within the Areas of Concern and a 30-km (19-mi) separation distance outside the Areas of Concern (**Chapter 2.4.2**).

Applicable routine IPFs for fish resources and EFH are active acoustic sound sources and vessel equipment and noise. Limits on concurrent seismic airgun surveys under Alternative B could change the timing of seismic surveys in certain areas. The locations cannot be predicted in advance, as they would depend on the schedule, planned coverage of individual surveys, and ports to be used for support activities. Seismic surveys will still be conducted; therefore, a change in the survey timing because of limits on concurrent seismic airgun surveys would not alter the impacts from active acoustic sound sources and vessel and equipment noise on fish and EFH. Therefore, under Alternative B, impacts of active acoustic sound sources are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, **minor** for fish resources and EFH affected by airguns, and **nominal** for fish resources and EFH affected by electromechanical sounds. Impacts of vessel and equipment noise are expected to remain **minor** for fish resources and EFH, and **nominal** for smalltooth sawfish and Gulf sturgeon under Alternative B. This mitigation does not apply to the other project-related IPFs and would not alter the impacts to fish resources and EFH from trash and debris, seafloor disturbance, drilling discharges, or entanglement; impacts would remain **nominal**.

4.4.3.1.3 Seismic Restrictions in the Areas of Concern within the EPA

Additional restrictions under Alternative B include the prohibition of deep-penetration seismic airgun surveys within the portion of the Areas of Concern (**Chapter 2.4.2**) falling within the EPA. This restriction does not apply to surveys related to currently leased blocks, any portion of the area encompassed by EPA Lease Sale 226, or OCS lease blocks adjacent to permitted survey areas but within an otherwise off-limit area.

A restriction on seismic surveys within a portion of the AOI could result in reduced impacts from active acoustic sound sources and vessel equipment and noise due to the reduced area of activity. The purpose of this mitigation measure is to protect marine mammals within the seasonally restricted areas from IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some oceanic fish species (**Appendix E, Section 4**) in the seasonally restricted area, as the effects on fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced in that region. The impacts of active acoustic sound sources and vessel and equipment noise from seismic airgun surveys would be reduced, but only in the portion of the Areas of Concern falling within the EPA. The size of the closure area is small compared with the size of the AOI, and the majority of deep-penetration seismic airgun surveys will occur in the WPA and CPA where seismic surveys will not be restricted. Thus, there will not be a substantial reduction in seismic survey activity in the AOI, and the overall impacts on fish resources and EFH would not change under Alternative B. Impacts of airgun active acoustic sound sources are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH. This mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will be **nominal** for fish resources and EFH under Alternative B. Impacts of vessel equipment and noise are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH under Alternative B. This mitigation does not apply to the other project-related IPFs and would not alter the impacts to fish resources and EFH from trash and debris, seafloor disturbance, drilling discharges, or entanglement; impacts would remain **nominal**.

4.4.3.1.4 Routine Activities Impact Conclusions

This analysis considered the impact-level criteria, AOI, and 10-year timeframe. Mitigation measures associated with Alternative B are outlined in **Chapter 2.4** and detailed in **Appendix B**. As discussed previously, the degree to which these mitigation measures (collectively) will affect or change the levels of impact to fish resources and EFH from each project-related IPF (including routine activities) is as follows:

- deep-penetration airgun survey noise – **nominal** to **minor**;
- non-airgun HRG electromechanical survey noise – **nominal**;
- vessel and equipment noise – **nominal** to **minor**;
- trash and debris – **nominal**;
- seafloor disturbance – **nominal**;
- drilling discharges – **nominal**; and
- entanglement – **nominal**.

Overall, impacts to fish resources and EFH from routine activities under Alternative B are expected to range from **nominal** to **minor**. Implementation of mitigation measures described under Alternative B may reduce potential impacts from the IPFs listed earlier to individuals within the AOI. Impact levels by IPF were determined using impact-level criteria discussed in **Chapter 4.4.2.1**, and each impact level was determined by considering effects to fish resources and EFH within the AOI as a whole.

4.4.3.2 Impacts of an Accidental Fuel Spill

Under Alternative B, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. Alternative B would change the timing of certain surveys because of additional coastal seasonal restrictions. However, spills from seismic survey vessels could occur in the closure areas during times outside the closure period, and spills from other survey vessels could occur during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Therefore, the impacts of the IPFs would be very similar to those analyzed for Alternative A in

Chapter 4.4.2.2. If an accidental fuel spill occurs, the spill size likely would be relatively small and the area of impact would be a small portion of the AOI. The type and severity of impacts to pelagic fish as well as buoyant eggs and larvae in localized areas would depend on the location of the event, but the impacts are expected to range from **nominal** to **minor**.

4.4.3.3 Cumulative Impacts

4.4.3.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.4.3.1 and 4.4.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** to **minor** impacts to fish resources and EFH, depending on the IPF.

Mitigation measures for the proposed action under Alternative B are described in **Chapter 2.4** and summarized in **Chapter 4.4.3.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3**). Most of the mitigation measures under Alternative B would not change the extent, severity, or timing of activities in the proposed action, and therefore the resultant impacts to fish resources and EFH would not change. Mitigation measures under Alternative B that would change the timing and extent of activities in the proposed action include a seasonal restriction for operation of airguns in Federal coastal waters, a minimum separation distance requirement for simultaneous seismic operations, and the prohibiting of deep-penetration seismic airgun surveys within portions of the EPA (**Chapter 2.4.2**).

4.4.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.4.2.3.2**) would remain the same under Alternative B.

4.4.3.3.3 Cumulative Impact Conclusions

The proposed action activities considered in assessment of cumulative impacts are the same for Alternatives A and B. Seasonal restriction of airgun operation in Federal coastal water under Alternative B may cause a shift in schedules for seismic surveys using airguns but not necessarily a reduction in the number and extent of surveys conducted in Federal coastal waters. Prohibition of deep-penetration seismic airgun surveys in the EPA also will not appreciably impact the number and extent of such surveys under Alternative B because almost all seismic exploration activity conducted during the analysis period will be conducted in the WPA and CPA (**Table 3.2-1**). Because there is little to no change in proposed action activities considered between Alternatives A and B, and because of the limited effect of Alternative B mitigation measures on the occurrence and extent of IPFs, EFH and fish resources would not be impacted by additional measures in Alternative B beyond that described for Alternative A. Therefore, for Alternative B, there would be a **nominal** to **minor** incremental cumulative increase in impacts to fish resources and EFH. The cumulative impacts on fish resources and EFH from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.4.2.3.2** above. The incremental contribution of the proposed action under Alternative B is expected to be **nominal** to **moderate** because the relative extent of Outer Continental Shelf G&G activities are considered a stressor to fish resources and EFH in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which fish resources and EFH could be subject to G&G activity.

4.4.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.4.2.1**). The following discussion outlines the effects of the additional mitigation measures included under Alternative C on fish resources and EFH.

4.4.4.1 Impacts of Routine Activities

Additional mitigation measures under Alternative C that would not change the extent, severity, or timing of G&G activities, and therefore related impacts to fish resources and EFH, include the expanded use of PAM for seismic airgun surveys, the expanded use of PSOs for seismic airgun surveys and HRG surveys, expansion of NTL 2016-BOEM-G02 (inclusion of manatees) for seismic airgun surveys and HRG surveys using airguns, and a pre-survey clearance period for HRG surveys. As such, those mitigation measures will not be addressed further.

4.4.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

Alternative C would require seasonal restrictions for seismic airgun survey operations in coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31 (**Figure 2.3-1**). The impacts of active acoustic sound sources and vessel and equipment noise from seismic airgun surveys would be reduced, but only within coastal waters between February 1 and May 31. The purpose of this mitigation measure is to protect marine mammals within the closure areas from IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some coastal fish species (**Tables 4.4-1, 4.4-2, and 4.4-4**) as the effects on fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced due to the seasonal restriction. However, seismic surveys still will occur outside this area, the closure duration is seasonal, and the closure area is small compared with the size of the AOI. Therefore, the overall impacts from the IPFs under Alternative C would not change substantially for most fish.

4.4.4.1.2 Routine Activities Impact Conclusions

Impacts of active acoustic sound sources from airguns are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH under Alternative C. The mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will be **nominal** for fish resources and EFH under

Alternative C. Impacts of vessel equipment and noise are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH. This mitigation does not apply to the other project-related IPFs and would not alter the impacts to fish resources and EFH from trash and debris, seafloor disturbance, drilling discharges, or entanglement; impacts would remain **nominal**.

Overall, impacts to fish resources and EFH from routine activities under Alternative C are expected to range from **nominal** to **minor**.

4.4.4.2 Impacts of an Accidental Fuel Spill

Under Alternative C, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. Similar to Alternative B, a change in survey timing would not substantially change the risk of a small fuel spill because spills from seismic survey vessels could occur in the closure areas during times outside the closure period and because spills from other survey vessels could occur during the closure period. Therefore, the impacts of the IPFs would be very similar to those analyzed for Alternative A in **Chapter 4.4.2.2**. If an accidental fuel spill occurs, the spill size likely would be relatively small and the area of impact would be a small portion of the AOI. The type and severity of impacts to pelagic fish, as well as buoyant eggs and larvae in localized areas, would depend on the location of the event but are expected to range from **nominal** to **minor** under Alternative C.

4.4.4.3 Cumulative Impacts

4.4.4.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.4.4.1 and 4.4.4.2** concluded that activities projected to occur under Alternative C would result in **nominal** to **minor** impacts to fish resources and EFH, depending on the IPF. Mitigation measures for the proposed action under Alternative C are described in **Chapter 2.5**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3**). Most of the mitigation measures under Alternative C, including seasonal restrictions, would not change the extent, severity, or timing of activities in the proposed action and, therefore, would not change the resultant impacts to fish resources and EFH.

4.4.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.4.2.3.2**) would remain the same under Alternative C.

4.4.4.3.3 Cumulative Impact Conclusions

Alternative C does not change the cumulative outcomes described in Alternative A; there would be a **nominal** to **minor** incremental increase in impacts to fish resources and EFH under Alternative C. The cumulative impacts on fish resources and EFH from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.4.2.3.2** above. The incremental contribution of the proposed action under Alternative C is expected to be **nominal** to **moderate** because the relative extent of Outer Continental Shelf G&G activities are considered stressor to fish resources and EFH in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which fish resources and EFH could be subject to G&G activity.

4.4.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.4.2.1**). The additional mitigation measure under Alternative D, which includes shutdowns for marine mammals, would not change the extent, severity, or timing of IPFs outlined in Alternatives A and C.

4.4.5.1 Impacts of Routine Activities

The additional mitigation measure under Alternative D would not reduce potential active acoustic impacts discussed under Alternatives A and C (**Chapters 4.4.2.1 and 4.4.4.2**). The impacts of active acoustic sound sources from airguns are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH under Alternative D. The mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will be **nominal** for fish resources and EFH under Alternative D. Impacts of vessel equipment and noise are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH. This mitigation does not apply to the other project-related IPFs and would not alter the impacts to fish resources and EFH from trash and debris, seafloor disturbance, drilling discharges, or entanglement; impacts would remain **nominal**.

Overall, impacts to fish resources and EFH from routine activities under Alternative D are expected to range from **nominal** to **minor**.

4.4.5.2 Impacts of an Accidental Fuel Spill

Alternative D would not add additional mitigation measures that would reduce risk of an accidental fuel spill. Therefore, the impacts of the IPFs would be very similar to those analyzed for Alternatives A and C in **Chapter 4.4.2.2**. If an accidental fuel spill occurs, the spill size likely would be relatively small and the area of impact would be a small portion of the AOI. The type and severity of impacts to pelagic fish as well as buoyant eggs and larvae in localized areas would depend on the location of the event but are expected to range from **nominal** to **minor**.

4.4.5.3 Cumulative Impacts

4.4.5.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.4.5.1 and 4.4.5.2** concluded that activities projected to occur under Alternative D would result in **nominal** to **minor** impacts to fish resources and EFH, depending on the IPF. Mitigation measures for the proposed action under Alternative D are described in **Chapter 2.6** and summarized in **Chapter 4.4.5.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3**). The mitigation measures are the same as described for Alternative C with the addition of shutdown protocols during seismic operations for all marine mammals except bow-riding dolphins. The shutdown protocols would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to fish resources and EFH also would not change.

4.4.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.4.2.3.2**) would remain the same under Alternative D.

4.4.5.3.3 Cumulative Impact Conclusions

Because proposed action activities conducted under Alternative D do not change the cumulative outcomes described in Alternatives A and C, there would be a **nominal** to **minor** incremental increase in impacts to fish resources and EFH from activities under the proposed action for Alternative D. The cumulative impacts on fish resources and EFH from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.4.2.3.2** above. The incremental contribution of the proposed action under Alternative D is expected to be **nominal** to **moderate** because the relative extent of Outer Continental Shelf G&G activities are considered stressor to fish resources and EFH in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which fish resources and EFH could be subject to G&G activity.

4.4.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.4.2.1**). The following discussion outlines the effects of the additional mitigation measures included under Alternative E on fish resources and EFH.

4.4.6.1 Impacts of Routine Activities

4.4.6.1.1 Reduced Level of Activity

The reduction of deep-penetration, multi-client activities by 10 percent or 25 percent would reduce the extent, severity, and timing of active acoustic sound sources, vessel and equipment noise, trash and debris, seafloor disturbance, drilling discharges, and entanglement compared with Alternative A. The analysis of Alternative A concluded that the impacts would range from **nominal** to **minor**; however, the reduction in activity would not change the overall impact level determinations for these IPFs under Alternatives E1 and E2.

Under Alternatives E1 and E2, there would be a 10 percent or 25 percent reduction in activities, respectively, for deep-penetration, multi-client activities. A reduction in activities under Alternatives E1 and E2 could reduce the impacts of acoustic sound sources on fish resources and EFH. However, seismic airgun surveys still will be conducted throughout the AOI and the majority of fish resources still will be impacted by airguns. The effects will likely still include extended displacement, extensive damage (quantifiable loss depending on the habitat type) to EFH, and extensive disruption of behavioral patterns (including spawning, feeding, or ontogenetic migrations) that may adversely affect a species.

Minor impacts to fish resources and EFH affected by airguns still would be expected under Alternatives E1 and E2. There is no reduction in non-airgun HRG surveys under Alternatives E1 and E2; therefore, the overall impacts to smalltooth sawfish, Gulf sturgeon, fish resources, and EFH affected by electromechanical sound sources would be **nominal**. Under Alternatives E1 and E2, a reduction of deep-penetration, multi-client activities by 10 percent or 25 percent, respectively, for deep-penetration, multi-client activities would reduce the overall vessel and equipment noise and may reduce the risk of entanglement. However, negative effects on fish behavior are still expected to be short term and localized in areas where activity is concentrated. For this reason, impacts of vessel and equipment noise are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH under Alternatives E1 and E2. Impacts from entanglement would remain **nominal**.

This mitigation does not apply to the other project-related IPFs and would not alter the impacts to fish resources and EFH from trash and debris, seafloor disturbance, or drilling discharges; impacts would remain **nominal**.

Overall, impacts to fish resources and EFH from routine activities under Alternative E are expected to range from **nominal** to **minor**.

4.4.6.2 Impacts of an Accidental Fuel Spill

Under Alternatives E1 and E2, impacts of an accidental fuel spill on fish resources and EFH would be very similar to those analyzed for Alternative C in **Chapter 4.4.4.2**. Alternatives E1 and E2 would reduce the number of survey line miles and vessel operating time conducting deep-penetration, multi-client surveys by 10 percent or 25 percent, respectively, but this reduction would not substantially change the risk of a small fuel spill because the majority of activities will continue to take place. A small diesel spill is expected to disperse rapidly, and volatile components are expected to evaporate. If an accidental fuel spill occurs, the spill size likely would be relatively small and the area of impact would be a small portion of the AOI. The type and severity of impacts to pelagic fish, as well as buoyant eggs and larvae in localized areas, would depend on the location of the event but are expected to range from **nominal** to **minor**.

4.4.6.3 Cumulative Impacts

4.4.6.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.4.6.1 and 4.4.6.2** concluded that activities projected to occur under Alternative E would result in **nominal** to **minor** impacts to fish resources and EFH, depending on the IPF. Mitigation measures for the proposed action under Alternative E are described in **Chapter 2.7** and summarized in **Chapter 4.4.6.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3**). The reduction of deep-penetration, multi-client activities (in line miles) by 10 percent (Alternative E1) or 25 percent (Alternative E2) would reduce the extent, severity, and timing of active acoustic sound sources, vessel and equipment noise, and entanglement; therefore, impacts for these IPFs would be incrementally decreased under Alternative E.

4.4.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.4.2.3.2**) would remain the same under Alternative E.

4.4.6.3.3 Cumulative Impact Conclusions

Reductions in the line miles of deep-penetration, multi-client activities would result in a net reduction of sound in the AOI. However, the changes under Alternative E do not change the impact level to the cumulative outcomes described in Alternative A. Therefore, there would be a **nominal** to **minor** incremental increase in impacts to fish resources and EFH under Alternative E. The cumulative impacts on fish resources and EFH from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.4.2.3.2** above. The incremental contribution of the proposed action under Alternative E is expected to be **nominal** to **moderate** because the relative extent of Outer Continental Shelf G&G activities are considered a stressor to fish resources and EFH in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which fish resources and EFH could be subject to G&G activity.

4.4.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.4.2.1**). The following discussion outlines the effects of the additional mitigation measures included in Alternative F on fish resources and EFH.

4.4.7.1 Impacts of Routine Activities

4.4.7.1.1 Closure Areas

Alternative F would require area closures in the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area (**Figure 2.8-1**). The closures apply to all G&G activities, which would reduce the impacts of active acoustic sound sources, vessel equipment and noise, trash and debris, seafloor disturbance, drilling discharges, and entanglement on fish resources and EFH compared with Alternative A.

The purpose of this mitigation measure is to protect marine mammals within the closure areas. This mitigation measure would provide an ancillary benefit to some coastal and pelagic fish species (**Tables 4.4-1 through 4.4-4**), as the effects on fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced in specialized habitats that support fish (including managed species), sea turtles, and ESA-listed species, following a reduction in active acoustic sound sources (e.g., seismic airgun and electromechanical sounds) and vessel and equipment noise. However, active acoustic sound sources and vessel and equipment noise still will be produced by G&G activities throughout the rest of AOI. Additionally, while activities may not be conducted within the closure areas, sound from seismic surveys, vessels, and equipment can propagate into the closure areas, which could affect fish behavior and hearing. The closure areas are small compared with the size of the AOI, and impacts to fish resources and EFH, smalltooth sawfish, and Gulf sturgeon will not be reduced outside the closure areas. Under Alternative F, there will be a reduction in seafloor disturbance, drilling discharges, and risk of entanglement from trash and debris in the closure areas. However, impacts from these IPFs are still possible outside the closure areas. Although reduced, overall impact levels under Alternative F would remain unchanged from the analysis in Alternatives A and C.

The impacts of active acoustic sound sources from airguns are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH under Alternative F. The mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will be **nominal** for fish resources and EFH under Alternative F. Impacts of vessel equipment and noise are expected to be **nominal** for smalltooth sawfish and Gulf sturgeon, and **minor** for fish resources and EFH. This mitigation does not apply to the other project-related IPFs and would not alter the impacts to fish resources and EFH from trash and debris, seafloor disturbance, drilling discharges, or entanglement; impacts would remain **nominal**.

Overall, impacts to fish resources and EFH from routine activities under Alternative F are expected to range from **nominal** to **minor**.

4.4.7.2 Impacts of an Accidental Fuel Spill

Under Alternative F, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. Alternative F would change the location where G&G activities could be conducted; however, spills from seismic airgun surveys, non-airgun HRG surveys, and other G&G activities could still occur within the AOI. The closure area is small compared with the size of the AOI, and impacts will be reduced only within the closure areas. If an accidental fuel spill occurs, the spill size likely would be relatively small and the area of impact would be a small portion of the AOI. The type and severity of impacts to pelagic fish, as well as buoyant eggs and larvae in localized areas, would depend on the location of the event but are expected to range from **nominal** to **minor**.

4.4.7.3 Cumulative Impacts

4.4.7.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.4.7.1 and 4.4.7.2** concluded that activities projected to occur under Alternative F would result in **nominal** to **minor** impacts to fish resources and EFH, depending on the IPF. Mitigation measures for the proposed action under Alternative F are described in **Chapter 2.8** and summarized in **Chapter 4.4.7.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3**). Mitigation measures under Alternative F are similar to Alternative C with the addition of area closures in four areas: CPA Closure Area; EPA Closure Area; Dry Tortugas Closure Area; and Flower Gardens Closure Area. Most mitigation measures under Alternative F would not substantially change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to fish resources and EFH also would not change. Mitigation measures under Alternative F that would change the timing and extent of activities in the proposed action are a seasonal restriction for operation of airguns in Federal and State coastal waters from February 1 through May 31, the prohibition of deep-penetration seismic airgun surveys within portions of the EPA (**Chapter 2.8.2**), and the four area closures for seismic airgun surveys.

4.4.7.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.4.2.3.2**) would remain the same under Alternative F.

4.4.7.3.3 Cumulative Impact Conclusions

Overall, exposure of fish and EFH in the closure areas to sound would be reduced by the Alternative F closure areas; there would be a **nominal** to **minor** incremental increase in impacts to fish resources and EFH under Alternative F. The cumulative impacts on fish resources and EFH from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.4.2.3.2** above. The incremental contribution of the proposed action under Alternative F is expected to be **nominal** to **moderate** because the relative extent of Outer Continental Shelf G&G activities are considered a stressor to fish resources and EFH in the GOM. Although the proposed action represents a small portion of these activities, it contributes to and extends the timeline under which fish resources and EFH could be subject to G&G activity.

4.4.8 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.4.2.1**) except the entanglement IPF is not included as part of Alternative G because no OBC surveys are part of the alternative.

Under Alternative G, no new permit/authorizations will be issued for G&G activities. Previously authorized activities still would occur under existing agreements or permits/authorizations but would drop off quickly. The VSP (2D only) and SWD surveys would continue at the level of activity in **Table 2.9-1**. The VSP surveys cover much shorter distances and use less sound energy (**Appendix F, Section 1.1.5**). Thus, noise levels from active acoustic sound sources, vessels, and equipment would not change immediately but would decrease over time. Impacts from other activities also would decrease over time. Therefore, cumulative impacts under Alternative G would remain the same as for A (**nominal** to **minor**) but would decline over time.

Impacts on smalltooth sawfish, Gulf sturgeon, fish resources, and EFH would remain similar to Alternatives A and C (**nominal** to **minor**) then decline to **no impact**. A substantial reduction in non-VSP activities likely would reduce impacts from all activities on smalltooth sawfish, Gulf sturgeon, fish resources, and EFH to **nominal**; however, impacts from entanglement would be reduced to **no impact**.

Overall, impacts to fish resources and EFH from activities under Alternative G are expected to range from **nominal** to **minor** and decline over time.

Spills could occur within the AOI following a reduction in activity. If an accidental fuel spill occurs, the spill size likely would be relatively small and the area of impact would be a small portion of the AOI. The type and severity of impacts to pelagic fish as well as buoyant eggs and larvae in localized areas would depend on the location of the event but are expected to range from **nominal** to **minor** and decline to **no impact** as activities are phased out.

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.4.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.4.2.3.2**) would remain the same under Alternative G. The cessation of G&G activities would result in the loss of an important tool for exploration to identify the location and size of oil and gas prospects, development of renewable energy projects, and exploration for non-energy marine minerals such as sand and gravel (or other sediment) for beach nourishment, coastal restoration, and public works projects. Such a loss would result in increased environmental risk to industry and could potentially lead to increased exploratory drilling or a dramatic reduction in oil and gas activity in the GOM.

4.4.9 Summary Conclusion

In summary, the IPFs that may impact fish resources and EFH within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars); (2) vessel and equipment noise; (3) trash and debris; (4) seafloor disturbance; (5) drilling discharges; (6) entanglement (i.e., with acoustic buoy releases, tethered acoustic pingers, and nodal tethering lines); and (7) accidental fuel spill.

Analysis of impacts to fish resources and EFH are assessed as **nominal** to **minor** for airgun surveys as well as vessel and equipment noise under Alternatives A through G based on the potential to disrupt spawning aggregations or schools of important prey species, the mobile and temporary nature of most surveys, the small area of the seafloor affected during the surveys, and the possibility of fishes to temporarily move away from noise affecting them. However, impacts under Alternative G would range from **nominal** to **minor**, declining to **no impact** as activities are phased out. Impacts from an accidental fuel spill range from **nominal** to **minor** for Alternatives A through F based on the location of the event and presence of fish or buoyant eggs and larvae. Impacts from an accidental fuel spill under Alternative G would range from **nominal** to **minor**, declining to **no impact** as activities are phased out. Other IPFs affecting fish resources and EFH are assessed as **nominal** for all alternatives, except for entanglement in Alternative G, which would be **no impact** because there no equipment used could cause entanglement.

4.5 BENTHIC COMMUNITIES

4.5.1 Description of the Affected Environment

The benthic environment of the AOI is complex, with varied G&G features (Rowe and Kennicutt, 2009) in water depths ranging from <200 to 3,500 m (656 to 11,483 ft). The benthic faunal assemblages of the GOM continental shelf in depths >200 m (656 ft) include deposit-feeding polychaete worms, crabs, lobsters, shrimps, clams, scallops, and oysters (USDOI, BOEM, 2012a, 2013c, 2013d). The GOM continental slope largely consists of fine muddy sediments and includes numerous low-density, high-diversity faunal assemblages (Rowe and Kennicutt, 2001). Fishes, snails, sea stars, sand dollars, sea cucumbers, and polychaete worms (bristle worms) are common on the continental slope of the GOM (USDOI, BOEM, 2015d, 2016a). Most benthic habitats within the AOI are within the abyssal zone (>1,000 m [3,280 ft]) and have biological assemblages consisting of more invertebrates and fewer fishes than the shelf and slope habitats. In AOI waters depths >2,300 m (7,546 ft), sea stars, sand dollars, and sea cucumbers are the dominant fauna (Rowe and Kennicutt, 2001) (USDOI, BOEM, 2013c, 2013d).

Although the GOM is dominated by soft bottom communities (**Chapter 4.5.1.1**), hard bottom and chemosynthetic communities occur throughout. Refer to **Chapter 4.5.1.2** for a more detailed discussion of hard bottom communities in the GOM and **Chapter 4.5.1.3** for a discussion of chemosynthetic communities in the GOM. **Chapter 4.5.1.4** provides a discussion of benthic species listed under the ESA as threatened or endangered. Detailed discussion of benthic communities can be found in **Appendix E, Section 5**.

As detailed in the Final PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016), the *Deepwater Horizon* oil spill impacted some benthic communities in the CPA and, therefore, warrants brief mention here. However, potential future oil-spill impacts resulting from a blowout are not included in the IPFs considered in **Chapter 4.3.2** because such spills are not a direct result of the proposed action.

Deepwater Horizon oil and dispersants came into direct contact with the seafloor by physical means, including sinking after release, settling of carbon ash after burning, biologically mediated sinking ("marine snow"), and/or current transport into shallower waters. In the deep sea, the Final PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016) documented a footprint >2,000 km^2 (770 mi^2) of impacts to benthic habitat surrounding the wellhead. Valentine et al. (2014) identified a 3,200-km^2 (1,236-mi^2) sized plume of oil at a depth of 1,500 m (4,921 ft) calculated to represent 4 percent to 31 percent of the total *Deepwater Horizon* oil sequestered in the deep ocean. Concentrations generally decreased with distance from the well. Within 3 km (2 mi) of the well, reductions in diversity of sediment-dwelling macrofauna and meiofauna were documented. At four known deepwater coral communities occurring at varying distances as far as 25 km (16 mi) from the well, varying degrees of impacts have been documented, including mortality of coral polyps, colonization of injured coral branches by opportunistic hydroid overgrowth, and branch loss (White et al., 2012; Hsing et al., 2013).

In the shallower waters of the continental shelf, contact with some benthic communities, including sea fan colonies and other soft corals in an approximately 16-km^2 (6-mi^2) area of the Pinnacle Trend (specifically at sites named Roughtongue Reef and Alabama Alps), occurred following submersion of oil/dispersant mixture. Surface waters containing oil and dispersants likely were pushed unusually deep as a result of Tropical Storm Bonnie's strong meteorological conditions (Silva et al., 2015; Etnoyer et al., 2016). Additional information pertaining to this resource and NMFS' determination of the effects of the *Deepwater Horizon* explosion, oil spill, and response may be found in the Final PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016).

4.5.1.1 Soft Bottom Communities

The continental shelf portions of the GOM have substrates that are primarily sandy sediments in the eastern GOM and sand, silt, and clay in the central and western GOM (Jenkins, 2011). Benthic fauna in these areas include mollusks, crustaceans (e.g., shrimp), and polychaetes. Vittor (2000) divided the northern GOM continental shelf into four assemblages based on the type of sediments and associated benthic fauna (**Appendix E, Section 5.1**). In the GOM, EFH for shrimp within the AOI extends from the U.S.-Mexico border east to Fort Walton Beach, Florida; shrimp EFH also extends into estuarine waters not covered in the AOI. Shrimp EFH is found in water depths ranging from 9 to 594 m (30 to 1,949 ft) and extends across all four assemblages as defined by Vittor (2000). The continental slope is a complex transitional zone characterized by varying ranges of productivity and faunal assemblages. Faunal assemblages of the continental slope and abyssal zone are described in the 2017-2022 GOM Multisale EIS (USDOI, BOEM, 2017a) and in **Appendix E**.

4.5.1.2 Hard Bottom Communities

While less common than soft bottom environments in the GOM, hard bottom environments are scattered throughout the AOI (**Figure 4.5 1**). This chapter focuses on deepwater hard bottom benthic communities; for a discussion of benthic chemosynthetic communities in the GOM, refer to **Chapter 4.5.1.3**.

The GMFMC manages GOM corals through a coral management unit that assesses 142 species of stony and soft corals, including fire corals, stony corals, and black corals. The EFH for the coral management unit includes the total distribution of coral species and life stages throughout the GOM, including coral reefs in the North and South Tortugas Ecological Reserves, East and West Flower Garden Banks, McGrail Bank, and the southern portion of Pulley Ridge. Additionally, EFH includes hard bottom areas on scattered pinnacles and banks from Texas to Mississippi, the shelf edge at the Florida Middle Grounds, the southwest tip of the Florida Reef Tract, and ephemeral hard bottom offshore of Florida from approximately Crystal River south to the Florida Keys (GMFMC, 2005).

4.5.1.2.1 Deepwater Coral Communities

Some hard bottom carbonate substrate within the deepwater benthic environment of the GOM supports ahermatypic (non-reef building) corals. Moore and Bullis (1960) first described a deepwater coral community in the GOM predominantly composed of the deepwater branching coral *Lophelia pertusa*. BOEM has examined seismic data to identify areas of high acoustic reflectivity and has identified >28,000 areas where deepwater reefs could exist (USDOI, BOEM, 2012b). Although only a small number of hard bottom habitats have been visually investigated, studies suggest that many of the deepwater hard bottom areas in the GOM have been colonized by chemosynthetic communities (USDOI, BOEM, 2012b). Colonies of *L. pertusa* are most commonly found in the upper shelf, but colonies have been found as deep as 3,000 m (9,842 ft) (USDOI, BOEM, 2012a, 2013c, 2013d). These findings suggest that suitable hard bottom areas exist throughout the AOI capable of supporting deepwater coral communities. On September 10, 2015, the GMFMC released an online coral web mapper showing locations of black coral, octocoral, sea pen, soft coral, sponge, and stony coral in the GOM (GMFMC, 2015). The web mapper also can be found on NOAA's website (USDOC, NOAA, 2016).

4.5.1.2.2 Live Bottoms (Pinnacle Trend)

Variable relief hard bottom features with extensions up to 20 m (66 ft) above the surrounding seafloor and up to 500 m (1,640 ft) in diameter were reported by Ludwick and Walton (1957) and Thompson et al. (1999) offshore Louisiana/Alabama. These "pinnacles" are known to exist in 74 OCS lease blocks in a 103 x 26 km (64 x 16 mi) area of the northeastern CPA, particularly in portions of the Main Pass, Viosca Knoll, and Destin Dome lease areas. The Pinnacle Trend consists of several hard bottom habitats (USDOI, BOEM, 2012a), including patch reefs, flat top reefs, reef-like mounds, ridges, scarps, and depressions. The pinnacles are located in water depths from 74 to 120 m (243 to 394 ft). The relatively steep sides and tops of the pinnacles provide exposed hard bottom habitat for sponges, octocorals (Gittings et al., 1992), fishes (Weaver et al., 2002), and ahermatypic corals (Continental Shelf Associates, Inc., 1992).

The biological diversity of the fauna in the Pinnacle Trend is directly related to the height of the pinnacle features (Gittings et al., 1992; Thompson et al., 1999) and distance from the Mississippi River Delta (Gittings et al., 1992). Biological diversity is higher on the tops and along the sides of higher relief pinnacles (Continental Shelf Associates, Inc., 1992). Along the base of the hard bottom features, a relatively persistent nepheloid (turbidity) emanating from the Mississippi River outflow impedes colonization of most sessile organisms. Only a few upright invertebrate species such as sea whips and sea fans can withstand the high turbidity (Weaver et al., 2002).

4.5.1.2.3 Live Bottoms (Low Relief)

Low-relief hard bottom habitats are found in all three planning areas. Low-relief live bottom habitats are found in the extreme northeastern corner of the CPA and are much more broadly distributed in the EPA. Low-relief hard bottom is characterized by features with <5 m (16 ft) of vertical relief above the surrounding seafloor. BOEM has instituted a Live Bottom (Low Relief) Stipulation to protect low-relief hard bottom habitats from impact by OCS energy exploration activities. BOEM conducts case-by-case reviews of plans, pipeline applications, structure removal applications, and ancillary activity applications in order to prevent seafloor-disturbing activities from affecting live bottom (low-relief) areas. Habitats considered in the Live Bottom (Low Relief) Stipulation include coral and spiny lobster EFHs. For a discussion on live bottom areas throughout the GOM, refer to **Appendix E, Section 5**.

4.5.1.2.4 Topographic Features

In the GOM, the term "topographic features" specifically refers to the 37 submerged banks protected from oil and gas activities and described in NTL 2009-G39 as "isolated areas of moderate to high relief that provide habitat for hard bottom communities of high biomass and diversity and large numbers of plant and animal species, and support, either as shelter or food, large numbers of commercially and recreationally important fisheries." These banks are located in the WPA (21 banks) and CPA (16 banks) (**Table 4.5-1; Figure 4.5-2**). Topographic feature formations are a result of protrusions of rock layers projected above the seafloor by the thick stratum of salt present beneath the GOM seafloor or represent fossilized shorelines (USDOI, BOEM, 2012a). BOEM has mandated "No Activity Zones" around major topographic features in the GOM (refer to USDOI, BOEM, 2014c) to protect the submerged banks from anchoring and other disturbances that may occur during oil and gas exploration and production activities. Detailed descriptions of topographic features that are managed areas (e.g., East and West Flower Garden Banks, Alderdice Bank, Bright Bank, Geyer Bank, McGrail Bank, Stetson Bank, and Sonnier Bank) are presented in **Chapter 4.7** and in USDOI, BOEM (2012, 2013c, 2013d). Most of the banks support diverse and abundant fauna, including hermatypic and ahermatypic corals, coralline algae, octocorals, sponges, and fish.

4.5.1.2.5 Artificial Reefs

In addition to natural hard bottom habitats, artificial reefs provide substrate for the proliferation of live bottom communities (SAFMC, 2009) and associated fish assemblages. **Figure 4.5-3** shows the locations of artificial reefs in the AOI. The USDOI's Rigs-to-Reefs policy, implemented by BSEE and BOEM, is a process by which operators of decommissioned oil and gas platforms donate the material to coastal States for use as artificial reefs. Recreational diving and fishing, as well as commercial fisheries benefit from the artificial reefs, which provide an additional option for conserving, managing, and/or developing fishery resources and can provide potential habitats for endangered or threatened species. As of 2013, there were >500 platform structure removals approved by BSEE for Rigs-to-Reef conversion on the OCS. Towing the jacket structures to an established State artificial reef for deployment accounted for 65 percent of the approvals. The remaining 35 percent were for partial removal or toppling the jacket in place within a newly permitted State artificial reef. As of 2016, there are >500 Rigs-to-Reef structures deployed in 142 established artificial reefs. Most Rigs-to-Reef structures have been deployed within artificial reef sites managed by Louisiana and Texas. A total of 19 Rigs-to-Reef structures have been deployed within Mississippi, Alabama, and Florida artificial reefs. Artificial reefs created by existing and future oil and gas infrastructure may contribute alternative habitat for corals and associated reef fauna by creating a complex habitat in a mostly featureless, soft bottom seafloor.

Artificial reefs typically are composed of material that provide hard surfaces such as metal, wood, and concrete that can support algae, barnacles, sponges, tubeworms, hydroids, anemones, oysters, and tunicates (Steimle and Figley, 1996; Steimle and Zetlin, 2000). The communities supported by artificial reefs often are similar to those occurring on natural hard bottoms, though the size, composition, location, and age of the reefs affect the structure and habitat value (Steimle and Zetlin, 2000; Wilson et al., 2003).

4.5.1.3 Chemosynthetic Communities

Chemosynthetic organisms are unique in that they use a carbon source rather than the photosynthesis-based food webs that support all other life on earth. Chemosynthetic bacteria can oxidize chemicals present in seafloor vents (often hydrogen sulfide, hydrogen gas, or ammonia) into organic molecules used to produce biomass (often sugars). Since they were first discovered in the GOM in 1983 (Paull et al., 1984) at the base of the Florida Escarpment, hundreds of chemosynthetic communities have been found in the GOM (USDOI, BOEM, 2012a, 2013c, 2013d; **Figure 4.5-1**). All known chemosynthetic communities in the GOM are found in deep water (>300 m [984 ft]), well beyond the boundary of the continental shelf (USDOI, BOEM, 2012a). Most hydrocarbon seeps are in areas where there is little sediment cover over underlying strata (USDOI, BOEM, 2012a, 2013c, 2013d), so hydrocarbons can vertically migrate through faults or other conduits to the surface. Many areas that fit these general descriptions have been seismically surveyed (Shedd et al., 2012b), and some have been proven to harbor chemosynthetic communities (USDOI, BOEM, 2015d, 2016a).

Chemosynthetic communities have been classified into four general types based on the dominant seep organism: (1) vestimentiferan tubeworms; (2) mytilid mussels; (3) vesicomyid clams; and (4) infaunal lucinid or thyasirid clams (MacDonald et al., 1990). Each of the dominant organisms creates unique seep communities based on differing faunal density, chemical usage, and associated heterotrophic (non-carbon fixing) fauna (USDOI, BOEM, 2012a). Growth rates of many organisms in these communities are extremely slow (Fisher, 1995), leading to long-lived individuals and communities. Powell (1995) noted that many sites stayed biologically and geologically stable for 500 to 4,000 years, with most communities showing no evidence of change in the dominant faunal organisms over time.

4.5.1.4 Listed, Candidate, and Species of Concern

Two coral species were listed as threatened under the ESA in 2006: elkhorn coral (*Acropora palmata*) and staghorn coral (*A. cervicornis*). Following a petition in 2009 from the Center for Biological Diversity (2009) to list 83 species of reef-building corals under the ESA, NMFS issued a Final Rule (*Federal Register*, 2014d) listing five additional Caribbean corals as threatened under the ESA: pillar coral (*Dendrogyra cylindrus*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), star coral (*Orbicella franksi*), and rough cactus coral (*Mycetophyllia ferox*). This brings the total number of ESA-listed coral species in the Caribbean to seven. All of the threatened species of coral are found within the AOI (Puglise and Kelty, 2007), but they are mostly limited to patch reefs surrounding the Florida Keys and off the southwest coast of Florida, with some occurring on the West and East Flower Garden Banks (USDOC, NMFS, 2013c, 2013d), McGrail Bank, 18 Fathom, and Bright Bank reefs in the northwestern GOM (Rezak et al., 1983, 1990). Small colonies of elkhorn coral were documented at the West and East Flower Garden Banks in 2003 and 2005, respectively (Zimmer et al., 2006).

4.5.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact benthic communities within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars); (2) trash and debris, (3) seafloor disturbance, (4) drilling discharges, and (5) accidental fuel spill.

In considering the potential impacts to benthic communities, it is important to make the distinction between the AOI and the planning areas. The total AOI covers 689,166 km^2 (266,089 mi^2) and includes 45,630 km^2 (17,618 mi^2) of State waters outside of the planning area boundaries; therefore, the total planning area in Federal waters considered for benthic communities is 643,536 km^2 (248,471 mi^2). The potential direct impacts considered here include the planning areas only and do not include State waters that extend to 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama, and 9 nmi (10.4 mi; 16.7 km) offshore Texas and Florida, which are beyond OCS lease block area boundaries and where proposed BOEM-authorized G&G activities would not occur. This distinction is important because the EPA does not include the Florida Keys and other sensitive shallow-water habitats within State waters (3 or 9 nmi from shore). In these areas outside of the planning areas but within the AOI, only potential indirect impacts propagating into the area from proposed activities are considered to benthic communities.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For benthic communities, the impact-level criteria, as presented here, have been used to evaluate the level of impact for each IPF.

- **Nominal** impacts to benthic communities would include impacts that might produce extremely small changes in abundance of individual species but no overall changes in species composition, community structure, and/or ecological functioning of benthic communities.
- **Minor** impacts to benthic communities would include those that are detectable but not severe. Benthic communities showing a minor impact are expected to realize limited changes in species composition, community structure, or ecological functioning beyond that of normal variability.
- **Moderate** impacts to benthic communities would include measurable, extensive, but not severe damage to communities. For benthic communities, moderate impacts would include changes in species composition, community structure, and/or ecological functioning that are locally or spatially extensive, but not severe. Under the moderate impact category, some impacts may be irreversible.

- **Major** impacts to benthic communities would include localized but long-lasting (decades) severe damage or short-term (<1 year) but spatially extensive severe damage to communities. For benthic communities, major impacts would encompass extensive and severe changes in species composition, community structure, and ecological functioning with measurable change in species composition or abundance beyond that of normal variability, or ecological function within a species range. Major impacts may be irreversible.

4.5.2.1 Impacts of Routine Activities

4.5.2.1.1 Active Acoustic Sound Sources

Impacts to benthic communities from impulsive sound generated by active acoustic sound sources (e.g., airguns and HRG surveys) are not well documented. However, there are four potential types of impacts to marine invertebrates from exposure to seismic survey noise (e.g., airguns): pathological, physiological, behavioral, and soundscape orientation associated with larval settlement. Pathological effects include lethal or permanent sublethal injury to organisms. Physiological effects include temporary and permanent primary and secondary stress responses (e.g., changes in levels of enzymes and proteins). Behavioral effects include temporary or permanent changes in behavior (e.g., feeding, startle, and avoidance behavior). Temporary acoustic soundscape changes could impact acoustic orientation used for larval settlement. Very few specific data are available regarding seismic sound impacts that may cause pathological or physiological effects on invertebrates, and these data are limited to a small number of invertebrate species and life stages. Boudreau et al. (2009) examined the effects of seismic exploration on snow crabs off the Atlantic Coast of Canada, and results showed no short-term or long-term effects of seismic exposure in adult or juvenile crabs or crab eggs. Most studies address behavioral responses to sound. McCauley et al. (2000) studied caged squid, with results showing a strong startle and avoidance response from exposure to an airgun. With the use of ramp-up, the strong startle response was not observed but an avoidance response was noted (i.e., individuals stayed close to the water surface during airgun operations), indicating that behavioral changes and avoidance to an operating airgun by squid may occur. André et al. (2011) indicated that captive giant squid exposed to short sweeps of relatively low-intensity, low-frequency sound between 50 and 400 Hz for 2 hours resulted in permanent and substantial alterations in the sensory hair cells of the statocysts. However, exposure parameters included long-term, confined exposure (i.e., the study was performed in a laboratory setting with specimens in small tanks). Observations obtained in such experimental settings are difficult to apply to open field conditions where sound propagation and attenuation may be very different, as are the conditions of exposure to animals.

There are few data indicating if and how invertebrates use sound in behavior, although several species make sounds and may communicate with these sounds (e.g., Budelmann, 1992; Popper et al., 2001; Hawkins et al., 2014). Several species of aquatic decapod crustaceans produce sounds; Popper et al. (2001) concluded that many are able to detect substratum vibrations at sensitivities sufficient to signal the proximity of mates, competitors, or predators. Popper et al. (2003) reviewed behavioral, physiological, anatomical, and ecological aspects of sound and vibration detection by decapod crustaceans and noted that many decapods have an array of hair-like receptors within and upon the body surface that may respond to water- or substrate-borne displacements, as well as proprioceptive organs that could serve secondarily to perceive vibrations. However, the acoustic sensory system of decapod crustaceans remains poorly studied (Popper et al., 2003). Lovell et al. (2005) and Lovell (2006) reported that the prawn *Palaemon serratus* is capable of detecting low-frequency sounds (100 to 3,000 Hz); however, there is no behavioral evidence of prawns responding to sounds to date.

There are no published data that indicate whether masking or TTS occurs in invertebrates, and little data to suggest whether sounds from seismic surveys would have any substantial impact on invertebrate behavior (Hawkins et al., 2014). Andriguetto-Filho et al. (2005) investigated the effects of seismic exploration on the economically important southern white shrimp (*Litopenaeus schmitti*), southern brown shrimp (*Farfantepenaeus subtilis*), and Atlantic seabob (*Xyphopenaeus kroyeri*) in northeastern Brazil. The study found no behavioral effects or damage to the hepatopancreas (glandular structure), gills, or gonads from exposures to sound with a source level of approximately 196 dB re 1 µPa at 1 m SPL_{rms}. Payne et al. (2007, 2008) also found no mortality or evidence of disorientation between control and experimental groups of American lobster (*Homarus americanus*) exposed to sounds at 202 and 227 dB re 1 µPa $SPL_{p\text{-}p}$.

Some invertebrates may be especially sensitive to substratum vibrations. André et al. (2011) conducted controlled exposure experiments on four cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Illex coindetii*), subjecting them to low-frequency sound. Exposure to low-frequency sounds resulted in permanent and substantial alterations of the sensory hair cells of the statocysts. Several aquatic decapod crustaceans produce sounds, and many are able to detect vibration through the substrate and the water at sensitivities sufficient to determine the proximity of other organisms. However, whether these invertebrates respond to propagated sound waves farther from the source is unknown (Normandeau Associates, Inc., 2012).

All of the more serious effects of intense seismic survey signals occur close to the array, and configuration of airguns arrays focus the sound energy downward, so the highest energy would be directly beneath the seismic source (McCauley, 1994). Seismic airgun arrays produce a sound field that is directive at longer distances (tens of meters) from the array, characterized by a main beam directed down through the water into the seafloor with side lobes that radiate substantial amounts of sound energy horizontally away from the array. As discussed previously, active acoustic sound sources from seismic activities have not been determined to have significant impacts to benthic communities within the planning areas; propagation of sound outside of the planning areas would have lower potential for producing impacts. Therefore, impacts to all benthic communities from active acoustic sound sources would be **nominal**.

4.5.2.1.2 Trash and Debris

The G&G activities for oil and gas, marine minerals, and renewable energy will include vessel and platform acoustic surveys; non-acoustic HRG surveys, including gravity and magnetic surveys; airborne and passive remote surveys; and a wide variety of geotechnical surveys, including bottom sampling and shallow test drilling. Many of these operations require multiple levels of vessel support (**Table 3.3-3**). Any of these operations could be on location for a few weeks to a few months and are expected to occur throughout the projected 10-year timeframe. Due to the prolonged presence of G&G activities, accidental releases of trash and debris could impact benthic communities by forceful contact, entanglement, and/or burial.

The effects of debris lost overboard from offshore drilling operations in the GOM have been addressed by several authors (e.g., Shinn et al., 1989, 1993; Dustan et al., 1991; Shinn and Lidz, 1992). These studies have evaluated operations in variable water depths (i.e., 21 to 149 m [69 to 489 ft]), over different substrates, and at variable times following the completion of drilling. Survey, sampling, and test well drilling operations generate trash composed of paper, plastic, wood, glass, and metal (**Chapter 3.3.1.7**).

All survey vessels performing work within U.S. jurisdictional waters are expected to comply with Federal regulations and MARPOL, as amended by the 1978 Protocol (MARPOL 73/78) (**Chapter 3.3.1.7**). In addition, all authorizations for shipboard surveys would include guidance for marine debris awareness covered under NTL 2015-BSEE-G03 (**Appendix B**). Because operators must comply with Federal regulations and would be-expected to follow the guidance provided by BOEM, the amount of trash and debris accidentally lost offshore would be minimal, some of which could sink to the seafloor. Therefore, impacts from trash and debris on benthic communities, as generated by seismic survey vessels, sampling, shallow well drilling, and other G&G-related activities, would be **nominal**.

4.5.2.1.3 Seafloor Disturbance

There are several G&G activities that could cause seafloor disturbance, including sampling (e.g., bottom sampling, shallow coring, jet probing), placement and removal of equipment on the seafloor (e.g., OBCs, anchors, receivers, monitoring buoys), and installation of up to two drill test wells (**Chapter 3.3.1.8**). Soft and hard/live bottom communities could be affected by these G&G activities.

Proposed activities under Alternative A include bottom sampling in all three Program Areas, including CPT samples, core samples, grab samples, vibracores, and jet probes (**Table 3.2-7**). The total of all bottom samplings is 2,238 samplings in all three Program Areas. Collection of each sample is estimated to disturb an area of approximately 10 m^2 (108 ft^2), although the actual area of the core or grab extracted may be much smaller. The maximum total area disturbed by bottom sampling is expected to be approximately 22,380 m^2 (240,896 ft^2) (**Table 3.2-7**).

Proposed activities that could impact benthic resources also include the installation of drill test wells and one COST well. For this impact analysis, the area of seafloor disturbance is assumed to average approximately 0.02 km^2 (0.01 mi^2) per well (**Table 3.2-7**). If the two drill test wells and one COST well in the proposed action were drilled, the total seafloor disturbance would be approximately 0.06 km^2 (0.02 mi^2) (**Table 3.2-7**), which is an extremely small portion of the total seafloor area of the planning areas.

Two bottom-founded monitoring buoys may be installed as part of the Renewable Energy Program. An anchor for boat- or discus-shaped buoys is expected to produce a footprint of approximately 0.56 m^2 (6 ft^2) and an anchor sweep of approximately 3.4 ha (8.4 ac) (**Chapter 3.3.1.8**). If both buoys were installed, the total impact area would be would be 6.8 ha (17 ac), including a 1.2-m^2 (13-ft^2) footprint for the anchors and a 6.8-ha (17-ac) footprint for the sweep area, which is an extremely small portion of the seafloor within the planning areas. Anchor sweep impacts are caused by the anchor chains or lines dragging across the seafloor; sediments are not removed and only the surficial sediments and associated benthic communities are impacted. No overall changes in species composition, community structure, or ecological functioning of benthic communities are expected (Grannis, 2005).

Certain surveys in oil and gas exploration (e.g., 3D, 4D, and WAZ) require placement of anchors, nodes, cables, sensors, and other equipment on or in the seafloor. The OBC and OBN surveys, vertical cable surveys, CSEM surveys, and MT surveys involve placement of sensors and anchors on the seafloor. In VSPs, receivers are placed in well boreholes in the seafloor. Each of these activities would affect a small area of seafloor temporarily. After a survey is completed, the sensors are removed and anchors are removed or left in place (if biodegradable). These surveys could be conducted anywhere within the planning areas. Locations and projected levels are not estimated; however, nodal surveys are relatively uncommon and typically performed in shallow waters. The total area of seafloor disturbed by survey cables, sensors, and anchors has not been calculated.

As outlined in NTLs 2009-G39 and 2009-G40, BOEM would require site-specific information regarding potential sensitive benthic communities (including hard/live bottom areas, deepwater coral communities, and chemosynthetic communities) prior to approving any G&G activities involving seafloor-disturbing activities or the placement of bottom-founded equipment (e.g., OBCs, anchors, receivers) or structures in the AOI (**Appendix B**). In addition, as detailed in NTLs 2009-G39 and 2009-G40, setbacks from sensitive bottom communities apply to seafloor-disturbing activities. These setbacks would include distancing seafloor-disturbing activity at least 500 ft (152 m) from a No Activity Zone surrounding a topographic feature; at least 100 ft (30 m) from any shallow-water hard bottom, pinnacle, live bottom, or Potentially Sensitive Biological Features; and 250 ft (76 m) from a deepwater benthic community (i.e., chemosynthetic communities and deepwater corals). Site-specific plans will be reviewed individually and likely will apply similar setbacks as default buffer zones when G&G activities take place in the planning areas where potentially sensitive biological features could be present. BOEM's Renewable Energy Program has developed guidelines for these site-specific surveys. All authorizations for seafloor-disturbing activities would be subject to restrictions to protect corals, hard/live bottom, and deepwater benthic communities; may include requirements for mapping and avoidance in areas where these communities are known or suspected; and may require photographic or video surveys of areas where bottom-founded instrumentation and appurtenances are to be deployed.

BOEM would use site-specific information and setbacks to ensure that physical impacts to sensitive benthic communities are avoided. Deepwater coral systems, chemosynthetic communities, and hard/live bottom habitats within the planning areas would be protected through distancing requirements from proposed bottom sampling activities. In considering all projected activities over the 10-year period, a total of 150,381 m^2 (1,618,688 ft^2) (**Table 3.2-7**) of seafloor would be disturbed and, given the distancing requirements detailed above, the potential impacts to benthic communities under this alternative would be **nominal**.

As discussed in the introduction to this chapter (**Chapter 4.5.2**), BOEM's jurisdiction includes the planning areas but not the areas of the AOI within State waters. Excluded from seafloor-disturbing activities would be the hermatypic coral reefs of the Florida Keys, Dry Tortugas National Park, Tortugas Ecological Reserve, East and West Flower Garden Banks, McGrail Bank, and Pulley Ridge. No BOEM-authorized G&G activities would occur in these areas; therefore, seafloor-disturbing activity impacts were not evaluated for hermatypic coral reefs.

4.5.2.1.4 Drilling Discharges

The oil and gas scenario assumes that up to two test wells and one COST well would be drilled in the planning areas during the time period of this Programmatic EIS. The test wells are drilled using conventional rotary drilling techniques, which is the same as routinely used for drilling oil and gas exploration and development wells. During the process, drilling fluid and cuttings would be discharged, dispersed in the water column, and accumulated on the seafloor (**Chapter 3.3.1.9**). Releases of toxic discharges are regulated by 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 (USDOI, BOEM, 2017a). Impacts to the benthic environment would include changes in sediment grain size and benthic community effects because of burial and smothering, anoxia, and sediment toxicity.

The average exploration well in the GOM is approximately 3,674 m (12,054 ft) below mudline (USDOI, MMS, 2007a). Each well discharges approximately 7,000 to 9,700 bbl of WBFs and 1,500 to 2,500 bbl of cuttings (USEPA, 1993, 2000). Assuming an average of 2,000 bbl of cuttings and 8,350 bbl of drilling fluid discharged per well, the total volumes for one COST well and two test wells would range from 2,000 to 6,000 bbl of cuttings and 8,350 to 25,050 bbl of drilling fluid.

Typical drilling fluids used on the OCS are WBFs or SBFs. Only WBFs, WBF solids, and treated SBF cuttings may be discharged directly into the ocean. During well intervals when WBF systems are used, cuttings and adsorbed WBF solids are discharged to the ocean at a rate of 0.2 to 2.0 m^3/hr (Neff, 1987). Overboard discharge of WBF results in increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and elevated concentrations of some trace metals (NRC, 1983; Neff, 1987). In shallow environments, WBFs disperse rapidly in the water column after discharge and quickly descend to the seafloor; in deeper water, however, fluids discharged at the sea surface are dispersed over a wider area (Neff, 1987).

Discharges of WBFs and cuttings with trace amounts of adhering SBF from the rig may affect benthic communities, primarily within several hundred meters of a wellsite. The fate and effects of WBF discharges have been reviewed by the NRC (1983) and Neff (1987); impacts of SBF cuttings discharges have been summarized by Neff et al. (2000). In general, cuttings with adhering SBF tend to clump together and form cuttings accumulations close to the drill site. Areas of SBF cuttings deposition may develop elevated organic carbon concentrations and anoxic conditions (Continental Shelf Associates, Inc., 2006). Where SBF cuttings have been discharged from a series of wells, cuttings tend to accumulate and concentrations have exceeded 1,000 mg/kg; benthic infaunal communities may be adversely affected by the toxicity of the base fluid and organic enrichment (with resulting anoxia) (Neff et al., 2000). In these instances, infaunal numbers may increase and diversity may decrease as opportunistic species that tolerate low oxygen and high hydrogen sulfide predominate (Continental Shelf Associates, Inc., 2006). The localized and limited drilling activity proposed under the G&G activity scenario strongly suggests that sizable cuttings accumulations and associated impacts would not occur.

Detectable drilling fluid and cuttings deposits may persist for 5 years or more around well sites, particularly in areas where multiple wells have been drilled (Continental Shelf Associates, Inc., 2006). Recovery of affected benthic communities typically begins as soon as a discharge ceases (Neff et al., 2005) and relies on recruitment of new fauna from planktonic larvae and immigration into disturbed areas from adjacent undisturbed sediments. The precise timing of recovery depends on several factors: the nature of the benthic community (e.g., species composition, reproductive triggers, larval mode); the physical characteristics of the benthic environment; and the chemical characteristics of the benthic environment (Neff et al., 2005). Neff et al. (2000) indicated that within 3 to 5 years of the cessation of SBF cuttings discharges, a complete recovery of the benthic community is possible; such recovery requires that the concentrations of SBF components (e.g., organics) in the sediments decrease to sufficiently low levels and that sediment oxygen concentrations increase to levels that can support benthic infauna.

The areal extent of impacts from drilling discharges during the proposed action would be relatively small. Assuming a typical effect radius of 500 m (1,640 ft), the affected area around each wellsite would represent approximately 3 percent of the seafloor within an OCS lease block (approximately 9 mi^2 [23 km^2]). Soft bottom communities are ubiquitous regionally, and the impact on soft bottom communities would be **nominal** within the AOI. Given BOEM's requirement for site-specific information regarding potential sensitive benthic communities and the application of setbacks from these resources as discussed in **Chapter 2.3.2**, impacts from drilling discharges on hard/live bottom areas, deepwater coral communities, and chemosynthetic communities of the AOI are expected to be **nominal**.

4.5.2.1.5 Routine Activities Impact Conclusions

Active acoustic sound sources from seismic activities have not been determined to have significant impacts to benthic communities, and impacts are expected to be **nominal**. Impacts from trash and debris are expected to be **nominal** due to existing requirements to prevent and minimize accidental loss. Based on the limited spatial extent of proposed seafloor-disturbing activities and requirements to minimize impacts to sensitive benthic communities, impacts are expected to be **nominal** for seafloor disturbance and drilling discharges. Overall, impacts to benthic communities from routine activities under Alternative A are expected to be **nominal**.

4.5.2.2 Impacts of an Accidental Fuel Spill

An accidental spill event could result in the release of diesel or other fuel by a survey vessel. Based on USCG spill statistics, a spill scenario was developed in **Chapter 3.3.2** that assumes a diesel spill volume of 1.2 to 7.1 bbl. Spills occurring at the ocean surface would disperse and weather; volatile components of the fuel would evaporate. Diesel and other fuels used for operation of survey vessels are light and would float on the ocean surface. A small proportion of the heavier fuel components could adhere to particulate matter in the upper portion of the water column and sink. The particulate matter contaminated with diesel fuel eventually would reach the benthos within or outside the AOI, depending on spill location, water depth, ambient currents, and sinking rate. However, given the relatively small size of the spill and the loss of most spilled fuel through evaporation and dispersion, a small diesel fuel spill would be expected to result in **nominal** impacts to benthic communities.

4.5.2.3 Cumulative Impacts

4.5.2.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.5.2.1 and 4.5.2.2** determined that routine activities and accidental events projected to occur under Alternative A would result in **nominal** impacts to benthic communities. The following analysis considers whether those incremental impacts, when added to or acting synergistically with other impact sources from the cumulative impacts scenario, may result in a significant impact.

Therefore, cumulative incremental impacts to benthic communities from the proposed action, 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 Outer Continental Shelf G&G-related impacts through stipulations and regulations, would be expected to be **nominal** with no anticipated population-level impacts.

4.5.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for benthic communities are compared with the IPFs from each of the cumulative scenario components on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The cumulative, long-term impacts on benthic communities of reasonably foreseeable, non-OCS G&G-related anthropogenic activities and shifting baseline environmental conditions could be substantial, although they are difficult to quantify, particularly when projecting future conditions. The activities that have the potential to affect benthic communities include (1) Federal and State oil and gas activity, (2) noise, (3) pollution, (4) seafloor disturbance and turbidity, (5) commercial fishing, and (6) climate change. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI.

The G&G activities have been ongoing in the GOM for at least the past 30 years, and it is reasonable to assume they will continue into the future; however, for the purpose of this Programmatic EIS, the cumulative analysis assesses a 10-year timeframe to coincide with the proposed action because it is not expected that G&G activities will have lasting effects or extend beyond the 10-year period of this Programmatic EIS. Impact analyses presented in **Chapters 4.5.2.1 and 4.5.2.2** concluded that activities projected to occur under Alternative A would result in **nominal** impacts to benthic communities.

Federal and State Oil and Gas Activities

Impacts from oil and gas activities 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 benthic communities, diminishing the potential effects. Therefore, at the regional, population-level scope of this analysis and assuming adherence to all expected regulations and mitigations, the incremental contribution would be expected to be **nominal** to **minor**. Proposed OCS oil- and gas-related activities would also contribute incrementally to the overall cumulative effects experienced by benthic communities and habitats. The OCS oil- and gas-related cumulative impacts to benthic communities are estimated to be **nominal** to **minor**. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (i.e., SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. For more information on impacts to benthic communities by oil and gas activities, refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapters 4.4 and 4.6 of the 2017-2022 GOM Multisale EIS.

Impacts to benthic communities from accidental oil spills (not including a catastrophic oil spill) are expected to range from **nominal** to **minor**. This range of potential impact levels reflects the relative uncertainty associated with unplanned and potentially uncontrolled accidental events and the uncertainty about the precise distribution of benthic communities. The exact impact would depend on overall frequency, extent, and severity of accidental spills and whether or not community-level accidental impacts can be clearly distinguished from natural variation.

Active Acoustic Sound Sources

Active acoustic sound sources, including airguns and electromechanical sources from oil and gas activities in State waters, vessel and equipment noise, as well as sonar and echolocation sources on fishing and commercial vessels, projected under the proposed action are described in **Chapter 3.4.1**. Scientific research vessels and other non-survey vessel activities would be expected to have similar types of active acoustic sound sources. Active acoustic sound sources associated with military activities in the GOM (**Chapter 3.4.3.6**) could involve military operations testing of air-to-air and air-to-surface operations as well as underwater explosives such as mines. Active acoustic sound sources under the proposed action would contribute to noise levels within the AOI. Noise from G&G operations would be survey or activity based, occurring on a transient and intermittent basis over the 10-year period of interest. The cumulative contribution of the active acoustic sound sources from the proposed action (**Chapter 4.5.2.1**) would be an increase in ocean noise for these activities of the cumulative scenario.

Overall, **Chapter 4.5.2.1** concluded that there would be increases in ambient noise levels within specific portions of the AOI during G&G operations; the impacts associated with the proposed action would result in a **nominal** incremental increase in noise impacts to benthic communities under the cumulative scenario.

Pollution

Trash and Debris

A point source investigation was conducted for oil and gas activities on the OCS (USDOI, MMS, 1996), indicating that the offshore oil and gas industry contributed 13 percent of all debris collected. Because of this study, the offshore oil and gas industry's adherence to laws and regulations has greatly reduced their share of the trash and debris deliberately jettisoned into the GOM.

Trash and debris from cumulative activities would include stationary facilities associated with oil and gas exploration and development, oil and gas support vessel operations, renewable energy development, and marine minerals use. Future activities would be required to follow MARPOL 73/78 and marine debris awareness covered under NTL 2015-BSEE-G03. Because operators must comply with Federal regulations and would be expected to follow guidance provided by BOEM, the amount of trash and debris offshore would be minimal as only accidental loss of trash and debris is anticipated, some of which could sink to the seafloor and harm benthic communities. As discussed in **Chapter 4.5.2.1**, the proposed activities under Alternative A would follow the same regulations and guidance, resulting in **nominal** impacts. Therefore, a **nominal** incremental increase in impacts from trash and debris to benthic communities under the cumulative scenario is expected.

Drilling Discharges

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 3.3.1.9**). Cuttings discharged at the surface tend to disperse in the water column and be distributed at low concentrations (Continental Shelf Associates, Inc., 2004a). 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 (Continental Shelf Associates, Inc., 2006). Cuttings shunted to the seafloor form piles concentrated within a smaller area than do sediments discharged at the sea surface (Neff, 2005).

Apart from the direct impacts of turbidity and sedimentation, the chemical content of drilling muds and cuttings (and, to a lesser extent, produced waters) are another potential IPF 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 benthic organisms, but only if they were to come into contact in undiluted strengths (Continental Shelf Associates, Inc., 2004b).

Seafloor Disturbances

Seafloor-disturbing activities associated with the Oil and Gas Program over the next 10 years will include the construction and installation of, at most, 8,233 exploration and production wells, 507 production structures (e.g., caissons, multi-leg platforms), and 17,437 km (10,835 mi) of pipelines (**Table 3.4-2**). Production structures can range from small caissons impacting hundreds of square feet of seafloor to much larger multiple-leg platforms to support multi-level production facilities with associated larger seafloor-disturbing footprints, each impacting tens of thousands of square feet of seafloor (LGL Limited Environmental Research Associates and Science Applications International Corporation, 1998). Offshore facility decommissioning, including platform and caisson removal, typically use one of two primary methods to sever structures attached to the seafloor: mechanical severance or explosive severance. Explosive charges generally are placed inside the platform legs or conductors at a depth of 4.6 to 7.6 m (15 to 25 ft) below the seafloor, which disturbs the seafloor adjacent to the legs. Structure-removal permit applications for the GOM are summarized in **Tables 3.4-3 and 3.4-4**. Because there are limited renewable energy activities projected, seafloor disturbances from such activities would be localized and evaluated to minimize seafloor disturbances near benthic communities, if they occur.

Seafloor disturbances could also occur from commercial and recreational fishing activities; dredge material disposal; existing, planned, and new cable infrastructure; military activities; scientific research; and cumulative vessel activity levels. Seafloor disturbances associated with marine mineral uses would be in pre-determined OCS sand resource areas (**Chapters 3.2.3 and 3.4.1.4**) for use in coastal restoration. Projected volumes of sand material from sand borrow projects over the 10-year period are provided in **Table 3.2-5**. The sand resource areas would be selected for the desired sand sediment qualities, and seafloor disturbances would be localized to the sand resource area. Seafloor-disturbing activities associated with Alternative A activities over the 10-year period would include a maximum of 3 wells, 2 bottom-founded monitoring buoys, and 2,238 bottom samplings (**Table 3.2-7**). The cumulative seafloor-disturbing activity impacts would result from the placement of material covering the seafloor, anchoring, bottom-fishing gear, and bottom sampling; however, these activities must avoid known benthic communities and are required to minimize direct impacts. One renewable energy development is being considered under the proposed action, and it would be required to minimize benthic community impacts from seafloor disturbances. The proposed action is expected to result in **nominal** impacts to benthic communities (**Chapter 4.5.1.4**) and, due to the minimal associated impacts overall, would result in a **nominal** incremental increase in impacts from seafloor disturbances.

Commercial Fishing

The primary anthropogenic activities impacting benthic communities are related to commercial fishing (**Chapter 4.9**). 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 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). Such gear 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 cumulative impact level of commercial fishing in the GOM can be separately concluded for shallow and deep waters. Currently, the overall amount of fishing effort in very deep waters of the GOM is spatially and temporally limited (Continental Shelf Associates, Inc., 2002). Therefore, at the present time, commercial fishing impacts on GOM deepwater benthic communities are only **nominal**. In shallow waters, it is more difficult to accurately estimate since the spatial and temporal factors are highly variable and necessary baseline information is still being collected, but there is significantly more fishing effort in shallow waters, with documented impacts to benthic communities. The overall impact to benthic communities of shallow water commercial fishing is best estimated to be **nominal** to **moderate**.

Climate Change

Climate change-related effects have the potential to alter baseline environmental conditions throughout the GOM, both in shallow live bottom habitats (refer to Chapter 4.6 of the 2017-2022 GOM Multisale EIS) and for deepwater benthic communities (refer to Chapter 4.4 of the 2017-2022 GOM Multisale EIS).

Of particular note for shallow-water live bottom benthic communities are the potential negative consequences that may be caused by the dual mechanisms of increasing ocean temperatures and ocean acidification. Sustained, unusually high water temperatures are documented to cause coral bleaching. Ocean acidification can reduce bioavailability of calcium carbonate and thereby inhibit normal rates of calcification by exoskeleton-building corals and other calcifying marine organisms. Decreased calcification rates have been observed in numerous shallow-water, zooxanthellate corals (Hofmann et al., 2010). Both mechanisms can inhibit growth and reproductive fitness of sessile benthic organisms.

There is extensive scientific literature available about climate change in general. However, there is currently relatively little literature dedicated to the potential impacts on deepwater benthic communities. 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), as with other benthic communities, reducing the bioavailability of calcium carbonate that potentially could decrease calcification rates. Such effects could make it more difficult for deepwater calcifying organisms to form or maintain calcium carbonate-based skeletons or shells, possibly inhibiting growth.

The cumulative impact level of future climate change-related factors on benthic communities is difficult to accurately estimate with the current level of scientific understanding. At present, the overall impact of climate change-related effects on both shallow and deepwater benthic communities is likely **nominal**.

4.5.2.3.3 Cumulative Impact Conclusions

Increases in ambient noise levels within specific portions of the AOI are expected during G&G operations; however, the impacts associated with the proposed action would result in a **nominal** incremental increase in noise impacts to benthic communities under the cumulative scenario. Seafloor disturbances associated with the cumulative scenario would include OCS activities, oil and gas decommissioning, renewable energy development, marine minerals, and commercial and recreational fishing activities; dredge material disposal; trash and debris; existing, planned, and new cable infrastructure; military activities; scientific research; and cumulative vessel activity levels. When compared with past levels of activities within the GOM, proposed activities do not represent a significant incremental increase to effects under the cumulative scenario. The cumulative impacts on benthic communities from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.5.2.3.2** above. The incremental contribution of the proposed action under Alternative A is expected to be **nominal** when considered in the context of cumulative impacts to the communities. Impacts from commercial fishing would be much more influential on benthic communities than Outer Continental Shelf G&G activity and would still occur without the presence of Outer Continental Shelf G&G operations.

4.5.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.5.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on benthic communities.

4.5.3.1 Impacts of Routine Activities

4.5.3.1.1 Coastal Waters Seasonal Restrictions (January 1 to April 30)

As evaluated in Alternative A (**Chapter 4.5.2.1**), impacts to benthic communities are expected to be **nominal**. Most of the additional mitigation measures (such as expanded PSO, the minimum separation distance, and use of required PAM) included in Alternative B would not reduce impacts to benthic communities. The additional mitigation measures included in Alternative B do not include additional restrictions that would change benthic community impacts from seafloor disturbances. The seasonal restriction in Federal coastal waters from January 1 to April 30 would reduce active acoustic impacts from airgun surveys to benthic communities, but it still would result in **nominal** impacts over the rest of the year.

4.5.3.1.2 Seismic Restrictions in the Areas of Concern within the EPA

The impacts to benthic communities from deep-penetration seismic airgun surveys would be reduced in the EPA due to the restriction in Alternative B and still would result in **nominal** impacts to benthic communities across the rest of the AOI.

4.5.3.1.3 Routine Activities Impact Conclusions

Active acoustic sound sources from seismic activities have not been determined to have significant impacts to benthic communities, and impacts are expected to be **nominal**. Impacts from trash and debris, seafloor-disturbing activities, and drilling discharges would not be affected by the mitigations in Alternative B and would remain **nominal**. Overall, impacts to benthic communities from routine activities under Alternative B are expected to be **nominal**.

4.5.3.2 Impacts of an Accidental Fuel Spill

Impacts from an accidental fuel spill on benthic communities are evaluated for Alternative A in **Chapter 4.5.2.2**. Because of the relatively small volume of fuel as well as the rapid weathering and dissipation qualities of the fuel in water, an accidental diesel fuel spill would be expected to result in **nominal** impacts to benthic communities. Area closures and restrictions included in the additional mitigation of Alternative B would result in restricted vessel activities, further reducing the potential impacts from an accidental fuel spill to benthic communities. However, impacts would remain **nominal**.

4.5.3.3 Cumulative Impacts

4.5.3.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.5.3.1 and 4.5.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** impacts to benthic communities. Mitigation measures for the proposed action under Alternative B are described in **Chapter 2.4** and summarized in **Chapter 4.5.3.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3**). Multiple mitigation measures under Alternative B would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to benthic communities would not change.

4.5.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.5.2.3.2**) would remain the same under Alternative B.

4.5.3.3.3 Cumulative Impact Conclusions

Some of the additional mitigation measures included in Alternative B, while reducing impacts to other resources, would have no effect on the impacts to benthic communities, such as the expansion of the PSO Program and PAM requirement during periods of reduced visibility. Other mitigation associated with this alternative, including seasonal coastal water restrictions for surveying and additional airgun seismic survey restricted areas, will reduce vessel activities within portions of the AOI, resulting in reductions in the potential impacts from active acoustic sound sources, trash and debris, and an accidental fuel spill. The Alternative B mitigation of increasing vessel separation distances during simultaneous airgun seismic surveys could reduce the cumulative impacts common to benthic community IPFs from active acoustic sound sources. While these mitigation measures would reduce the cumulative impacts from the associated IPFs, it would not change the degree of impacts from the proposed action. The cumulative impacts on benthic communities from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.5.2.3.2** above. The incremental contribution of the proposed action under Alternative B is expected to be **nominal** when considered in the context of cumulative impacts to the communities. Impacts from commercial fishing would be much more influential on benthic communities than Outer Continental Shelf G&G activity and would still occur without the presence of Outer Continental Shelf G&G operations.

4.5.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.5.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative C on benthic communities.

4.5.4.1 Impacts of Routine Activities

4.5.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

As evaluated in Alternative A (**Chapter 4.5.2**), impacts on benthic communities are expected to be **nominal**. Most of the additional mitigation measures included in Alternative C would not reduce impacts to benthic communities. The additional mitigation measures included in Alternative C do not include additional restrictions that would change benthic community impacts from seafloor disturbances or drilling discharges. The seasonal restriction in Federal coastal waters from February 1 to May 31 would reduce active acoustic impacts from airgun surveys to benthic communities and still would result in **nominal** impacts.

4.5.4.1.2 Routine Activities Impact Conclusions

Active acoustic sound sources from seismic activities have not been determined to have significant impacts to benthic communities, and impacts are expected to be **nominal**. Impacts from trash and debris, seafloor-disturbing activities, and drilling discharges would not be affected by the mitigations in Alternative C and would remain **nominal**. Overall, impacts to benthic communities from routine activities under Alternative C are expected to be **nominal**.

4.5.4.2 Impacts of an Accidental Fuel Spill

Impacts from an accidental fuel spill on benthic communities are evaluated for Alternative A in **Chapter 4.5.2.2**. Due to the relatively small volume of fuel as well as the rapid weathering and dissipation of the fuel in water, an accidental diesel fuel spill would be expected to result in **nominal** impacts to benthic communities. Area closures and restrictions included in the additional mitigation of Alternative C would result in restricted vessel activities, further reducing the potential impacts from an accidental fuel spill on benthic communities; therefore, impacts would be **nominal**.

4.5.4.3 Cumulative Impacts

4.5.4.3.1 OCS Program G&G survey activities

Impact analyses presented in **Chapters 4.5.4.1 and 4.5.4.2** concluded that activities projected to occur under Alternative C would result in **nominal** impacts to benthic communities. Mitigation measures for the proposed action under Alternative C are described in **Chapter 2.5** and summarized in **Chapter 4.5.4**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3**). Most mitigation measures under Alternative C would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to benthic communities also would not change.

4.5.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.5.2.3.2**) would remain the same under Alternative C.

4.5.4.3.3 Cumulative Impact Conclusions

Some of the additional mitigation measures included in Alternative C, while reducing impacts to other resources, would have no effect on the impacts to benthic communities. The seasonal coastal water restrictions for surveying will reduce vessel activities within portions of the AOI, resulting in associated reductions in the potential impacts of common benthic community IPFs from active acoustic sound sources, trash and debris, seafloor disturbances, drilling discharges, and an accidental fuel spill. While this mitigation measure would reduce the cumulative impacts from the associated IPFs, it would not meaningfully change the degree of incremental impacts from the proposed action. The cumulative impacts on benthic communities from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.5.2.3.2** above. The incremental contribution of the proposed action under Alternative C is expected to be **nominal** when considered in the context of cumulative impacts to the communities. Impacts from commercial fishing would be much more influential on benthic communities than Outer Continental Shelf G&G activity and would still occur without the presence of Outer Continental Shelf G&G operations.

4.5.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.5.2**). The additional mitigation measure under Alternative D, which includes shutdowns for marine mammals, would not reduce potential active acoustic impacts discussed under Alternatives A and C (**Chapters 4.5.2.1 and 4.5.4.1**) on benthic communities; therefore, impacts would remain **nominal**. This mitigation would not alter the impact levels to benthic communities from trash and debris, seafloor disturbance, or drilling discharges, and would remain **nominal**. Under Alternative D, impacts of an accidental fuel spill on benthic communities would be as described for Alternatives A and C (**Chapters 4.5.2.2 and 4.5.4.2**) and would remain **nominal**.

4.5.5.1 Impacts of Routine Activities

For Alternatives A and C (**Chapters 4.5.2.1 and 4.5.4.1**), impacts on benthic communities are expected to be **nominal**. The additional mitigation measure included in Alternative D would not reduce impacts to benthic communities; therefore, impacts to benthic communities would remain **nominal**. Overall, impacts to benthic communities from routine activities under Alternative D are expected to be **nominal**.

4.5.5.2 Impacts of an Accidental Fuel Spill

Impacts from an accidental fuel spill on benthic communities are evaluated for Alternative A in **Chapter 4.5.2.2**. Due to the relatively small volume of fuel as well as the rapid weathering and dissipation of the fuel in water, an accidental diesel fuel spill would be expected to result in **nominal** impacts to benthic communities. Area closures and restrictions included in the additional mitigation measures of Alternative D would result in restricted vessel activities, further reducing the potential impacts from an accidental fuel spill on benthic communities; therefore, impacts would be **nominal**.

4.5.5.3 Cumulative Impacts

4.5.5.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.5.5.1 and 4.5.5.2** concluded that activities projected to occur under Alternative D would result in **nominal** impacts to benthic communities. Mitigation measures for the proposed action under Alternative D are described in **Chapters 2.6** and summarized in **Chapter 4.5.5**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3**). The mitigation measures are the same as described for Alternative C, with the addition of shutdown protocols during seismic operations for all marine mammals except bow-riding dolphins. The addition of shutdown protocols for all marine mammals except bow-riding dolphins under Alternative D would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to benthic communities also would not change.

4.5.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.5.2.3.2**) and would remain the same under Alternative D.

4.5.5.3.3 Cumulative Impact Conclusions

The cumulative impacts on benthic communities from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.5.2.3.2** above. The incremental contribution of the proposed action under Alternative D is expected to be **nominal** when considered in the context of cumulative impacts to the communities. Impacts from commercial fishing would be much more influential on benthic communities than Outer Continental Shelf G&G activity and would still occur without the presence of Outer Continental Shelf G&G operations.

4.5.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.5.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative E on benthic communities.

4.5.6.1 Impacts of Routine Activities

4.5.6.1.1 Reduced Level of Activity

As evaluated in Alternatives A and C (**Chapters 4.5.2.1 and 4.5.4.1**), impacts on benthic communities are expected to be **nominal**. The additional mitigation measures included in Alternative E would result in survey line mile reductions but not additional mitigation measures that would reduce benthic community impacts from seafloor disturbances or drilling discharges. The additional mitigation measure included in Alternative E would reduce acoustic impacts to benthic communities from deep-penetration, multi-client surveys and may reduce the amount of trash and debris due to the reduction of these surveys; however, impacts to benthic communities would be **nominal**.

4.5.6.1.2 Routine Activities Impact Conclusions

Active acoustic sound sources from seismic activities have not been determined to have significant impacts to benthic communities, and impacts are expected to be **nominal**. Impacts from trash and debris, seafloor-disturbing activities, and drilling discharges would not be affected by the mitigations in Alternative E and would remain **nominal**. Overall, impacts to benthic communities from routine activities under Alternative E are expected to be **nominal**.

4.5.6.2 Impacts of an Accidental Fuel Spill

Impacts from an accidental fuel spill on benthic communities are evaluated for Alternative A in **Chapter 4.5.2.2**. Due to the relatively small volume of fuel as well as the rapid weathering and dissipation of the fuel in water, an accidental diesel fuel spill would be expected to result in **nominal** impacts to benthic communities. Area closures and restrictions and seismic activity reductions included in the additional mitigation of Alternative E would result in fewer survey vessel activities, further reducing the potential impacts from an accidental fuel spill on benthic communities; therefore, impacts still would be **nominal**.

4.5.6.3 Cumulative Impacts

4.5.6.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.5.6.1 and 4.5.6.2** concluded that activities projected to occur under Alternative E would result in **nominal** impacts to benthic communities. Mitigation measures for the proposed action under Alternative E are described in **Chapter 2.7** and summarized in **Chapter 4.5.6.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3**). The reduction of deep-penetration, multi-client activities (in line miles) by 10 percent (Alternative E1) or 25 percent (Alternative E2) would reduce the extent, severity, and timing of active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, and trash and debris; therefore, impacts for these IPFs would be decreased under Alternative E.

4.5.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.5.2.3.2**) would remain the same under Alternative E.

4.5.6.3.3 Cumulative Impact Conclusions

The cumulative impacts on benthic communities from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.5.2.3.2** above. Despite a potential reduction in impacts, the incremental contribution of the proposed action under Alternative E is expected to be **nominal** when considered in the context of cumulative impacts to the communities. Impacts from commercial fishing would be much more influential on benthic communities than Outer Continental Shelf G&G activity and would still occur without the presence of Outer Continental Shelf G&G operations.

4.5.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.5.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative F on benthic communities.

4.5.7.1 Impacts of Routine Activities

4.5.7.1.1 Closure Areas

As evaluated in Alternatives A and C (**Chapters 4.5.2.1 and 4.5.4.1**), impacts on benthic communities are expected to be **nominal**. Most of the additional mitigation measures included in Alternative F would not reduce impacts to benthic communities because most of the diverse and abundant areas fall outside the areas considered for closure under this alternative. The closure areas associated with this alternative would provide additional protection for specialized habitats that support fish and listed species. Benthic organisms within the closure areas, including those within the FGBNMS, would receive protection from direct auditory injuries and masking that may result from acoustic seismic survey activities. The additional mitigation measures included in Alternative F do not include restrictions that would change benthic community impacts from seafloor disturbances or drilling discharges. The closure areas would reduce active acoustic impacts from airgun surveys to benthic communities in those areas, still resulting in **nominal** impacts.

4.5.7.1.2 Routine Activities Impact Conclusions

Active acoustic sound sources from seismic activities have not been determined to have significant impacts to benthic communities, and impacts are expected to be **nominal**. Impacts from trash and debris, seafloor-disturbing activities, and drilling discharges would not be affected by the mitigations in Alternative F and would remain **nominal**. Overall, impacts to benthic communities from routine activities under Alternative F are expected to be **nominal**.

4.5.7.2 Impacts of an Accidental Fuel Spill

Impacts from an accidental fuel spill on benthic communities are evaluated for Alternative A in **Chapter 4.5.2.2**. Due to the relatively small volume of fuel spilled as well as the rapid weathering and dissipation qualities of the fuel in water, an accidental diesel fuel spill would be expected to result in **nominal** impacts to benthic communities. Area closures and restrictions included in the additional mitigation of Alternative F would result in restricted vessel activities, further reducing the potential impacts from an accidental fuel spill on benthic communities; therefore, impacts still would be **nominal**.

4.5.7.2.1 Cumulative Impacts

4.5.7.2.2 OCS Program G&G survey activities

Impact analyses presented in **Chapters 4.5.7.1 and 4.5.7.2** concluded that activities projected to occur under Alternative F would result in **nominal** impacts to benthic communities. Mitigation measures for the proposed action under Alternative F are described in **Chapters 2.8** and summarized in **Chapter 4.5.7.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3**). Mitigation measures under Alternative F are similar to Alternative C, with the addition of area closures in four areas: CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area. Most mitigation measures under Alternative F would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to benthic communities also would not change. Mitigation measures under Alternative F that would change the timing and extent of activities in the proposed action are a seasonal restriction for operation of airguns in Federal and State coastal waters from February 1 through May 31, the prohibition of deep-penetration seismic airgun surveys within portions of the EPA (**Chapter 2.4.2**), and the four area closures listed previously for seismic airgun surveys. While this mitigation measure would reduce the cumulative impacts from the associated IPFs, it would not meaningfully change the degree of impacts from the proposed action.

4.5.7.2.3 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.5.2.3.2**) would remain the same under Alternative F.

4.5.7.2.4 Cumulative Impact Conclusions

The cumulative impacts on benthic communities from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.5.2.3.2** above. The incremental contribution of the proposed action under Alternative F is expected to be **nominal** when considered in the context of cumulative impacts to the communities. Impacts from commercial fishing would be much more influential on benthic communities than Outer Continental Shelf G&G activity and would still occur without the presence of Outer Continental Shelf G&G operations.

4.5.8 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.5.2**).

Under Alternative G, a limited number of VSP and SWD surveys would occur and no seafloor-disturbing activities are projected (**Table 2.9-1**). If no new seafloor-disturbing activities occur under Alternative G, then **no impact** will occur to the benthic communities from seafloor disturbance or drilling discharges. However, geophysical surveys using active acoustic sound sources still will occur in the near term; therefore, impacts to benthic communities would range from **no impact** to **nominal**. Overall, impacts to benthic communities from activities under Alternative G are expected to range from **no impact** to **nominal**.

Impacts from an accidental fuel spill on benthic communities are evaluated for Alternative A in **Chapter 4.5.2.2**. Due to the relatively small volume of fuel spilled as well as the rapid weathering and dissipation qualities of the fuel in water, an accidental diesel fuel spill would be expected to result in **nominal** impacts to benthic communities. Because Alternative G would not have the involvement of vessels, fuel spills would be less likely to occur; therefore, impacts would range from **no impact** to **nominal**.

Impact analyses presented above concluded that activities projected to occur under Alternative G would result in **no impact** to **nominal** for benthic communities, depending on the IPF. Alternative G is described in **Chapter 2.9**.

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.5.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.5.2.3.2**) would remain the same under Alternative G. The cessation of G&G activities would result in the loss of an important tool for exploration to identify the location and size of oil and gas prospects, development of renewable energy projects, and exploration for non-energy marine minerals such as sand and gravel (or other sediment) for beach nourishment, coastal restoration, and public works projects. Such a loss would result in increased environmental risk to industry and could potentially lead to a dramatic reduction in oil and gas activity in the GOM. The cease of activity for future G&G surveys requiring a permit/authorization from BOEM would not add a substantial increase to the cumulative impacts.

4.5.9 Summary Conclusion

In summary, the IPFs that may impact benthic communities within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; and side-scan sonars); (2) trash and debris; (3) seafloor disturbance; (4) drilling discharges; and (5) accidental fuel spill.

Impacts to benthic communities are assessed as **nominal** for all applicable IPFs and alternatives, except Alternative G, due to the existing protective measures in place for avoiding known sensitive communities during seafloor-disturbing activities and the prevalence of soft bottom in the AOI. In addition, active acoustic sound sources have not been determined to have significant impacts to benthic communities. Impacts under Alternative G range from **no impact** to **nominal** depending on the IPF.

4.6 MARINE AND COASTAL BIRDS

4.6.1 Description of the Affected Environment

The GOM supports a diverse avifauna, with both resident and migratory species, and includes a variety of coastal habitats important to the ecology of marine and coastal bird species. The status, general ecology, general distribution, migratory movements, and abundance of these birds are discussed in **Appendix E, Section 6** and summarized in the following subsections. Also, information on bird conservation regions (BCRs) and important bird areas (IBAs) is provided in **Figures 4.6-2 through 4.6-4 and Appendix E**.

Three distinct ecological groups of birds, within 17 families, occur within the AOI: seabirds, waterfowl, and shorebirds (refer to **Appendix E, Section 6 and Table 4.6-1**). Bird species within a family share common physical and behavioral characteristics. Because of these commonalities, birds will be presented by family rather than individual species, as the potential for exposure to G&G activities will be similar for species within a family. Within the AOI, there are three bird species listed under the ESA that will be discussed separately (**Chapter 4.6.1.2**). No ESA candidate species or species of concern have been identified within the AOI.

4.6.1.1 Unlisted Species

Seabirds

Seabirds within the AOI include members from five taxonomic orders (Charadriiformes, Gaviiformes, Pelecaniformes, Podicipediformes, and Procellariiformes) that live in the marine environment and feed at sea (Warnock et al., 2002). Some seabirds can be categorized by the marine zones in which they tend to forage. For example, pelagic seabirds (e.g., shearwaters) forage away from the coastal zone and in the open ocean while shorebirds (e.g., sandpipers, godwits) forage in coastal waters. However, there are seabirds that have less restrictive foraging practices and use both nearshore and pelagic zones (Michel, 2013). Modes of prey acquisition include picking from the sea surface, shallow diving below the sea surface, and diving to depths of several meters (Shealer, 2002). Species that dive below the sea surface may be exposed to underwater noise produced during G&G surveys. Seabird species from the Procellariidae (petrels and shearwaters), Pelecanidae (pelicans), Sulidae (gannets and boobies), Phalacrocoracidae (cormorants), and Laridae (gulls and terns) families occur within the AOI and regularly dive below the sea surface. Some seabirds (e.g., cormorants) are known to deep dive for relatively long durations.

Surveys within the northern GOM (Hess and Ribic, 2000) reported that terns (*Sterna* spp.), storm petrels (Hydrobatidae), shearwaters (*Puffinus* spp.), and jaegers (*Stercorarius* spp.) were the most frequently sighted seabirds in deepwater areas. Additionally, the distribution and relative densities of seabird species within the deepwater areas of the GOM vary temporally (i.e., seasonally) and spatially, based on hydrographic features such as Loop Current eddies, the presence of *Sargassum* lines, upwellings, convergence zones, thermal fronts, salinity gradients, and areas of high planktonic productivity (Ribic et al., 1997; Hess and Ribic, 2000).

Waterfowl

Waterfowl such as sea ducks (i.e., diving ducks) and dabbling ducks (Order Anseriformes) feed and rest within coastal (nearshore and inshore) waters outside of their breeding seasons. Members of the order Gaviiformes (loons) may be present in coastal waters also. Waterfowl that may occur within coastal and inshore waters of the AOI include species within the subfamilies Aythyinae (diving ducks) and Merginae (sea ducks) (Sibley, 2000). Diving ducks include the Canvasback (*Aythya valisineria*), Ring-necked Duck (*Aythya collaris*), scaups (*Aythya affinis* and *A. marila*), Bufflehead (*Bucephala albeola*), and Common Goldeneye (*Bucephala clangula*). Hooded Mergansers (*Lophodytes cucullatus*) are the primary sea duck species that may occur within the AOI. Similar to diving seabirds, sea ducks may be vulnerable to underwater noise produced during G&G activities because they dive beneath the water surface for feeding. However, most diving ducks and sea ducks are located in bays and estuaries, which are outside of the AOI.

Shorebirds

Shorebirds utilize coastal environments for nesting, feeding, resting, and migration stopover. The Gulf Coast is of particular importance to beach-nesting birds, species that breed on beaches, flats, dunes, bars, barrier islands, and similar nearshore habitats. The northern Gulf Coast, from the Mississippi River Delta of Louisiana to the Florida Panhandle, represents 18 percent of the southeastern U.S. coastline and supports a disproportionately high number of beach-nesting bird species. Shorebirds primarily found along the coastline of the AOI include species within four families: Charadriidae (plovers); Haematopodidae (oystercatchers); Recurvirostridae (avocets and stilts); and Scolopacidae (sandpipers). Fifty-three species of shorebirds regularly occur in the U.S. (Brown et al., 2001), with 43 species occurring during migration or wintering periods in the AOI. Six shorebird species breed in the GOM (Helmers, 1992): American Oystercatcher (*Haematopus* *palliates*); Snowy Plover (*Charadrius alexandrines*); Wilson's Plover (*Charadrius wilsonia*); Willet (*Catoptrophorus semipalmatus*); Killdeer (*Charadrius vociferous*); and Black-necked Stilt (*Himantopus mexicanus*). The Lower Mississippi/western Gulf Coast region is rich with a variety of shorebird habitats, and the Gulf Coast has some of the most important shorebird habitat in North America, particularly the Laguna Madre ecosystem along the south Texas coast (Brown et al., 2001; Withers, 2002). Resident shorebirds primarily rely on the shorelines adjacent to the AOI for their life functions, while some migrants overwinter along shorelines adjacent to the AOI. Some shorebird species cross and stopover in the AOI during their annual migration.

4.6.1.2 Listed Species

Under the ESA, there are three threatened species of marine and coastal birds present within the AOI: Piping Plover (*Charadrius melodus*) (*Federal Register,* 1985); Roseate Tern (*Sterna dougallii*) (*Federal Register*, 1987); and Red Knot (*Calidris canutus rufa*) (*Federal Register,* 2014e). Piping Plover and Red Knot are shorebirds unlikely to come into contact with G&G activities. Roseate Terns are more likely to come into contact with G&G activities because they forage offshore and feed by plunge-diving, often submerging completely when diving for fish. **Appendix E, Section 6** provides life history information of marine and coastal birds occurring in the AOI. While there are additional threatened, endangered, or candidate species that occur in the coastal areas of the AOI (e.g., Red-cockaded Woodpecker [*Picoides borealis*], Wood Stork [*Mycteria americana*], Mississippi Sandhill Crane [*Grus canadensis pulla*], interior subpopulation of the Least Tern [*Sternula antillarum*], and Whooping Crane [*Grus americana*]), they are not considered marine or coastal birds based on their reliance on terrestrial habitats or they are not documented in the AOI. Therefore, these species were not analyzed further because they are not likely to be affected by G&G activities.

4.6.1.3 Effects of the *Deepwater Horizon* Oil Spill on Marine and Coastal Birds

At present, estimates of avian mortality associated with the *Exxon Valdez* oil spill far exceed current estimates of avian mortality associated with the *Deepwater Horizon* explosion, oil spill, and response even though the *Deepwater Horizon* oil spill volume/size far exceeds that of the *Exxon Valdez* oil spill. This is because of the nearshore location of the *Exxon Valdez* oil spill, where bird diversity and abundance were high, where oil was released suddenly (impairing cleanup), and where oil accumulated. The Final PDARP/PEIS documented large-scale and pervasive impacts to birds in the northern GOM because of the *Deepwater Horizon* oil spill (*Deepwater Horizon* NRDA Trustees, 2016). At least 93 resident and migratory bird species across all five Gulf Coast States were exposed to *Deepwater Horizon* oil in multiple habitats, including offshore/open waters, island waterbird colonies, barrier islands, beaches, bays, and marshes (early USDOI, FWS [2011] efforts estimated 102 species).

The quantified impacts summarized earlier captured only a portion of the overall impact to birds. The *Deepwater Horizon* oil penetrated into marshes, which serve as important bird habitat. A study by Tran et al. (2014) reviewed an FWS dataset of 7,229 dead birds to investigate the location and species of birds along the Gulf Coast that were most impacted by the *Deepwater Horizon* oil spill. The largest concentration of birds was found along the coastlines of Louisiana, Alabama, and the Florida Panhandle. The Laughing Gull (*Larus atricilla*) and Brown Pelican (*Pelecanus occidentalis*) were the species most often mortally impacted by the oil spill. Although full exposure and mortality of interior marsh birds was not estimated, meaningful injury to marsh birds likely occurred given densities of key species (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). Similarly, island waterbird colonies were occupied by hundreds of thousands of breeding birds at the time of the oil spill. Although some mortality in colonies was included in the numbers stated previously, the Final PDARP/PEIS recognized that these methods were inadequate to fully assess the magnitude of impacts at these colonies.

Mortality from the *Deepwater Horizon* explosion, oil spill, and response was sufficient to cause a small negative shift in baseline abundances of 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 to 15 million for four procellariiform (shearwaters and related) species, 9,000 for one pelecaniform (pelican and related) species, and 96,000 to 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 at 600,000 birds using one model and 800,000 birds using another model (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. 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 the proposed action or alternatives.

Recovery (NRDA) data have become available since the analyses by Haney et al. (2014a, 2014b). Total nearshore mortality was determined in six recent NRDA final reports on the *Deepwater Horizon* explosion, oil spill, and response as 54,099 to 100,134 waterbirds (USDOI, FWS, 2015a-e; Industrial Economics 2015a). Total offshore mortality was determined in one NRDA final report on the *Deepwater Horizon* explosion, oil spill, and response as 2,317 to 3,141 birds (Industrial Economics, 2015b).

The ecosystem ramifications of these impacts are not limited to the northern GOM. Many birds that occur in the spill-affected region migrate to areas across North, Central, and South America, where their impaired performance or reduction in numbers could have radiating effects on ecosystems similar to those described previously. Two studies (not funded by NRDA) on the *Deepwater Horizon* explosion, oil spill, and response have addressed this. Franci et al. (2014) found no confirmed impacts of oil on the endocrine status and no evidence of exposure to oil of Northern Gannets (*Morus bassanus*) that migrated to eastern Canada after overwintering in the northern GOM in winter 2010-2011. Seegar et al. (2015) found evidence in fall 2010 of polycyclic aromatic hydrocarbon (PAH) contamination in the blood of migrant Tundra Peregrine Falcons (*Falco* *peregrinus tundrius*) that probably were exposed to *Deepwater Horizon* PAHs in oil. In 2011, the migrants showed a return to basal levels of these hydrocarbons because birds have the ability to process hydrocarbons relatively quickly into substances they can excrete. Additional information pertaining to this resource and NMFS' determination of the effects of the *Deepwater Horizon* explosion, oil spill, and response may be found in the Final PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016).

4.6.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact marine and coastal birds within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars), (2) vessel and equipment noise, (3) vessel traffic (i.e., physical disturbance to and risk of collisions), (4) aircraft traffic and noise (e.g., helicopters, fixed-wing aircraft), (5) trash and debris (i.e., ingestion of and entanglement in), and (6) an accidental fuel spill. As all G&G survey activities are performed using vessels, all activities could impact marine and coastal birds. Active acoustic sound sources, including airguns and non-airgun HRG (electromechanical) sources, could impact marine and coastal birds that may be present in the survey area via sound exposure. Vessel traffic and its associated noise, including equipment noise, are discussed together as they can disrupt marine and coastal birds and displace them from the survey area. The potential for impacts from the release of trash and debris to marine and coastal birds is also discussed. The accidental spill scenario is presented in detail in **Chapter 3.3.2** and considers a spill of 1.2 to 7.1 bbl of fuel, which could adversely affect marine and coastal birds.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level categories. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For marine and coastal birds, the following impact-level criteria have been used to evaluate the level of impact for each IPF.

Nominal impacts to marine and coastal birds would include those where little to no measurable impacts to local populations are observed or expected. No mortality or serious injury to any individual marine or coastal bird is expected to occur. Nominal impacts are limited to minimal short-term behavioral or other low-level impacts on individuals (i.e., small numbers, low severity, and short duration). No mortalities or physical injuries are included.

Minor impacts to marine and coastal birds would include those that are detectable but not extensive or severe and that are expected to affect individuals or groups within the AOI. Minor impacts include limited short-term displacement of any species from preferred feeding, breeding, or nursery grounds or migratory routes (including critical habitat for listed species); short-term disruption of behavioral patterns that may adversely affect a marine or coastal bird species; or mortality or life-threatening injury of individuals (other than listed species) in small numbers that would not adversely affect the population.

Moderate impacts to marine and coastal birds at the population level may be extensive (potentially affecting large numbers of individuals within regions of the AOI) but not severe or may be severe but not extensive. Moderate impacts to marine and coastal birds would include limited levels of serious injury or mortality to listed or non-listed species but in low enough numbers that the continued viability of the population is not threatened. Moderate impacts also would include extended displacement of a coastal bird species from preferred feeding, breeding, or nursery grounds or migratory routes (including critical habitat for listed species); extensive damage to critical habitat for listed marine and coastal birds; and extensive disruption of behavioral patterns that may adversely affect a marine or coastal bird species. The viability or continued existence of affected marine and coastal bird populations would not be threatened, although some impacts may be irreversible.

Major impacts to marine and coastal birds would be extensive and severe. Major impacts to marine and coastal birds would include mortality or life-threatening injury of individuals of a listed (endangered/threatened) species or non-listed species, either of which would be in sufficient numbers to adversely affect the population. Major impacts to marine and coastal birds also would include mortality or permanent (or long-term) displacement of a coastal bird species from preferred feeding, breeding, or nesting grounds or migratory routes (including critical habitat for listed species) to the extent that the long-term survivability of the species may be adversely affected; extensive, long-term damage to critical habitat for marine and coastal birds; and chronic disruption of behavioral patterns that may adversely affect a marine or coastal bird species.

4.6.2.1 Impacts of Routine Activities

4.6.2.1.1 Active Acoustic Sound Sources

The primary potential for impact to marine and coastal birds from airguns and active acoustic non-airgun HRG (i.e., electromechanical) sources is to birds that dive below the water surface and are exposed to underwater noise (Turnpenny and Nedwell, 1994). The listed (threatened) shorebird species, Piping Plover and Red Knot, are unlikely to come into contact with G&G activities. Diving species (e.g., grebes, loons, some diving ducks, Roseate Terns) are more likely to come into contact with G&G activities because they forage offshore and feed by plunge-diving, often submerging completely when diving for fish. Species that plunge-dive are at risk of exposure to active acoustic sound sources because seismic sources are directive, with a main beam directed down through water to the seafloor and side lobes that project sound horizontally. The sound energy projected horizontally from the array is much less intense than that projected vertically. In addition, active acoustic sound sources such as side-scan sonar and subbottom profilers (electromechanical sources) are highly directive (e.g., downward), with beam widths as narrow as a few degrees and with most (except subbottom profilers) operating at frequencies >12 kHz; this directivity, frequency of operation, and narrow beam width diminishes the risk to bird species, including plunge-diving species. Because of these factors, other species of seabirds, waterfowl, and shorebirds would not be affected by active acoustic sound sources and are not discussed further for this IPF.

Active acoustic sound sources include airguns and non-airgun HRG (electromechanical) sources, which produce similar impacts to seabirds and waterfowl that dive below the water surface, such as members of the Procellariidae, Pelecanidae, Sulidae, Phalacrocoracidae, and Laridae families. Birds have a relatively restricted hearing range, from approximately 300 Hz to approximately 10 kHz (Dooling and Popper, 2000). However, this hearing range is for airborne noise; there are limited data regarding birds' hearing range for underwater noise, and there is no evidence that birds use underwater sound.

Proposed G&G activities include the use of airguns as seismic sources during deep-penetration seismic airgun surveys for oil and gas exploration and for HRG surveys of oil and gas leases. Electromechanical sources typically would be used during HRG surveys for renewable energy development and sand source evaluation in the Marine Minerals Program, where a high-resolution boomer, sparker, or CHIRP subbottom profiler; SBES; MBES; or side-scan sonar is used to delineate near-surface geologic strata and features. The autonomous underwater vehicle surveys for oil and gas leases include a similar equipment suite. These sources may operate simultaneously with the airguns during deep-penetration seismic airgun surveys. The VSP surveys, which utilize airguns as sound sources and sensor strings deployed down boreholes, are conducted to support well drilling. The VSP survey airgun arrays will generate impulsive sound similar to that of other G&G surveys that use airguns.

Active acoustic sound levels are expected to reach an $SPL_{0\text{-peak}}$ of 248 dB re 1 μPa at 1 m for a large airgun array (8,000 in^3). Most energy from a large airgun array is produced at frequencies <500 Hz (**Appendix D**). Active acoustic sound levels are expected to reach an $SPL_{0\text{-peak}}$ of 228 dB re 1 μPa at 1 m for a small airgun (90 in^3). Most energy from a small airgun is produced at frequencies <600 Hz (**Appendix D**). Electromechanical sources vary in terms of operating frequency and sound levels and are expected to range from an $SPL_{0\text{-peak}}$ of 195 to 213 dB re 1 μPa at 1 m (refer to **Table 3.4-2**).

Airgun pulses are directional, with the majority of the sound energy directed towards the seafloor and lower sound energy levels projected lateral to the airgun array. Other survey equipment produces higher frequencies. Electromechanical sources usually have one or two (sometimes three) main operating frequencies. The low-frequency underwater noise generated by airguns would fall within the airborne hearing range of birds, as does one type of survey equipment (subbottom profilers), whereas the operating frequency of other types of survey equipment (e.g., side-scan sonar, echosounders) and the sound they produce is outside of birds' airborne hearing range and should be inaudible to birds. Therefore, if birds can hear within the same range for underwater noise as their airborne hearing range, the G&G survey activities that could impact diving seabirds and waterfowl are deep-penetration seismic airgun surveys as well as HRG surveys using airguns.

Some seabirds and waterfowl, including members of the families Laridae, Rhyncopidae, Pelecanidae, Fregatidae, and Anatidae, rest on the water surface or make short, shallow dives. Other species (e.g., Long-tailed Duck, common loon) dive to deeper depths (up to 60 m [197 ft]) and spend more time submerged than on the surface. Because airgun array pulses are directional, only birds that dive (shallow or deep) could come in contact with active acoustic sounds from airguns and HRG equipment. The short exposure time to deep-diving species if they dive below airgun arrays, along with relatively lower lateral sound energy level exposures to airgun arrays if they are near but to the side of the apparatus, would result in a **nominal** impact to diving birds.

Diving seabirds and waterfowl such as members of the families Gaviidae, Phaethontidae, Phalacrocoracidae, Sulidae, Hydrobatidae, Procellariidae, Podicipedidae, and Anatidae could be susceptible to active acoustic sounds generated from seismic airgun surveys, especially species that would probably dive rather than fly away from a vessel (e.g., grebes, loons, and some diving ducks). However, seismic pulses are directed downward and, while energy is projected laterally by an array, it is much reduced in energy from that directed downward; therefore, direct impact from lateral exposure is greatly reduced. No mortality or injury is anticipated. Impacts would be limited to short-term displacement or avoidance. Therefore, the potential impact from the low-frequency noise associated with G&G seismic airgun surveys to diving birds is **nominal**. In addition, active acoustic electromechanical sound sources such as side-scan sonar and subbottom profilers are highly directive, with beam widths as narrow as a few degrees; the ramifications of this directionality include a lower risk of high-level exposure to diving birds that may forage close to (but not beneath) a seismic vessel.

Investigations into the effects of airguns on seabirds are extremely limited; however, studies performed by Stemp (1985) and Lacroix et al. (2003) did not observe any mortality in several species of seabirds exposed to seismic survey noise. These studies did not observe any differences in distribution or abundance of the seabird species as a result of seismic survey activity. Based on the directionality of the sound generated from seismic airgun arrays as well as low-frequency equipment used for non-airgun HRG surveys and the limited study results available, mortality or life-threatening injury is not expected and little disruption of behavioral patterns or other non-injurious effects is expected, resulting in a **nominal** direct impact for seabirds exposed to HRG sound sources.

As discussed in **Appendix E, Section 6**, there are four BCRs within the AOI that include coastal waters and are important feeding areas for seabirds and waterfowl. Underwater noise generated from active acoustic sound sources (i.e., airguns or other survey equipment) would attenuate significantly prior to reaching nearshore waters. Sound attenuation, or transmission loss, is the reduction in sound intensity between the source and another point in the field. In deepwater operations, impulsive sound spreads in all directions (i.e., spherical spreading). In shallow waters

(<50 m [164 ft]), transmission losses are higher, resulting in a smaller potentially affected area (Turnpenny and Nedwell, 1994). Therefore, most underwater noise will attenuate substantially prior to reaching coastal BCRs. Sound produced during seismic airgun surveys and non-airgun HRG surveys may cause temporary displacement of seabirds and waterfowl from small portions of BCRs due to the displacement of prey species during survey activities. If prey species exhibit avoidance of the area in which a survey is performed, it is expected to be limited to a very small portion of a bird's foraging range. Therefore, temporary displacement of marine and coastal bird species from a portion of their feeding areas during non-migration seasons is possible, resulting in **nominal** indirect impacts from airgun and HRG surveys. However, if seismic airgun survey activities and potential temporary displacement of species from a portion of preferred feeding areas occurred during bird species migration, then the impact would be considered **minor** because these individuals may have a higher energy demand for finding an alternative food source.

As provided in **Appendix E, Section 6**, there are several coastal, nearshore, or offshore IBAs as well as 24 national wildlife refuges (NWRs) that include coastal habitat within the AOI. The area contained within the IBAs continues offshore into open water where G&G surveys could occur (**Figure 4.6-4**). The IBAs and NWRs are important foraging grounds for many species of marine and coastal birds. The sound produced during seismic airgun surveys and non-airgun HRG surveys may cause an indirect impact on seabirds and waterfowl that use these areas if the sound causes their prey species to be temporarily displaced from portions of the IBAs and NWRs during survey activities. Depending on the season in which a survey takes place as well as the duration of the survey, temporary prey displacement could result in additional energetic requirements for the migrating birds to find additional or different locations for foraging. However, these IBAs are large (e.g., the Barataria Terrebonne IBA is close to 3 million ac [1,214,057 ha]), and bird prey species likely would not be affected by seismic airgun survey activities to a level that would affect foraging success. If prey species exhibit avoidance of the area in which the survey is performed, it is expected to be limited to a very small portion of a bird's foraging range. Therefore, temporary displacement of marine and coastal bird species from a portion of preferred feeding grounds during migration and from locations of non-critical activities during non-migration seasons could occur, resulting in **nominal** indirect impacts from airgun and HRG surveys. However, if airgun and HRG surveys and potential temporary displacement of species from a portion of preferred feeding areas occurred during bird species migration, then the impact would be considered **minor**.

4.6.2.1.2 Vessel and Equipment Noise and Vessel Traffic

The primary potential direct impacts to marine and coastal birds from vessel traffic and noise are from underwater sound generated by vessels and equipment, with secondary direct impacts from attraction to vessels and subsequent collision or entanglement. Potential indirect impacts include disturbance to nesting or roosting, and disturbance to feeding or modified prey abundance (Schwemmer et al., 2011). Under Alternative A, all G&G survey activities are performed from vessels, except remote-sensing surveys conducted via aircraft and satellites; most survey activities could impact marine and coastal birds from vessel traffic and noise, including equipment noise

(**Chapter 3.3.1.3**). Projected levels of vessel trips for survey and support vessels are provided in **Table 3.3-3**.

Underwater Noise

Sound generated from individual vessels can contribute to ambient noise levels in the marine environment on variable spatial scales. Survey vessels would contribute to the overall noise environment in the AOI by transmitting noise through air and water. Underwater noise produced by vessels is a combination of narrow-band (tonal) and broadband sound. Tones typically dominate up to 50 Hz, whereas broadband sounds may extend to 100 kHz. According to Southall (2005) and Richardson et al. (1995), vessel noise typically falls within the range of 100 to 200 Hz. Noise levels decrease quickly with distance from the vessel. Underwater noise generated from survey vessels would decrease prior to reaching the coastline and shore/beach habitats of birds, including threatened and endangered species present in the AOI (i.e., Piping Plover, Roseate Tern, and Red Knot). Because of the attenuation of underwater noise from survey vessels prior to reaching the shore/beach, underwater noise is expected to produce **nominal** impacts to bird species, including Piping Plover and Red Knot.

Seabirds and waterfowl that rest on the water surface, skim the water surface, or make shallow dives for short durations would not come in contact with underwater noise generated by vessels and equipment, or the contact would be for such a short time that it would result in little disruption of behavioral patterns or in other non-injurious effects. Therefore, impacts to these seabirds and waterfowl from vessel and equipment noise would be **nominal**.

Diving seabirds and waterfowl could be susceptible to underwater noise generated from survey vessels and equipment. The number of vessels typically involved in a G&G survey ranges between one and six, depending on the type of survey. This level of vessel activity per survey event is not a significant increase in existing vessel and equipment noise present in the GOM, and noise levels decrease quickly with distance. In addition, drilling-related noise associated with the installation of up to one COST well and two shallow test wells associated with oil and gas exploration G&G activities is continuous and generally at low frequencies (<500 Hz), including infrasonic frequencies (<15 Hz) in at least some cases (Richardson et al., 1995). Machinery noise can be continuous or transient and variable in intensity. Noise levels vary with the type of drilling rig and water depth. Drilling-related noise from jack-up platforms is continuous and generally of very low frequencies (near 5 Hz). Drilling-related noises from semisubmersible platforms range in frequency from 10 to 4,000 Hz, with estimated sound levels of 154 dB re 1 μPa-m. Source levels for drillships have been reported as high as 191 dB re 1 μPa during drilling. Therefore, most underwater noise from drilling operations would be expected to be within the hearing range of most diving seabirds and waterfowl. Because noise decreases rapidly with distance from the source, only a small area of the AOI would experience vessel and equipment noise and potential associated disruption. Because the potential for interaction between noise-producing activities and the occurrence of diving seabirds and waterfowl individuals or flocks is very low, impacts of underwater noise from survey vessels and equipment to diving seabirds and waterfowl are expected to be **nominal**.

The four BCRs within the AOI are important feeding areas for seabirds and waterfowl. Most of the underwater noise generated from survey vessels would decrease prior to reaching the nearshore waters of the BCRs; therefore, impacts to marine and coastal birds using the BCRs are expected to be **nominal**.

Furthermore, there are five IBAs off the coast of Louisiana and three off the coast of Florida. The area contained within these IBAs continues offshore into open water where G&G surveys could occur. The IBAs are important foraging grounds for many species of marine and coastal birds. The terns and diving seabirds and waterfowl that use these areas could be exposed to survey vessel and equipment noise. However, because of underwater noise attenuation with distance, only a very small area of the IBAs would experience vessel and equipment noise. Again, the potential for interaction of noise-generating activities and occurrence of waterfowl within an IBA would likely be low. Therefore, impacts to seabirds and waterfowl present within offshore IBAs from the underwater noise made by survey vessels and equipment are expected to be **nominal**. However, if G&G activities and the associated underwater noise occurred during migration season, preferred feeding grounds of these birds could be affected through disturbance to feeding or modified prey abundance. Migrating waterfowl have higher energy demands than non-migratory species; thus, any additional energy expenditure required for seeking alternative food sources would impact the health of the bird. Under such circumstances, this indirect impact would be considered **minor** for diving seabirds and waterfowl.

Vessel Attraction

The number of vessels typically involved in a G&G survey ranges between one and six, depending on the type of survey (e.g., grab sampling, geologic coring, and vibracoring surveys require a single vessel; 3D, 4D, and WAZ seismic surveys require 3 to 6 vessels). This level of vessel traffic is not a significant increase to existing vessel traffic in nearshore and offshore waters of the GOM. In addition, vessels perform surveys at relatively slow speeds (4 to 6 kn [5 to 7 mph]), which permits marine and coastal birds to easily move out of the way of survey vessels.

The potential for bird strikes on a rig or vessel is not expected to be significant at the population level. However, many seabird species, including members of the Procellariidae, Pelecanididae, and Laridae families, are attracted to offshore rigs and vessels due to light attraction at night (Montevecchi et al., 1999; Wiese and Jones, 2001; Black, 2005; Montevecchi, 2006). Some birds engage in ship-following as a foraging strategy, especially with commercial or recreational fishing vessels. In addition, in an open environment like the ocean, objects are easy to detect and birds locate vessels easily from long distances and approach to investigate. Bird mortality has been documented as a result of light-induced attraction and subsequent collision with vessels at night (Black, 2005).

Historically, BOEM has directed vessels to have down-shielded work lighting to minimize potential attraction and collision with birds. If terns or birds within the Procellariidae and Pelecanididae families were attracted to the survey vessels or were to dive near a survey vessel, there is a very low potential for vessel collision or entanglement because the vessels are moving relatively slowly (4 to 6 kn [5 to 7 mph]) and seismic gear (e.g., hydrophone streamers) is towed 1 to 3.5 m (3 to 11.5 ft) below the sea surface. There is no empirical evidence indicating that marine and coastal birds could become entangled in seismic survey gear. Given the low potential for collision or gear entanglement, the impacts are expected to result in a **nominal** direct impact to seabirds.

Shorebirds, including the Piping Plover and Red Knot, are not known to be attracted to vessels. However, these birds may fly at a lower altitude during inclement weather conditions as part of trans-GOM migrations, which may increase the potential for a vessel strike. Therefore, while impacts could occur, they are expected to be **nominal**.

The IBAs are important foraging grounds for many species of marine and coastal birds, and they often support large bird populations. Loons or similar low-flying waterfowl would be susceptible to injury from collision with a vessel. However, even if seabirds and waterfowl were attracted to survey vessels, there is a very low potential for collision or entanglement with vessels or equipment because of the vessels' slow speed and depth of gear. Given the low potential for collision or gear entanglement, impacts are not expected to result in significant mortality or serious injury to bird populations, resulting in a **nominal** direct impact to seabirds and waterfowl within the IBAs from vessel attraction.

Disturbance to Nesting or Roosting

Impacts to marine and coastal birds from disturbance of breeding colonies by airborne noise from vessels (including helicopters) and equipment may occur (Turnpenny and Nedwell, 1994). Most marine and coastal bird species nest and roost along the shore and on coastal islands. Survey vessels for nearshore non-airgun HRG projects are expected to make daily round-trips to their shore base, whereas larger seismic vessels performing airgun surveys may remain offshore for weeks or months and are likely to remain offshore for most of a survey's duration. Seismic vessels may be supported by supply vessels operating from ports along the Gulf Coast. For this analysis, two primary ports have been identified that support G&G survey activities (Port Fourchon, Louisiana, and the Port of Galveston, Texas), but 48 additional ports have been identified that can support OCS activities (Dismukes, 2011). Additionally, for conducting crew changes, helicopters will be used to support seismic survey activities. Projected levels of helicopter traffic are provided in **Table 3.3-3**.

Vessels/helicopters could cause disturbance to breeding birds, and possibly decrease nesting success if they come too close to a breeding colony. The G&G surveys would not occur close enough to land for vessel traffic to affect marine and coastal bird breeding colonies during survey activities. However, survey vessels for nearshore projects typically would make daily round-trips from a shore base to offshore work areas. Daily vessel transit presumably would occur at one of the shore bases identified, or at other established ports, which have established ingress and egress vessel traffic transiting routes within nearshore areas. Because of existing vessel traffic, marine and coastal birds are not expected to roost in adjacent areas. If they do roost near the shore base, the addition of G&G-related survey vessels would not significantly increase existing vessel traffic and potential for disruption to the roosting birds. In addition, noise generated offshore from survey vessels and equipment typically would attenuate prior to reaching the coastline and nesting habitats of coastal birds. Birds that roost or nest within hearing range of vessel routes likely have adapted and would not be stressed by the noise. Impacts of airborne vessel, helicopter, and equipment noise to nesting or roosting marine and coastal birds would be **nominal**.

Many shorebirds are ground nesters. As discussed previously, these bird species would not nest in areas disturbed by survey vessels transiting from port to offshore or coastal locations; therefore, there would be **no impact** to the nesting of these particular shorebird species.

There are four BCRs within the AOI that include coastal waters. However, G&G surveys would not occur close enough to land to affect marine and coastal bird breeding colonies during survey activities. In addition, potential daily transits for survey vessels would occur at established ports that have existing vessel traffic. The addition of G&G-related survey vessels would not significantly increase vessel traffic in these areas. Therefore, impacts of vessel and equipment noise from G&G activities to nesting or roosting marine and coastal birds in the BCRs would be **nominal**.

The area contained within the eight IBAs continues offshore into open water where G&G survey activities could occur. The IBAs include important foraging grounds for many species of marine and coastal birds; however, the coastal areas of the IBAs where nesting and roosting take place would not experience the same potential impacts from vessel traffic as offshore areas. Therefore, the impact of vessel and equipment noise to nesting or roosting marine and coastal birds within IBAs would be **nominal**. However, if a G&G survey were to take place within an IBA during offshore foraging activities, the impact from vessel and equipment noise in these sensitive areas would be of short duration and would be **minor**.

Disturbance to Feeding or Modified Prey Abundance

Marine and coastal birds have specialized feeding habitat requirements (Kushland et al., 2002). Survey vessel and equipment noise could cause pelagic bird species, including members of the families Laridae, Stercorariidae, Pelecanidae, Phaethontidae, Sulidae, Fregatidae, Hydrobatidae, and Procellariidae, to be disturbed, forcing relocation to alternative feeding areas. Alternative areas used as a result of this localized, temporary displacement and disruption of feeding may not provide food sources (prey) or habitat requirements similar to that of the original (preferred) habitat; this could result in additional energy expenditures by the birds and diminished foraging efficiency. However, if these species temporarily moved out of impacted areas, the area presumably would be limited to a very small portion of a bird's foraging range. Temporary relocation likely would not affect foraging success or result in long-term effects. Impacts to pelagic birds from disturbance associated with vessel and equipment noise would be **nominal**.

Many marine and coastal birds, as well as terrestrial birds, use the Mississippi Flyway, and many terrestrial birds migrating to the tropics take a shortcut across the GOM (**Figure 4.6-1 and**

Appendix E, Section 6). Marine and coastal birds have specialized habitat requirements for nesting and feeding, and IBAs contain these specialized habitats (Kushland et al., 2002). During their annual migrations, several marine and coastal birds have very specific coastal stopover locations for species-specific foraging to accumulate fat reserves (Brown et al., 2001; McWilliams and Karasov, 2005). Noise produced from survey vessels may result in indirect impacts to marine and coastal birds by impacting prey abundance and distribution within stopover locations. An alteration of prey abundance and distribution would result in additional energy requirements (increased foraging effort) for migrating birds. However, bird prey species likely would not be affected by survey vessels to a level that would affect foraging success. As noted previously, surveys would not take place within coastal nearshore areas or bays. If prey species exhibit avoidance of the area in which a survey is performed, it is expected to be limited to a very small portion of a bird's foraging range and for a limited time. Therefore, temporary displacement of marine and coastal bird species from a portion of preferred feeding grounds during migration and from location of non-critical activities during non-migration seasons could occur, resulting in **nominal** impacts.

4.6.2.1.3 Aircraft Traffic and Noise

Aircraft traffic and noise would result from remote-sensing (aeromagnetic) surveys and helicopter support during drilling of a COST well and shallow test wells (**Chapter 3.2.1**), and from support and service during deep-penetration seismic airgun surveys. BOEM anticipates that one aeromagnetic survey may be conducted in the AOI during the 10-year period covered by this Programmatic EIS (**Chapter 3.2.1.2**). Helicopter flights will be used to conduct crew changes for larger seismic vessels; the number of anticipated transits is provided in **Table 3.3-3** and discussed in **Chapter 3.3.1.4**.

Aeromagnetic surveys would be conducted by fixed-wing aircraft flying at speeds of approximately 135 kn (155 mph) (Reeves, 2005). Most offshore aeromagnetic surveys are flown at altitudes of 61 to 152 m (200 to 500 ft). In addition, helicopters are a potential source of aircraft noise during the drilling of COST and shallow test wells, and for crew changes during extended seismic surveys. Up to one COST well and two shallow test wells could be drilled in the planning areas during the time period of this Programmatic EIS. Potential direct impacts to marine and coastal birds from aircraft traffic include noise disturbance and collision.

Noises generated by project-related survey aircraft that are directly relevant to birds include airborne sounds from passing aircraft for birds on the sea surface and birds in flight. Helicopters and fixed-wing aircraft generate noise from their engines, airframes, and propellers. The dominant tones for both types of aircraft generally are <500 Hz (Richardson et al., 1995) and within the airborne auditory range of birds. The amount of aircraft noise entering the water depends on aircraft altitude, the aspect (direction and angle) of the aircraft relative to the receiver, and sea surface conditions. The level and frequency of sounds propagating through the water column are affected by water depth and seafloor type (Richardson et al., 1995). Because of the expected airspeed (135 kn [155 mph]), noise generated by survey aircraft is expected to be brief in duration, and birds may return to pre-disturbance behavior within 5 minutes of the overflight (Komenda-Zehnder et al., 2003); however, birds can be disturbed up to 1 km (0.6 mi) away from an aircraft (Efroymson et al., 2000).

The physical presence of low-flying aircraft can disturb marine and coastal birds, including those on the sea surface and those in flight. Behavioral responses to flying aircraft include flushing from the sea surface into flight or rapid changes in flight speed or direction. These behavioral responses can result in collision with the survey aircraft. However, Efroymson et al. (2000) reported that the potential for bird collision decreases for aircraft flying at speeds >81 kn (93 mph). In addition, the FAA recommends that aircraft fly at a minimum altitude of 610 m (2,000 ft) or more above ground over noise sensitive areas such as National Parks, NWRs, Waterfowl Production Areas, and Wilderness Areas (USDOT, FAA, 2004).

Considering the relatively low number of planned aeromagnetic surveys (1), COST wells (1), and shallow test wells (2), as well as helicopter traffic for crew change-out and the short exposure periods expected to aircraft-related noise, physical disturbance, and collisions, potential impacts from this activity likely would range from **nominal** during the non-migration season to **minor** during the migration season (because of the greater numbers and higher densities of migrants crossing the GOM).

4.6.2.1.4 Trash and Debris

Plastic is found in the surface waters of all the world's oceans and poses a potential hazard to most marine life, including seabirds, through entanglement and ingestion (Laist, 1987). Ingestion of plastic by marine and coastal birds can cause obstruction and ulceration of the gastrointestinal tract, which can result in mortality. In addition, accumulation of plastic in seabirds has been shown to be correlated with the body burden of polychlorinated biphenyls (PCBs), which can cause lowered steroid hormone levels and result in delayed ovulation and other reproductive problems (Pierce et al., 2004).

The G&G survey activities generate trash composed of paper, plastic, wood, glass, and metal that may be accidentally lost overboard. Over the last several years, companies operating offshore have developed and implemented trash and debris reduction and improved handling practices to reduce the amount of offshore trash introduced into the marine environment. These changes have resulted in a reduction of accidental loss of trash and debris. In addition, all authorizations for shipboard surveys would include guidance for marine debris awareness (NTL 2015-BSEE-G03) (**Appendix B**).

All survey vessels performing work within U.S. jurisdictional waters are required to comply with Federal regulations and implement MARPOL 73/78. Within MARPOL Annex V, "Regulations for the Control of Pollution by Garbage from Ships," as implemented by 33 CFR part 151, are regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore presumably would be minimal, as only accidental loss of trash and debris is anticipated, some of which would float on the water surface. Therefore, impacts on marine and coastal birds from trash and debris generated by survey vessels or sampling, shallow test or COST well drilling, and other G&G-related activities would be **nominal**.

4.6.2.1.5 Routine Activities Impact Conclusions

Temporary displacement of marine and coastal bird species from a portion of preferred feeding grounds during migration and from locations of non-critical activities during non-migration seasons could occur, resulting in **nominal** indirect impacts from airgun and HRG surveys. However, if airgun and HRG surveys and potential temporary displacement of species from a portion of preferred feeding areas occurred during bird species migration, then the impact would be **minor**. Impacts from vessel and equipment noise, vessel traffic, and aircraft traffic and noise are expected to be **nominal** in most circumstances; however, if spatial and temporal conditions of proposed activities coincide with biologically important areas or activities, impacts could be **minor**. Impacts from trash and debris would be **nominal**. Overall, impacts to marine and coastal birds from routine activities under Alternative A are expected to range from **nominal** to **minor**.

4.6.2.2 Impacts of an Accidental Fuel Spill

An accidental event could result in the release of diesel or other fuel by a survey vessel. The proposed action would slightly increase vessel traffic activity in the AOI and the risk of collision and a resultant fuel spill. Based on USCG spill statistics, a spill scenario was developed in **Chapter 3.3.2** that determined a diesel spill volume of 1.2 to 7.1 bbl is reasonably foreseeable. Diesel and other fuel used for operation of survey vessels is light and would float on the water surface, disperse, and weather; volatile components of the fuel would quickly evaporate. An accidental fuel spill could occur offshore or nearshore, and the marine and coastal bird species affected and the type of effect would vary depending on the location of the fuel spill (Wiese and Jones, 2001; Castège et al., 2007). If the accident occurred in nearshore waters, including the BCRs, shorebirds, waterfowl, and coastal seabirds such as members of the Laridae, Rhyncopidae, Gaviidae, Pelecanidae, Phalacrocoracidae, Fregatidae, Ardeidae, Rallidae, and Podicipedidae families, could be impacted directly or indirectly. Direct impacts would include physical oiling of individuals. The potential effects of oil spills on marine and coastal birds include tissue and organ damage from oil ingested and inhaled during feeding and grooming as well as interference with food detection, predator avoidance, homing of migratory species, disease resistance, growth rates, reproduction, and respiration. Indirect effects could include oiling of nesting and foraging habitats as well as displacement of affected birds to secondary locations.

The likelihood of a vessel collision is quite low and the potential for a resultant fuel spill even lower (**Chapter 3.3.2**). With the use of AIS on large sea-going vessels, radar, and licensing of vessel captains, the likelihood of a vessel collision is quite low, and the potential for a resultant fuel spill is even lower. Spills would more likely result during material transfer or maintenance activities. Although unlikely, a small spill (1.2 to 7.1 bbl) would result in the release of diesel or other fuel. Areal coverage of the spill would represent only a very small portion of the AOI. Therefore, an accidental fuel spill within nearshore waters would not be expected to result in significant impacts to marine and coastal birds. Direct impacts to birds from accidental fuel spills are unlikely; however, if an accident occurs, there could be indirect impacts on prey species (food supply). Impacts to shorebirds, waterfowl, and seabird species would range from **nominal** to **minor** depending on timing and location of the spill. A small spill of 1.2 to 7.1 bbl would quickly dissipate through spreading, evaporation, and weathering. It is unlikely that more than a small number of birds would come into contact with the spill regardless of season. This would not lead to population-level effects for non-listed species. Populations of listed species are already in peril, so an accidental fuel spill affecting any individuals of these species or their food supply would result in **moderate** impacts.

If a fuel spill event occurred in offshore waters, diesel and other fuel would float on the water surface for several days. Dispersal, weathering, and evaporation would rapidly reduce the amount of fuel on the sea surface. Oceanic and pelagic seabirds such as members of the Sulidae, Phaethontidae, Hydrobatidae, and Procellariidae families could be directly and indirectly affected by a spill. Direct impacts could include oiling of plumage and ingestion of oil (from preening) or displacement from important feeding or nesting habitat. Indirect impacts could include oiling of prey and prey habitats. The likelihood of a vessel collision occurring is low, and the potential for a resultant fuel spill even lower. Because of the anticipated small fuel spill size (1.2 to 7.1 bbl), the area of impact would be relatively small. Impacts to oceanic and pelagic birds from a fuel spill incident involving survey vessels within offshore waters would range from **nominal** to **minor**.

A greater presence of marine and coastal birds is expected within IBAs. If a diesel spill were to occur within or adjacent to an IBA, there would be a greater potential for impact to oceanic and pelagic birds. Impacts from accidental spill events involving survey vessels within IBAs would range from **nominal** to **minor**, depending on spill timing and location.

4.6.2.3 Cumulative Impacts

4.6.2.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.6.2.1 and 4.6.2.2** determined that activities projected to occur under Alternative A would result in **nominal** to **minor** impacts to marine and coastal birds, depending upon the IPF. The following analysis considers whether those incremental impacts, when added to or acting synergistically with other impact sources from the cumulative impacts scenario, may result in a significant impact.

Cumulative incremental impacts to coastal and marine birds from the proposed action, when taking into consideration the potential G&G surveys, impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, and the wide-ranging behavior of coastal and marine birds, would be expected to be **nominal** with no anticipated population-level impacts.

4.6.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for marine and coastal birds are compared with the IPFs from each of the cumulative scenario components on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The activities that have the potential to affect marine and coastal birds include (1) Federal and State oil and gas activities, (2) noise, (3) obstruction lighting, (4) vessel and aircraft traffic, (5) pollution, (6) habitat loss, and (7) climate change. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI.

The G&G activities have been ongoing in the GOM for at least the past 30 years, and it is reasonable to assume they will continue into the future; however, for the purpose of this Programmatic EIS, the cumulative analysis assesses a 10-year timeframe to coincide with the proposed action because it is not expected that G&G activities will have lasting effects or extend beyond the 10-year period.

Federal and State Oil and Gas Activity

Oil and gas activity that may impact coastal and marine birds include discharges and wastes, noise, platform severance with explosives (barotrauma), platform presence and lighting, and pipeline landfalls. The impacts to birds from oil- and gas-related activities are similar wherever they may occur in the GOM, and all are considered **nominal** to **minor**. Impacts from oil spills on waterbirds would be expected to be **moderate** because of the extensive overlap of their distributions with oiled areas and shorelines expected from a large oil spill (≥1,000 bbl).

In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. For more information on impacts from oil and gas activity to coastal and marine birds, refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.8 of the 2017-2022 GOM Multisale EIS.

Noise

Active Acoustic Sound Sources

The primary potential for impact to marine and coastal birds from airguns and other active acoustic non-airgun HRG (electromechanical) sources is to seabirds and waterfowl that dive below the water surface and are exposed to underwater noise (Turnpenny and Nedwell, 1994). Sound sources from the cumulative scenario are generated by commercial and recreational fishing, military activities, scientific research, and cumulative vessel activities. Noise generated under this component comes from echosounders, subbottom profilers, side-scan sonars, and naturally occurring noise from biological or physical processes. The active acoustic sound sources under the proposed action (airgun and electromechanical sound sources) are described in **Chapter 3.3.1.1**. At present, three of the Gulf Coast Sates (i.e., Alabama, Louisiana, and Texas) produce oil and gas in

State waters, with Louisiana and Texas having the highest production rates (**Table 3.4-5**). Overall, **Chapter 4.6.2.1** determined that there would be increases in ambient noise levels within specific portions of the AOI during G&G operations but **nominal** to **minor** impacts to marine and coastal birds from the proposed activities, depending on the location and timing of the activities. State waters are outside the permitting jurisdiction of BOEM; therefore, G&G activities under the proposed action will not be permitted to occur within State waters, which will reduce the cumulative impact of the proposed action.

Active acoustic sound sources, including airguns and non-airgun HRG (electromechanical) sources, projected under the proposed action are shown in **Table 3.2-1**, which provides the number of surveys and line miles for all acoustic G&G activities. Under the cumulative scenario, impacts from the proposed action would not result from direct ensonification but from G&G activity noise (airgun and electromechanical sound sources used during survey activities) in deeper waters that propagates into shallower State waters. Therefore, the proposed action would produce a **nominal** incremental increase in impacts to marine and coastal birds from active acoustic sound sources under the cumulative scenario.

Vessel and Equipment Noise

Potential direct impacts to marine and coastal birds from vessel and equipment noise are from airborne and underwater sound generated by vessels and equipment; potential indirect impacts include disturbance to feeding or modified prey abundance (Schwemmer et al., 2011). Underwater noise from vessel traffic and other anthropogenic sources within the AOI is increasing, and vessel traffic is a major contributor to ambient noise levels, particularly in the low-frequency bands. According to Southall (2005), vessel noise typically falls within the range of 100 to 200 Hz, and noise levels dissipate quickly with distance from the vessel; therefore, some vessel noise would be below the hearing range of birds (refer to **Chapter 4.6.2.1**) and should be inaudible to them.

Survey vessel and equipment noise could disturb pelagic seabird species, forcing relocation to alternative areas. Alternative areas used as a result of localized, temporary displacement and disruption of feeding may not provide food sources (prey) or habitat requirements similar to that of the original preferred habitat; this could result in additional energetic requirements of the birds due to diminished foraging efficiency.

Offshore platform decommissioning could cause noise impacts to birds under the cumulative scenario. Offshore facility decommissioning, including platform and caisson removal, typically use one of two primary methods to sever structures attached to the seafloor: mechanical severance or explosive severance (the latter results in a shockwave and release of acoustic energy). Explosive charges generally are placed inside the platform legs or conductors 4.6 to 7.6 m (15 to 25 ft) below the seafloor. Structure-removal permit applications for the GOM between 2002 and 2013 are summarized in **Table 3.4 3**.

Furthermore, marine and coastal birds have specialized habitat requirements for nesting and feeding, and IBAs contain these specialized habitats (Kushland et al., 2002). During annual migrations, several marine and coastal birds have very specific stopover locations for species-specific foraging to accumulate fat reserves (Brown et al., 2001; McWilliams and Karasov, 2005). Noise produced from survey vessels may result in indirect impacts to marine and coastal birds by directly impacting prey abundance and distribution. An alteration of prey abundance and distribution would result in additional energy expenditure (increased foraging time) for migrating birds.

Table 3.4-2 provides the number of support vessel trips anticipated under the cumulative scenario within the Oil and Gas Program . Depending on survey type, 1-6 survey vessels may be required for surveys within the proposed action. **Table 3.3-3** provides the projected number of vessels required by survey type for the proposed action. The amount of vessel and equipment noise generated by the proposed activities is very small compared with what exists under the OCS Program component. Underwater noise from vessels conducting G&G activities as part of the proposed action are expected to cause **nominal** or **minor** impacts to marine and coastal birds, depending on location and timing (season) (**Chapter 4.6.2.1**).

Overall, underwater noise from vessel traffic quickly dissipates and becomes inaudible to bird species. If feeding seabirds are temporarily displaced from preferred areas, it likely would be limited to a very small portion of a bird's foraging range and unlikely to affect foraging success. Additionally, if prey species abundance and distribution are altered by underwater noise from vessel traffic, they are unlikely to be affected at a level that would affect foraging success. If prey species exhibit avoidance of the area in which a survey is performed, it is expected to be limited to a very small portion of a bird's foraging range and for a limited time.

The proposed activity represents a short-term incremental increase in the overall level of noise generated by vessels and equipment within the AOI; therefore, the impacts associated with the proposed action would result in a **nominal** incremental increase in noise impacts to marine and coastal birds under the cumulative scenario.

Aircraft Noise

Potential direct impacts to marine and coastal birds from aircraft noise include disturbance to feeding, nesting, or roosting. Detailed information on noise generated by aircraft and its relevance to bird impacts is provided in **Chapter 4.6.2.1**. BOEM anticipates that up to one aeromagnetic survey may be conducted in the AOI during the time period covered by this Programmatic EIS. In addition, helicopters are a potential source of aircraft noise for crew changes during extended seismic surveys (**Chapter 3.3.1.4**). Up to one COST well and up to two shallow test wells would be drilled in the planning areas during the time period of this Programmatic EIS. Noise from G&G operations would be survey or activity based, occurring on a transient and intermittent basis over the period of interest. Aircraft noise from G&G activities is expected to cause a **nominal** or **minor** impact to marine and coastal birds, depending on location and timing (season) (**Chapter 4.6.2.1**).

The proposed action would cause an increase in the overall level of aircraft noise within the AOI under the Offshore Developments component of the cumulative scenario, resulting in increases in ambient noise levels within specific portions of the AOI during G&G operations. However, the incremental increase is not significant compared with the level of aircraft traffic that exists under the cumulative scenario. Therefore, it is expected that impacts associated with aircraft noise in the AOI will be **nominal**, and there would be a **nominal** incremental increase in aircraft traffic and noise impact to marine and coastal birds from the proposed action under the cumulative scenario.

Lighting

A source of cumulative impacts is obstruction lighting on platforms in State waters or on the OCS; obstruction lighting is under the jurisdiction of USCG and is not likely to be changed by mitigations to protect birds. The impact level of obstruction lighting would need further study.

Vessel and Aircraft Traffic

Potential impacts to marine and coastal birds from vessel traffic are from attraction to vessels and subsequent collision or entanglement and from disturbance to nesting, roosting, and foraging sites (Schwemmer et al., 2011). Many seabird species are attracted to offshore rigs and vessels, but shorebirds, including the Piping Plover and Red Knot, are not known to be attracted to vessels. However, shorebirds may fly at a lower altitude in response to inclement weather conditions during trans-GOM migrations, which may increase the potential for a vessel strike. Birds are attracted to vessel lighting and some species engage in ship-following. No empirical evidence exists indicating impacts to birds from seismic survey gear (e.g., airgun arrays, hydrophone streamers). Impacts from vessel traffic resulting from the proposed action are discussed in **Chapter 4.6.2.1** and range from **nominal** to **minor**, depending on location and timing (season) of the activities.

Vessel and aircraft traffic associated with the OCS Program activities will originate from selected ports in the CPA and WPA, and will cross State waters to reach fields within the OCS. This discussion of vessel traffic draws from the previous discussion on vessel noise, with respect to projected and past OCS Program vessel traffic levels and other cumulative vessel traffic levels. **Table 3.3-3** provides the number of estimated vessels required by survey type and by Program Area for the proposed action, including 19,689 trips for support vessels and 1,008 trips for survey vessels. For cumulative vessel traffic, **Table 3.4-2** provides a summary of projected support vessel operations anticipated for the Oil and Gas Program. **Tables 3.4-7 and 3.4-8** provide vessel trip data for all vessels in the GOM. Exact numbers of cumulative vessel trips associated with renewable energy and marine minerals support activities are not known, but they are expected to be relatively small and spatially and temporally limited. Other sources of vessels associated with the cumulative scenario include those associated with oil and gas activities in State waters, drilling and production activities (within State waters and OCS waters), commercial shipping, commercial and recreational fishing, military activities, scientific research, offshore construction activities, maintenance dredging of Federal channels, dredged material disposal, coastal restoration programs, and Mississippi River hydromodification and subsidence issues (**Table 3.4-1**).

The cumulative scenario for vessels could include the short-term presence of structures in the AOI (e.g., drill rigs, LNG vessels offloading cargo) and others that may be long term or permanent (e.g., platforms) to which members of these marine bird families would be attracted. **Table 3.4.2** provides a summary of oil and gas exploration and development activities in the GOM under the cumulative scenario, showing that 359 to 507 production structures are anticipated to be installed during the 10-year period analyzed in this Programmatic EIS. In contrast, during the same time period, it is anticipated that there would be the drilling of one COST well, and up to two shallow test wells may be drilled with associated short-term structures under the proposed action scenario. Overall, G&G activities would produce a **nominal** incremental increase in impact from vessel traffic to marine and coastal birds under the cumulative scenario.

The potential direct impact to marine and coastal birds from aircraft traffic is bird strikes. Helicopter traffic would result from oil and gas exploration activities on the OCS Program portion of the cumulative scenario as they often are used to transport personnel to offshore oil rigs. A summary of aircraft operations (helicopter operations) in support of oil and gas exploration and development activities is provided in **Table 3.3-3**, showing that 7,497 helicopter flights are anticipated during the 10-year period of analysis.

Aircraft traffic would result from remote-sensing surveys, including aeromagnetic surveys, and helicopter traffic supporting G&G surveys (**Chapter 3.3.1.4**). Under the proposed action, aircraft traffic would increase as a result of G&G activities (**Table 3.3-3**), but the increase relative to anticipated aircraft traffic under the cumulative scenario (**Table 3.4-2**) is small. Therefore, G&G activities would produce a **nominal** incremental increase in impact from aircraft traffic to marine and coastal birds under the cumulative scenario.

Pollution

Trash and Debris

Survey activities associated with the proposed action generate trash composed of paper, plastic, wood, glass, and metal (**Chapter 3.3.1.7**) that may be accidentally lost overboard. As discussed in **Chapter 4.6.2.1**, impacts from trash and debris on marine and coastal birds, as generated by the proposed action, would be **nominal** because all activities would be required to follow existing requirements for marine debris elimination, such as NTL 2015-BSEE-G03 and MARPOL 73/78. Despite these regulations, unknown quantities of plastics and other materials are discarded and lost in the marine environment, and so remain a threat to individual birds (Azzarello and van Vleet, 1987). The amount of trash and debris dumped offshore from G&G activities would be minimal as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. Therefore, impacts from trash and debris on marine and coastal birds, as generated by the proposed action, would result in a **nominal** incremental increase in impacts to marine and coastal birds under the cumulative scenario.

Discharges and Wastes

These activities include oil- and gas-related produced waters, drilling muds and cuttings, and air emissions. Routine discharges and wastes affecting air and water quality are under the jurisdiction of USEPA (including NPDES) or BOEM, and regulations assure that impacts on birds are **nominal** because USEPA's and BOEM's regulations protect against the unreasonable degradation of the marine environment.

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 USEPA. Also, agricultural nutrient (fertilizer) and pesticide runoff occurs. 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.

Habitat Loss

Use of navigable waters by vessels may cause erosion of banks by vessel wakes, causing wetland habitat loss. The impacts to wetlands from non-OCS oil- and gas-related vessel traffic is expected to be **moderate** to **major** (refer to Chapter 4.3.1 of the 2017-2022 GOM Multisale EIS). Because wetland habitat loss would be **moderate** to **major**, the potential impacts on birds would be **moderate** to **major** also. Wetland loss is discussed in more detail in Chapter 4.8 of the 2017-2022 GOM Multisale EIS. As discussed there, impacts on whole populations from factors other than from erosion by vessels are expected to be **nominal**.

Climate Change

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, in April 2016, the United States joined a United Nations brokered agreement to keep the global temperatures within 2 °C (36 °F) of the pre-industrial climate, and preferably below 1.5 °C (35 °F). However, this might not occur if various positive feedbacks on global warming, such as a decrease in albedo of ice and snow shift to become irreversibly uncontrollable. Impacts on birds from greenhouse gases are discussed in more detail in Chapter 4.8 of the 2017-2022 GOM Multisale EIS. Forecasted impact levels of climate change and ocean acidification from burning the hydrocarbons produced by a proposed action cannot be determined at this time. If not curtailed, climate change could possibly result in a decline in biodiversity that is vital to the ecosystems that support all bird life (McDaniel and Borton, 2002), and impacts could be as great as **major**; however, there is still a need for research on this.

4.6.2.3.3 Cumulative Impact Conclusions

Overall, activities associated with the proposed action would increase levels of vessel and aircraft noise and traffic within the AOI, resulting in sporadic increases in ambient noise levels during proposed G&G operations. Sources of noise associated with the cumulative scenario that may affect marine and coastal birds of the AOI include active acoustic sound, vessel and equipment, and aircraft. Other IPFs that may affect marine and coastal birds include the presence of vessel and aircraft traffic, trash and debris, and an accidental fuel spill. Many of these IPFs may occur simultaneously during some projected operations under the OCS Program. For example, during deep-penetration seismic, shallow-penetration seismic, and HRG survey operations, the IPFs such active acoustic sound, vessel and equipment noise, vessel traffic, and aircraft noise and traffic (during some survey activities) will occur together.

The spatial distribution of activities projected under the proposed action during the project period are most concentrated within deepwater regions of the CPA and WPA, and less concentrated within continental shelf waters (**Table 3.2-1**). Very little activity is projected to occur within the EPA. Temporally, activity levels associated with the proposed action vary by activity type and year (**Tables 3.2-1 through 3.2-5**).

When compared with past levels of activities within the GOM, proposed activities do not represent a significant incremental increase to activities under the cumulative scenario. Surveys utilizing active acoustic sound sources have occurred within the GOM for decades, including within State waters and continental shelf and deepwater regions of the OCS. Commercial, military, and recreational vessel traffic also has occurred in the GOM, including the AOI, for many years. In some cases, such as large commercial vessels, traffic is and has been more concentrated along Gulfwide shipping lanes that funnel into major coastal ports. Commercial and recreational fishing vessels have utilized broad areas of the northern GOM, but primarily on the continental shelf and shelf edge. Military vessels likely have traveled through all areas of the GOM. The projected fuel spill associated with the proposed activity is relatively small, and when compared with past spill events, the contribution of the projected spill is **nominal**.

In conclusion, activities associated with Alternative A are more concentrated within deepwater regions of the CPA and WPA and less concentrated on the continental shelf of these planning areas. In addition, projected levels of activities will vary over the 10-year project period. When compared with past, present, and future activities, including similar non-OCS Program activities (**Figure 3.4-1**), the cumulative effects of all IPFs to marine and coastal birds within the AOI over the 10-year period would result in a **nominal** incremental increase in impacts. The cumulative impacts on coastal and marine birds from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.6.2.3.2** above. The incremental contribution of the proposed action under Alternative A is expected to be **nominal** when considered in the context of cumulative impacts to coastal and marine birds. Impacts from habitat loss would be much more influential on benthic communities than Outer Continental Shelf G&G activity and would still occur without the presence of Outer Continental Shelf G&G operations.

4.6.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.6.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on marine and coastal birds.

4.6.3.1 Impacts of Routine Activities

Additional mitigation measures under Alternative B that would not change the extent, severity, or timing of G&G activities, and therefore related impacts to marine and coastal birds, include the expansion of NTL 2016-BOEM-G02 (inclusion of manatees and the NTL shall apply to all deep-penetration seismic airgun surveys in the GOM regardless of water depth) and the expanded use of PAM. As such, those mitigation measures will not be addressed in the following discussion.

4.6.3.1.1 Coastal Waters Seasonal Restrictions

Alternative B would include a seasonal restriction from (a) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath) and (b) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the UME in the northern GOM (**Figure 2.2-1 and Chapter 2.4.3**). No airgun surveys would be authorized within the closure area during this time.

The additional seasonal restriction for Federal coastal waters under Alternative B would change the timing of seismic airgun surveys in certain areas. As discussed in **Chapter 4.6.2.1**, impacts of active acoustic sound sources on marine and coastal birds are expected to be **nominal** to **minor**, depending on location. A change in survey timing in the additional closure area would temporarily alter the impacts of active acoustic noise from seismic airgun surveys on marine and coastal birds; however, a change in the timing of airgun surveys would not reduce the overall impact of active acoustic sound sources, and impacts are still expected to range from **nominal** to **minor** because the additional closure is probably not of sufficient length to significantly reduce impact levels.

Under Alternative B, the additional seasonal restriction for Federal coastal waters would limit vessel traffic and associated vessel and equipment noise from seismic airgun surveys in the coastal areas during certain times of the year compared with Alternative A. As discussed in **Chapter 4.6.2.1**, impacts of vessel traffic and noise on marine and coastal birds are expected to be **nominal** to **minor**, depending on location. A change in survey timing in the closure area could limit exposure to vessel traffic and noise from seismic airgun surveys on some groups of marine and coastal birds (e.g., shorebirds). However, the impacts to marine and coastal birds from vessel traffic and noise still would be expected to be **nominal** to **minor** because the additional closure is probably not of sufficient length to significantly reduce impact levels.

The additional seasonal restriction for coastal areas under Alternative B would not affect the potential for one aeromagnetic survey to occur or for the drilling of two shallow test wells and a

COST well to occur. Therefore, the impacts from aircraft traffic and noise would remain unchanged (**nominal** to **minor**) for the additional coastal seasonal restriction under Alternative B.

Under Alternative B, none of the additional mitigation measures would affect the potential impacts to marine and coastal birds from trash and debris. Through required compliance with USCG and USEPA regulations as well as BSEE guidance, impacts of trash and debris to marine and coastal birds are expected to be **nominal**.

4.6.3.1.2 Minimum Separation Distances

Alternative B would establish a 40-km (25-mi) separation distance between simultaneously operating deep-penetration seismic airgun surveys within the Areas of Concern (**Chapter 2.4.2**) to limit ensonification of specific areas of the AOI at the same time. When outside the Areas of Concern, the separation distance will be 30 km (19 mi). However, the separation distance requirement does not apply to multiple ships operating in a coordinated survey such as a WAZ survey, and it need not be maintained if unsafe or due to weather conditions.

Limits on concurrent seismic airgun surveys under Alternative B could change the timing of these surveys in certain areas and limit the ensonification of specific areas from multiple airgun surveys, but they would not alter the extent of survey types or the aerial coverage of surveys in the AOI. The locations that benefit from the limit on ensonification cannot be predicted in advance and would depend on the schedule, planned coverage of individual surveys, and ports to be used for support activities. As discussed in **Chapter 4.6.2.1**, impacts of active acoustic sound sources, vessel traffic, and vessel and equipment noise on marine and coastal birds are expected to range from **nominal** to **minor**, depending on location, time of year (migratory seasons), and bird species. A change in survey timing because of limits on concurrent seismic airgun surveys would not alter the overall impacts from active acoustic sound, vessel traffic, vessel and equipment noise, or aircraft traffic and noise on marine and coastal birds; however, limiting the ensonification of areas from multiple airgun surveys would reduce active acoustic sound source impacts from airguns, which make up the bulk of the survey line miles in the proposed action. However, listed species could still be impacted, resulting in no substantial change from the impact levels estimated for Alternative A (**nominal** to **minor**). As discussed in **Chapter 4.6.2.1**, impacts of trash and debris on marine and coastal birds are expected to be **nominal** through required compliance with USCG and USEPA regulations as well as BSEE guidance, and impacts would be largely unchanged by limits on concurrent seismic airgun surveys.

4.6.3.1.3 Seismic Restrictions in the Areas of Concern within the EPA

Additional restrictions under Alternative B include the prohibition of deep-penetration seismic airgun surveys in the portion of the Areas of Concern (**Chapter 2.4.2**) within the EPA. This restriction does not apply to surveys related to currently leased blocks, any portion of the area encompassed by EPA Lease Sale 226, or OCS lease blocks adjacent to permitted survey areas but within an otherwise off-limit area.

A restriction on deep-penetration seismic airgun surveys within portions of the AOI would change the location and timing of airgun surveys in certain areas; however, the seasonal coastal restriction is unlikely to affect the level of survey effort because operators would likely survey outside these areas during the closed seasons. As discussed in **Chapter 4.6.2.1**, impacts of active acoustic sound sources on marine and coastal birds are expected to be **nominal** to **minor**, depending on location. A restriction on seismic surveys within portions of the AOI would reduce impacts from active acoustic sound sources within specific areas of the EPA and for 2 months within Federal coastal waters, but it would not alter the impacts of other active acoustic sound sources from other equipment types in those areas. While restrictions on airgun surveys would reduce impacts in those specific areas, overall impacts from active acoustic sound sources would remain unchanged from Alternative A because listed species, IBAs, and prey abundance could still be impacted, as described in **Chapter 4.6.2.1**. Therefore, impacts of active acoustic sound sources on marine and coastal birds are expected to remain **nominal** to **minor** under Alternative B.

Under Alternative B, a restriction of seismic airgun surveys within portions of the EPA and in Federal coastal waters would limit vessel traffic and noise, including equipment noise, from these surveys. Implementation of a minimum separation distance within the Areas of Concern would limit airgun sound in these areas compared with Alternative A. As discussed in **Chapter 4.6.2.1**, impacts of vessel traffic and noise on marine and coastal birds are expected to be **nominal** to **minor**, depending on location. Restricting seismic activity within Federal coastal waters for 2 months and within portions of the EPA under Alternative B could result in a localized restriction of vessel traffic and noise for some groups of marine and coastal birds (e.g., shorebirds); however, overall impacts from vessel traffic and noise would be expected to remain **nominal** to **minor** because the restriction of vessel traffic and noise would be localized and temporary within coastal waters.

The restriction of seismic surveys within Federal coastal waters and portions of the EPA under Alternative B would not affect the potential for one aeromagnetic survey to occur or for the drilling of two shallow test wells and a COST well to occur, and it would not limit the need for helicopter crew transfers. Therefore, impacts from aircraft traffic and noise would remain unchanged (**nominal** to **minor**) for the additional airgun survey restrictions under Alternative B.

Impacts of trash and debris to marine and coastal birds are expected to be **nominal** through required compliance with USCG and USEPA regulations as well as BSEE guidance; therefore, impacts would be unchanged under Alternative B.

4.6.3.1.4 Routine Activities Impact Conclusions

Temporary displacement of marine and coastal bird species from a portion of preferred feeding grounds during migration and from locations of non-critical activities during non-migration seasons could occur, resulting in **nominal** indirect impacts from airgun and HRG surveys. However, if airgun and HRG surveys and potential temporary displacement of species from a portion of preferred feeding areas occurred during bird species migration, then the impact would be **minor**. Impacts from vessel and equipment noise, vessel traffic, and aircraft traffic and noise are expected to be **nominal** in most circumstances, but if spatial and temporal conditions of proposed activities coincide with biologically important areas or activities, impacts could be **minor**. Impacts from trash and debris would be **nominal**. Overall, impacts to marine and coastal birds from routine activities under Alternative B are expected to range from **nominal** to **minor**.

4.6.3.1.5 Impacts of an Accidental Fuel Spill

Under Alternative B, impacts of an accidental fuel spill on marine and coastal birds would be very similar to those analyzed in **Chapter 4.6.2.2** for Alternative A. The analysis concluded that impacts to shorebirds, waterfowl, and seabird species would range from **nominal** to **minor** depending on timing and location. Populations of listed species are already in peril; therefore, an accidental fuel spill that affected any of these species or their food supply would cause **moderate** impacts. Alternative B would change the timing of certain surveys because of a seasonal restriction and limits on concurrent seismic airgun surveys. Additionally, certain surveys will not be conducted within portions of the EPA. However, fuel spills from seismic survey vessels could occur in the closure areas during times outside of the closure period. Also, fuel spills from other survey vessels could occur during the closure period or in the EPA depending on the frequency of the HRG sound source used. A change in survey timing or type because of limits on concurrent seismic airgun surveys or on survey type would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential impacts on marine and coastal birds would be the same as under Alternative A (**nominal** to **moderate**), depending on the spill location and whether listed bird species within the AOI are affected by the spill.

4.6.3.2 Cumulative Impacts

4.6.3.2.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.6.3.1 and 4.6.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** to **moderate** impacts to marine and coastal birds, depending on the IPF. Mitigation measures for the proposed action under Alternative B are described in **Chapter 2.4** and summarized in **Chapter 4.6.3.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3**). Mitigation measures under Alternative B would not appreciably change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to marine and coastal birds would not change.

4.6.3.2.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.6.2.3.2**) would remain the same under Alternative B.

4.6.3.2.3 Cumulative Impact Conclusions

Cumulative incremental impacts to marine and coastal birds from the proposed action, when taking into consideration G&G survey activities, OCS oil- and gas-related activities that are not associated with G&G survey activities, the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, and the wide-ranging behavior of marine and coastal birds, would be expected to be **nominal** to **minor** with no anticipated population-level impacts. The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A (**Chapter 4.6.2**) and would remain under Alternative B.

4.6.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.6.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative C on marine and coastal birds.

4.6.4.1 Impacts of Routine Activities

Additional mitigation measures under Alternative C that would not change the extent, severity, or timing of G&G activities, and therefore related impacts to marine and coastal birds, include the expanded use of PAM for seismic airgun surveys, the expanded use of PSOs for seismic airgun surveys and HRG surveys, expansion of NTL 2016-BOEM-G02 (inclusion of manatees) for seismic airgun surveys, a pre-survey clearance period for HRG surveys, and expansion of NTL 2016-BOEM-G02 to include HRG surveys using airguns. As such, those mitigation measures will not be addressed in the following discussion.

4.6.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

Alternative C would include a seasonal restriction in all Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31. No airgun surveys would be authorized within the closure area during this time.

As discussed in **Chapter 4.6.2**, applicable routine IPFs for marine and coastal birds are active acoustic sound sources, vessel traffic and associated vessel and equipment noise, aircraft traffic and noise, and trash and debris. **Chapter 4.6.2.1** states that impacts of active acoustic sound sources on marine and coastal birds are expected to range from **nominal** to **minor**, depending on location, timing, and species impacted.

Restricting seismic airgun surveys in Federal and State coastal waters of the GOM from February 1 through May 31 would result in limited impacts from acoustic sound sources, vessel traffic, and associated vessel noise within the seasonal restriction area for a period of 4 months. This restriction would limit impacts to bird species migrating in the spring; however, the seasonal restriction would only alter the timing of surveys in the closure area. A change in the timing of seismic airgun surveys could limit impacts on some groups of marine and coastal birds (e.g., shorebirds) for a period of time, but it would not alter the overall impacts of active acoustic noise, vessel traffic, and the associated vessel noise from G&G surveys on marine and coastal birds. Therefore, impacts of active acoustic sound sources on marine and coastal birds under Alternative C are expected to remain **nominal** to **minor**, depending on location, timing, and bird species.

The additional seasonal restriction for coastal areas under Alternative C would not affect the potential for one aeromagnetic survey to occur or for the drilling of two shallow test wells and a COST well to occur. Therefore, impacts from aircraft traffic and noise would remain unchanged (**nominal** to **minor**) for the additional coastal seasonal restriction under Alternative C.

Impacts of trash and debris to marine and coastal birds are expected to be **nominal** through required compliance with USCG and USEPA regulations as well as BSEE guidance; therefore, impacts would be unchanged under Alternative C.

4.6.4.1.2 Routine Activities Impact Conclusions

Temporary displacement of marine and coastal bird species from a portion of preferred feeding grounds during migration and from locations of non-critical activities during non-migration seasons could occur, resulting in **nominal** indirect impacts from airgun and HRG surveys. However, if airgun and HRG surveys and potential temporary displacement of species from a portion of preferred feeding areas occurred during bird species migration, then the impact would be **minor**. Impacts from vessel and equipment noise, vessel traffic, and aircraft traffic and noise are expected to be **nominal** in most circumstances, but if spatial and temporal conditions of proposed activities coincide with biologically important areas or activities, impacts could be **minor**. Impacts from trash and debris would be **nominal**. Overall, impacts to marine and coastal birds from routine activities under Alternative C are expected to range from **nominal** to **minor**.

4.6.4.2 Impacts of an Accidental Fuel Spill

Under Alternative C, impacts of an accidental fuel spill on marine and coastal birds would be very similar to those analyzed in **Chapter 4.6.2.2** for Alternative A. The analysis concluded that impacts to shorebirds, waterfowl, and seabird species would range from **nominal** to **minor**, depending on timing and location. The populations of listed species are already in peril, so an accidental fuel spill that affected any of these species or their food supply would cause **moderate** impacts. Alternative C would change the timing of seismic surveys because they would be restricted in coastal waters for 4 months. The change in timing of the seismic surveys would slightly limit the likelihood of an accidental fuel spill during the closure period. However, fuel spills from seismic survey vessels could occur in the closure areas during times outside the closure period (February 1 through May 31), and fuel spills from other survey vessels could occur within the closure area during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential impacts on marine and coastal birds would be the same as under Alternative A and would range from **nominal** to **moderate**, depending on the spill location and whether listed bird species within the AOI are affected by the spill.

4.6.4.3 Cumulative Impacts

4.6.4.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.6.4.1 and 4.6.4.2** concluded that activities projected to occur under Alternative C would result in **nominal** to **moderate** impacts to marine and coastal birds, depending on the IPF. Mitigation measures for the proposed action under Alternative C are described in **Chapter 2.5** and summarized in **Chapter 4.6.4.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3**). Most mitigation measures under Alternative C would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to marine and coastal birds would not change.

4.6.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.6.2.3.2**) would remain the same under Alternative C.

4.6.4.3.3 Cumulative Impact Conclusions

The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A. The cumulative scenario would remain unchanged for Alternative C, and the associated impacts would remain the same. Alternative C would change the timing of seismic airgun surveys in certain areas and decrease impacts to marine and coastal birds during the closure; however, the coastal seasonal restriction would not appreciably change the cumulative impacts noted under Alternative A. While a coastal seasonal restriction is effective in decreasing impacts during the restriction period, it will not result in a substantial change in the overall activities, and any resultant incremental increase in impacts would remain **nominal**. Cumulative incremental impacts to marine and coastal birds from the proposed action, when taking into consideration G&G survey activities, OCS oil- and gas-related activities that are not associated with G&G survey activities, the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, and the wide-ranging behavior of marine and coastal birds, would be expected to be **nominal** to **minor** with no anticipated population-level impacts. The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A (**Chapter 4.6.2**) would remain under Alternative C.

4.6.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.6.2**). The additional mitigation measure (shutdowns for marine mammals) under Alternative D would not reduce potential active acoustic impacts discussed under Alternatives A and C (**Chapters 4.6.2.1 and 4.6.4.1**). Impacts would remain **nominal** from airgun and HRG surveys and **minor** if airgun and HRG surveys occurred during species migration. This mitigation would not alter the impact levels to marine and coastal birds from vessel and equipment noise, aircraft traffic and noise, or trash and debris, and impacts would remain **nominal** to **minor**. Under Alternative D, impacts of an accidental fuel spill on marine and coastal birds would be as described for Alternatives A and C (**Chapters 4.6.2.2 and 4.6.4.2**) and would remain **nominal** to **moderate**.

4.6.5.1 Impacts of Routine Activities

Mitigation measures under Alternative D include all measures provided under Alternatives A and C with the addition of shutdown protocols for all marine mammals except bow-riding dolphins during seismic surveys. Therefore, as discussed under Alternatives A and C (**Chapters 4.6.2.1 and 4.6.4.1**), the mitigation measures provided under Alternative D, except for the seasonal restriction for the operation of airguns in coastal waters, would not change the extent or severity of G&G activities and, consequently, the associated impacts to marine and coastal birds. As such, those mitigation measures will not be addressed in the following discussion.

As discussed in **Chapter 4.6.2**, applicable routine IPFs for marine and coastal birds are active acoustic sound sources, vessel traffic and associated vessel and equipment noise, aircraft traffic and noise, and trash and debris. As discussed in **Chapter 4.6.2.1**, impacts of active acoustic sound sources on marine and coastal birds are expected to be **nominal** to **minor**, depending on location, timing, and bird species. As discussed in **Chapter 4.6.2.1**, impacts of vessel traffic and vessel and equipment noise on marine and coastal birds are expected to be **nominal** to **minor**, depending on location. Impacts from aircraft traffic and noise would remain unchanged (**nominal** to **minor**) for the additional coastal seasonal restriction under Alternative D. Impacts of trash and debris to marine and coastal birds are expected to be **nominal** through required compliance with USCG and USEPA regulations as well as BSEE guidance; therefore, impacts would be unchanged under Alternative D. Overall, impacts to marine and coastal birds from routine activities under Alternative D are expected to range from **nominal** to **minor**.

4.6.5.2 Impacts of an Accidental Fuel Spill

Under Alternative D, impacts of an accidental fuel spill on marine and coastal birds would be very similar to those analyzed in **Chapter 4.6.2.2** for Alternative A. The analysis concluded that impacts to shorebirds, waterfowl, and seabird species would range from **nominal** to **minor**, depending on timing and location. Populations of listed species are already in peril; therefore, an accidental fuel spill that affected any of these species or their food supply would cause **moderate** impacts.

Alternative D would change the timing of certain surveys because of the coastal seasonal restriction. However, fuel spills from seismic survey vessels could occur in the closure area during times outside the closure period. Also, fuel spills from other survey vessels could occur within the closure area during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential impacts on marine and coastal birds would be the same as under Alternative A (**nominal** to **moderate**), depending on the spill location and whether listed bird species within the AOI are affected by the spill.

4.6.5.3 Cumulative Impacts

4.6.5.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.6.5.1 and 4.6.5.2** concluded that activities projected to occur under Alternative D would result in **nominal** to **moderate** impacts to marine and coastal birds, depending on the IPF.

Mitigation measures for the proposed action under Alternative D are described in **Chapter 2.6** and summarized in **Chapter 4.6.5.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3**). The mitigation measures are the same as described for Alternative C, with the addition of shutdown protocols during seismic operations for all marine mammals except bow-riding dolphins. The addition of shutdown protocols for all marine mammals except bow-riding dolphins under Alternative D would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to marine and coastal birds would not change.

4.6.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.6.2.3.2**) would remain the same under Alternative D.

4.6.5.3.3 Cumulative Impact Conclusions

Cumulative incremental impacts to marine and coastal birds from the proposed action, when taking into consideration G&G survey activities, OCS oil- and gas- related activities that are not associated with G&G survey activities, the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, and the wide-ranging behavior of marine and coastal birds, would be expected to be **nominal** to **minor** with no anticipated population-level impacts. The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A (**Chapter 4.6.2**) and would remain the same under Alternative D.

4.6.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.6.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative E on marine and coastal birds.

4.6.6.1 Impacts of Routine Activities

The reduction of deep-penetration, multi-client activities by 10 percent or 25 percent under Alternatives E1 and E2, respectively, would limit the extent and severity of airgun sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, and trash and debris associated with these surveys; therefore, impacts for these IPFs would be incrementally limited under Alternatives E1 and E2.

4.6.6.1.1 Reduced Level of Activity

Active acoustic sound sources associated with deep-penetration, multi-client (airgun) activities under Alternative E would be limited by 10 percent and 25 percent for Alternatives E1 and E2, respectively, thereby limiting the potential for associated impacts to marine and coastal birds. Deep-penetration, multi-client seismic surveys, such as 2D, 3D, WAZ, and 4D surveys, make up the majority of G&G survey activity in the proposed action (**Table 3.2-1**).

As presented in **Chapter 4.6.2.1**, impacts to marine and coastal birds from Alternative A from active acoustic sound sources are expected to be **nominal** or **minor**, depending on the location of the survey and the equipment being used.

Active acoustic sound sources under Alternatives E1 and E2 include limited deep-penetration, multi-client surveys based on a 10 percent or 25 percent reduction in line miles. Because seabirds and waterfowl only rest on the water surface or make shallow dives for short durations, the rate at which they are exposed to active acoustic sounds generated from deep-penetration, multi-client (airgun) surveys would be limited; therefore, impacts from airguns would be limited to **nominal** for these birds. Because electromechanical sources from HRG surveys are not changed in this alternative, impacts would remain as described under Alternative A (**nominal** to **minor**).

Even at limited levels under Alternatives E1 and E2, BCRs, IBAs, and NWRs may be indirectly impacted through temporary prey displacement, resulting in temporary displacement of marine and coastal bird species from important feeding areas. The limitation of activity under Alternatives E1 and E2 would not significantly change the likelihood of marine and coastal bird species being temporarily displaced; in considering impact-level criteria, impacts from airguns under Alternatives E1 and E2 would remain **nominal** to **minor**.

Similar to Alternative A, the primary potential impacts to marine and coastal birds from vessel traffic and noise are from underwater vessel and equipment noise, attraction to vessels and subsequent collision or entanglement, disturbance to nesting or roosting, and disturbance to feeding or modified prey abundance. Under Alternatives E1 and E2, a reduction in survey line miles would reduce vessel traffic and noise, resulting in a reduction in overall impacts; however, considering impact-level criteria, impacts from vessel traffic and vessel and equipment noise under Alternatives E1 and E2 would remain **nominal** to **minor**.

Helicopters will be used to support deep-penetration, multi-client activities by transporting crew to and from vessels. A 10 percent (Alternative E1) or 25 percent (Alternative E2) reduction in deep-penetration, multi-client activities (compared with Alternative A) would limit the number of flights required to support these surveys. However, because the timing of the reduction is not known, potential impacts from this activity would range from **nominal** during the non-migration season to **minor** during the migration season (because of the greater numbers and higher densities of migrants crossing the GOM).

Impacts of trash and debris to marine and coastal birds are expected to be **nominal** through required compliance with USCG and USEPA regulations as well as BSEE guidance; therefore, impacts would be unchanged under Alternative E.

4.6.6.1.2 Routine Activities Impact Conclusions

Airguns are the most deeply penetrating and loudest (and hence most dangerous) active acoustic sound sources and are the only ones relatively reduced by Alternative E. Impacts from airguns would be reduced to **nominal** due to the limitation of activity; electromechanical sources from HRG surveys are not reduced in this alternative, so impacts would remain as described Alternative A (**nominal** to **minor**). Impacts from other IPFs, including vessel and equipment noise, vessel traffic, aircraft traffic and noise, and trash and debris, would remain unchanged (**nominal** to **minor**). Overall, impacts to marine and coastal birds from routine activities under Alternative E are expected to range from **nominal** to **minor**.

4.6.6.2 Impacts of an Accidental Fuel Spill

Under Alternative E, impacts of an accidental fuel spill on marine and coastal birds would be very similar to those analyzed for Alternatives A and C (**Chapters 4.6.2.2 and 4.6.4.2**). The analysis concluded that impacts to common species would range from **nominal** to **minor**, depending on timing and location. An accidental fuel spill that affected any listed species or their food supply would cause **moderate** impacts.

Alternative E would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential impacts on marine and coastal birds would be the same and would range from **nominal** to **moderate** for Alternatives E1 and E2, depending on the spill location and whether listed bird species within the AOI are affected by the spill.

4.6.6.3 Cumulative Impacts

4.6.6.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.6.6.1 and 4.6.6.2** concluded that activities projected to occur under Alternative E would result in **nominal** to **moderate** impacts to marine and coastal birds, depending on the IPF. Mitigation measures for the proposed action under Alternative E are described in **Chapter 2.7** and summarized in **Chapter 4.6.6.1**. The reduction of deep-penetration, multi-client activities (in line miles) by 10 percent (Alternative E1) or 25 percent

(Alternative E2) would reduce the extent, severity, and timing of active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, and trash and debris; therefore, impacts for these IPFs would be incrementally decreased under Alternative E.

4.6.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.6.2.3.2**) would remain the same under Alternative E.

4.6.6.3.3 Cumulative Impact Conclusions

Cumulative incremental impacts to marine and coastal birds from the proposed action, when taking into consideration G&G survey activities, OCS oil- and gas-related activities that are not associated with G&G survey activities, the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, and the wide-ranging behavior of marine and coastal birds, would be expected to be **nominal** to **minor** with no anticipated population-level impacts. The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A (**Chapter 4.6.2**) and would remain the same under Alternatives E1 and E2.

4.6.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.6.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative F on marine and coastal birds.

4.6.7.1 Impacts of Routine Activities

The additional mitigation measures under Alternative F would not change the extent or severity of IPFs analyzed; consequently, the impacts to marine and coastal birds would be unchanged under Alternative F compared with Alternative C, ranging from **nominal** to **minor**.

Alternative F would require area closures in the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area for seismic airgun survey operations. Impacts from active acoustic sound sources, vessel and equipment noise, vessel traffic, and aircraft traffic and noise on marine and coastal birds are expected to range from **nominal** to **minor** (**Chapter 4.6.4.1**). Impacts from trash and debris to marine and coastal birds are expected to be **nominal**, as in Alternative A. The additional closure of four areas would limit or eliminate impacts from the relevant IPFs on marine and coastal birds as these surveys would not occur within the designated areas; however, the overall level of G&G activity within the AOI would remain unchanged and any limitation or elimination of impacts would be localized. None of the additional closure areas are of any specific importance to marine and coastal birds; therefore, the impacts to marine and coastal birds under Alternative F would be expected to remain **nominal** to **minor**, based on location, timing, and bird species. Overall, impacts to marine and coastal birds from routine activities under Alternative F are expected to range from **nominal** to **minor**.

4.6.7.2 Impacts of an Accidental Fuel Spill

Under Alternative F, impacts of an accidental fuel spill would be very similar to those analyzed in **Chapter 4.6.4.2** for Alternative C. The analysis concluded that impacts to common shorebirds, waterfowl, and seabirds would range from **nominal** to **minor**. An accidental fuel spill affecting listed species or their food supply would cause **moderate** impacts.

The risk of an accidental spill related to G&G activities would be lessened within the closure areas because seismic airgun operations would be prohibited; however, vessels could still use the area for transit, so the risk of an accidental spill still would exist. Additionally, the overall extent of survey activity within the GOM would not be reduced under Alternative F, and the overall risk of an accidental spill, although low, would remain despite certain areas being closed because spills from seismic survey vessels could occur outside the closure areas and still impact the closure areas from transit of spilled fuel. Also, spills from other vessels could occur within the closure areas. Therefore, Alternative F would not substantially change the risk of a small fuel spill or the risk of impacts from a spill. Overall, the risk of an accidental fuel spill and the potential impacts on marine and coastal birds would be the same as under Alternative C and would range from **nominal** to **moderate**, depending on the spill location and whether listed bird species within the AOI are affected by the spill.

4.6.7.3 Cumulative Impacts

4.6.7.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.6.7.1 and 4.6.7.2** concluded that activities projected to occur under Alternative F would result in **nominal** to **moderate** impacts to marine and coastal birds, depending on the IPF.

Mitigation measures for the proposed action under Alternative F are described in **Chapter 2.8** and summarized in **Chapter 4.6.7.1**. Mitigation measures under Alternative F are similar to Alternative C with the addition of closures in four areas: CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area.

4.6.7.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.6.2.3.2**) would remain the same under Alternative F.

4.6.7.3.3 Cumulative Impact Conclusions

The cumulative scenario would remain unchanged for Alternative F, and the associated impacts would remain the same. Alternative F would change the timing of seismic airgun surveys in certain areas and would restrict airgun surveys from four areas within the AOI; however, the coastal seasonal restriction area and the area closures and restrictions would not appreciably change the cumulative impacts noted under Alternative A. While the area closures are effective in decreasing impacts, they, or the addition of the restriction of airgun surveys in areas farther offshore, will not result in a decrease in the overall activities, and the resultant impacts for the proposed action to the cumulative scenario and the incremental increase in impacts would be **nominal**. Cumulative incremental impacts to marine and coastal birds from the proposed action, when taking into consideration G&G survey activities, OCS oil- and gas-related activities that are not associated with G&G survey activities, the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, and the wide-ranging behavior of marine and coastal birds, would be expected to be **nominal** to **minor** with no anticipated population-level impacts. The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A (**Chapter 4.6.2**) and would remain under Alternative F.

4.6.8 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.6.2**).

Under Alternative G, BOEM would cease issuing permits/authorizations for new G&G surveys and would not approve G&G surveys proposed under exploration or development plans. However, G&G activities previously authorized under an existing permit/authorization or lease would proceed. Active acoustic sounds would persist in the near term and at greatly reduced impact levels commensurate with the reduction in survey effort (**Table 2.9-1**). Impacts to marine and coastal birds from vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and an accidental fuel spill generated from G&G activities would be **nominal** under Alternative G and would eventually be reduced to **no impact**. Overall, impacts to marine and coastal birds from activities under Alternative G are expected to be **nominal**.

Under Alternative G, impacts of an accidental fuel spill on marine and coastal birds would be very similar to those analyzed for Alternative A (**Chapter 4.6.2.2**). The analysis concluded that impacts to shorebirds, waterfowl, and seabird species would range from **nominal** to **minor**, depending on timing and location. Populations of listed species are already in peril; therefore, an accidental fuel spill that affected any of these species or their food supply would cause **moderate** impacts.

Alternative G would not have the involvement of the quantity of vessels, but the risk remains that an accidental spill could occur. Therefore, impacts under Alternative G would range from **nominal** to **moderate**, depending on the spill location and whether listed bird species within the AOI are affected by the spill.

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.6.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.6.2.3.2**) would remain the same under Alternative G. The cessation of activity for future G&G surveys requiring a permit/authorization from BOEM would substantially decrease the cumulative impacts from all IPFs. However, VSP and SWD surveys are expected to continue under Alternative G. Therefore, following cessation of the majority of activities, there would be a **nominal** incremental increase in impacts from active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and an accidental fuel spill.

4.6.9 Summary Conclusion

In summary, the IPFs that may impact marine and coastal birds within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; and side-scan sonars), (2) vessel and equipment noise, (3) vessel traffic (i.e., physical disturbance to and risk of collisions), (4) aircraft traffic and noise (e.g., helicopters, fixed-wing aircraft), (5) trash and debris (i.e., ingestion of and entanglement in), and (6) accidental fuel spill.

Impacts to marine and coastal birds are assessed as **nominal** to **minor** for active acoustic sound sources, vessel and equipment noise, vessel traffic, and aircraft traffic and noise for Alternatives A through D and Alternative F. Due to the reduced level of proposed activities under Alternative E, the impact level for seismic airgun surveys is expected to be **nominal**. Due to the minimal level of proposed deep-penetration seismic airgun surveys and eventual phasing out of survey activities under Alternative G, the impact level is **nominal**, declining to **no impact**. Impacts from an accidental fuel spill are **nominal** under most circumstances but may increase to **minor** based on timing and location and could increase to **moderate** if a listed species or their prey are directly impacted across all alternatives. Impacts under Alternative G would be reduced to **nominal**, eventually declining to **no impact**.

4.7 MARINE PROTECTED AREAS

4.7.1 Description of the Affected Environment

An MPA is defined by Executive Order 13158 as “any area of the marine environment that has been reserved by Federal, State, territorial, Tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.” In practice, MPAs are defined areas where natural and/or cultural resources are given greater protection than the surrounding waters. In the U.S., MPAs span a range of habitats, including the open ocean, coral reefs, deepwater habitats, coastal areas, intertidal zones, estuaries, and the Great Lakes, and they can include freshwater or terrestrial areas. A National System of MPAs was established in 2009 as a nationwide program for the effective stewardship, conservation, restoration, sustainable use, understanding, and appreciation of marine resources. The National System currently includes 437 Federal, State, and territorial MPAs covering an area of 494,765 km^2 (191,030 mi^2) according to NOAA's National Marine Protected Areas Center website (USDOC, NOAA, NMPAC, 2013). For the purpose of this analysis, National System MPAs are presented; however, it is recognized in **Chapter 4.5** that additional areas are afforded protection by other management systems (e.g., GMFMC) (Simmons et al., 2014), and specific management areas (e.g., banks, topographic features) may be included within boundaries of existing National System MPAs.

There are 94 National System offshore MPAs within the AOI; these are listed in **Table 4.7-1** and their locations are shown in **Figures 4.7 1 and 4.7-2**. They are additionally described in **Appendix E, Section 7**. **Table 4.7-1** contains sites that currently are members of the National System of MPAs, as well as sites listed and eligible for inclusion as part of the National System. The information was obtained from the MPAs Inventory located on NOAA's National Marine Protected Areas Center website. All sites listed are afforded some degree of protection based on their associated management plans.

The following chapter is summarized by the different groupings of MPAs as provided in **Appendix E, Section 7**. For the affected environment, a summary for each grouping is provided, and the summary entails the typical marine or coastal habitats and noted fauna present within that grouping of MPAs, as opposed to addressing each MPA individually. As noted, more specific details about each MPA is provided in **Appendix E**, including what portion of the MPA falls within the AOI.

Although an MPA has been established for a specific intent concerning preservation of particular fauna/flora (e.g., seasonal closure of a particular fishing gear to relieve pressure on fish stocks within a reserve), other fauna/flora are present in these areas although not highlighted in this chapter on MPAs. Such fauna are addressed in other chapters of this Programmatic EIS. In the interest of brevity, this Programmatic EIS does not re-list all of the potential faunal groupings that could be and are likely present because these are addressed in their respective chapters.

4.7.1.1 Offshore Marine Protected Areas

Offshore MPAs within the AOI include NMSs, deepwater MPAs, and other fishery management areas (**Figure 4.7-1; Table 4.7-1**).

National Marine Sanctuaries

Two NMSs are located within the AOI: Florida Keys National Marine Sanctuary (FKNMS) and FGBNMS, the latter of which is located in the northwestern GOM. These regions contain important habitats and fauna, and are administered by NOAA's National Office of Marine Sanctuaries (ONMS).

The FKNMS, which is not located within any of BOEM's planning areas, supports 6,000 species of marine life and contains the world's third largest barrier reef, extensive seagrass meadows, and mangrove-fringed islands. A variety of plants, invertebrates, fishes, reptiles, birds, and mammals that use or contribute to sanctuary resources in the FKNMS are protected at the Federal or State level. Each of these species is a valuable natural resource that contributes to the ecological balance of the NMS. Animal species at risk depend on the sanctuary's diverse habitats, including mangroves, beaches (below high water mark), seagrass beds, and coral reefs. State and federally listed threatened and endangered marine and aquatic fauna include elkhorn coral, staghorn coral, pillar coral, all five species of sea turtles found in the western Atlantic (i.e., loggerhead, green, hawksbill, Kemp's ridley, and leatherback sea turtles), American alligator (*Alligator mississippiensis*), American crocodile (*Crocodylus acutus*), smalltooth sawfish, Roseate Tern, Least Tern, and West Indian manatee. The FKNMS is also in the migratory range of three species of whales: humpback whale, fin whale, and North Atlantic right whale. The sanctuary also protects elements of history such as shipwrecks and other archaeological treasures, including approximately 669 historic artificial reefs that have been documented to date. As of January 2016, 14 shipwrecks and 2 lighthouses within the FKNMS are listed on the National Register of Historic Places.

The FGBNMS is located in the northwestern GOM and consists of three distinct areas: East Flower Garden Bank, West Flower Garden Bank, and Stetson Bank. The Flower Garden Bank reefs are the northernmost living coral reefs on the U.S. continental shelf. Isolated from other coral reef systems by >556 km (300 nmi), the East and West Flower Garden Banks favor hard corals and support at least 21 species. Eight species of coral are found on Stetson Bank, where the cooler water temperatures favor non-reef-building corals and sponges. Located in the general region of the East and West Flower Garden Bankss are other reefs as well as mid-shelf and shelf-edge banks with existing or proposed designation as Habitat Areas of Particular Concern (HAPCs), including Sonnier Bank, McGrail Bank, Bright Bank, Geyer Bank, and Alderdice Bank. These designated deepwater (>70 m [230 ft]) habitats contain outcroppings rising up from the seafloor populated with benthic invertebrates, coralline algae, deep corals, and a variety of fish species. An HAPC designation alone does not provide additional protection to an area, but designated coral HAPCs (i.e. the East and West Flower Garden Banks, Stetson Bank, and McGrail Bank) have protective measures from certain fishing operations and fishing vessel bottom anchoring. Designated HAPCs are also identified as areas for special consideration during individual species assessments.

More than 300 different fish species and 3 species of sea turtles (hawksbill, leatherback, and loggerhead) inhabit FGBNMS waters. Macroalgae, crustaceans, sharks, skates, rays, many different types of benthic invertebrates, and a variety of seabirds thrive in the protected waters around the Flower Garden Banks (Showalter and Schiavinato, 2003). The FGBNMS is home to resident subadult loggerhead sea turtles (*Caretta caretta*) and hawksbill sea turtles (*Eretmochelys imbricata*). Manta rays (*Manta* sp.) are present within the sanctuary year-round, and schooling scalloped hammerhead sharks (*Sphyrna lewini*) and spotted eagle rays (*Aetobatus narinari*) are present in large numbers during the winter months. Other occasional charismatic megafauna visitors include whale sharks (*Rhincodon typus*) and several different species of mobulid rays. For additional details on these sanctuaries, refer to **Appendix E, Section 7**.

Offshore, the Pulley Ridge HAPC, the deepest hermatypic (reef-building) coral reef in the continental U.S., is located on Pulley Ridge off the southwest coast of Florida. The ridge is a drowned barrier island approximately 100 km (62.1 mi) long by 5 km (3.1 mi) wide, oriented parallel to the Florida peninsula northwest of the Dry Tortugas (**Figure 4.7-1**). Live corals dominated by *Agaricia* sp. occur between the 60- and 70-m (197- and-230 ft) isobaths on the reef along with a diverse assemblage of fish species comprising a mixture of shallow-water and deepwater species.

Within the Pulley Ridge HAPC, fishing activities involving pots, traps, longlines, nets, and anchoring are prohibited, but growing concern for the hermatypic corals in the area may lead to future management actions (Fisheries Leadership and Sustainability Forum, 2015). The GMFMC deepwater coral working group has expressed concern over ongoing damage to Pulley Ridge habitat by fishing operations and is considering additional protective measures. In May 2015, the Joint Coral Scientific and Statistical Committee and Coral Advisory Panel (Coral SSC/AP) recommended extended boundaries for the Pulley Ridge HAPC, stating specific concerns over the golden crab (*Chaceon fenneri*) fishery (Coral SSC/AP, 2015).

Other Federal Fishery Management Areas

Other Federal offshore MPAs have been designated by NMFS and the GMFMC with different degrees of management and protection, including reserves such as the Tortugas Marine Reserve and specialized management areas such as the Reef Fish Stressed Area (**Figure 4.7-1**).

Protections in these areas can range from gear restrictions (seasonal closures on gear such as longlining or anchoring fish traps on the seafloor) to complete limitations on any access. The MPAs were designated to protect a variety of different fauna, ranging from large pelagic fishes such as tunas, billfish, and sharks to more seafloor- and reef-associated fish species such as gag grouper (USDOI, BOEM, 2013b, 2013c) to coastal fishes. Measures were developed to protect non-targeted yet still affected fauna such as sea turtles to more general regional protective measures for benthic habitat and associated fauna/flora.

In deeper regions, Federal fishery management areas include McGrail Bank, designated as a coral HAPC, harboring unique hermatypic coral areas dominated by blushing star coral, *Stephanocoenia intersepta* (Schmal and Hickerson, 2006). Year-round fishing regulations within McGrail Bank include the prohibition of bottom longline, bottom trawl, buoy gear, pot or trap, and bottom anchoring by fishing vessels.

Benthic habitat in the Florida Middle Grounds HAPC supports a wide variety of hermatypic corals, octocorals, sponges, other invertebrates, and fish. This area is recognized as the northernmost coral reef community in the GOM (Simmons et al., 2014). The Big Bend area of the

GOM offers deepwater shelf habitats characterized by the Madison Swanson Marine Reserve HAPC and Steamboat Lumps. Little is known about the sessile community, but the shelf-edge habitats are documented aggregation and spawning sites for multiple species of grouper. The Madison Swanson and Steamboat Lumps HAPCs are closed to bottom fishing year-round to protect spawning grouper.

In terms of protections specifically for flora, the Pelagic *Sargassum* Habitat Restricted Area, which extends along the Atlantic Coast of the U.S. from Virginia to a narrow region along the Florida Keys, has seasonal restrictions on the harvest of pelagic *Sargassum* (*Federal Register*, 2003e).

The Tortugas Marine Reserve consists of two regions totaling 513 km^2 (151 nmi^2) and was created in 2001 at the western extent of the FKNMS (with benthic habitat and associated fauna previously noted). The reserve is closed to all consumptive use, including fishing and anchoring, and a portion of it is only open to permitted marine research (Jeffrey et al., 2012).

Additionally, the wider Caribbean contains International Union for Conservation of Nature (IUCN) designated MPAs for whales, dolphins, and porpoises (Hoyt, 2005). These MPAs are based on IUCN protection initiatives for cetaceans and includes other marine mammal species. The FKNMS is the only cetacean MPA within the GOM.

4.7.1.2 Coastal Marine Protected Areas

Coastal MPAs within the AOI include national seashores, NWRs, National Estuarine Research Reserves (NERRs), and State-designated MPAs (**Figure 4.7-2; Table 4.7-1**).

National Park System (National Seashores)

There are four coastal national parks within the boundary of the AOI administered by the National Park Service: Dry Tortugas National Park, Everglades National Park, Gulf Islands National Seashore, and Padre Island National Seashore (**Figure 4.7 2**).

The Dry Tortugas consist mostly of open water habitat and seven small islands within the FKNMS, and includes coral reefs and their associated communities. It also provides habitat for a great diversity of bird species.

Everglades National Park includes the southern portion of mainland Florida, Florida Bay, and portions of the upper Florida Keys. Coastal components include segments of open water, shallow waters, extensive seagrass meadows, and mangrove-fringed shorelines and islands.

Gulf Islands National Seashore spreads across two island chains off the coast of Mississippi and the Florida Panhandle. The Gulf Islands consist of eight barrier islands, six in Mississippi and two in Florida, making it the Nation’s largest national seashore, spanning >240 km (149 mi) of the GOM. Coastal components include segments of beaches, open water, shallow water, benthic habitat (primarily sand and mud bottom), isolated areas of seagrasses with associated marine flora, invertebrates, and fish (Lavoie et al., 2013). Beach areas provide habitat for a variety of bird species and nesting habitat for several species of sea turtles.

Padre Island National Seashore lies along the Gulf Coast of Texas and stretches 180 km (112 mi), making it the longest barrier island in the United States. Padre Island separates the GOM from the Laguna Madre, one of only a few hypersaline lagoons in the world. Coastal components include beaches, open GOM waters, benthic habitats of primarily sand and sand marl bottom with associated marine flora, invertebrates, and fish. Beach areas provide habitat for a variety of bird species as well as nesting habitat for several species of sea turtles.

National Wildlife Refuges

The NWR system is a network of U.S. lands and waters managed by the FWS specifically for the enhancement of wildlife. There currently are 19 NWRs contained or with portions within the AOI (**Table 4.7 1; Figure 4.7 2; Appendix E, Section 7**).

All terrestrial and aquatic resources within the NWR system are managed with the goals of conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the U.S. for the benefit of present and future generations of Americans. Management approaches and conservation methods differ among NWRs but typically include managing and rehabilitating wildlife habitat, controlling invasive species, and assisting in the recovery of rare wildlife species (USDOI, FWS, 2002).

The 19 NWRs were included as they have varying amounts of their coastal areas falling within the AOI (**Table 4.7-1**), and the vast majority provide coastal habitat to a diversity of bird species. Protection of important habitat utilized by migratory and/or resident birds appears to be a common objective for the initial establishment of most of these NWRs addressed in **Appendix E, Section 7**. Additionally, several of the listed NWRs provide important habitat for protected coastal species. For example, Ten Thousand Islands NWR and its adjacent waters are utilized by Florida's manatee population, and it provides habitat for large concentrations of wading birds, shorebirds, waterfowl, and other water birds. Many of the NWRs have coastal water components that consist of open water regions with benthic habitats primarily composed of soft sediment substrates and associated marine fauna and flora.

National Estuarine Research Reserve System

The NERR System is a partnership between NOAA and the coastal States that protects >1.3 million ac (526,091 ha) of coastal and estuarine habitat in a network of 28 reserves located in 22 States and Puerto Rico. The NERRs consist of relatively pristine estuarine areas that contain key habitat for purposes of long-term research, environmental monitoring, education, and stewardship, and are protected from significant ecological change or developmental impacts (NERR System, 2011). The NERRs partly within the AOI are Apalachicola, Rookery Bay, and Mission-Aransas (**Table 4.7-1; Figure 4.7-2; Appendix E, Section 7**).

State-Designated Marine Protected Areas

There are numerous State-designated coastal MPAs located along the coastal boundary of the AOI that include State parks, resource conservation areas (e.g., nature preserves, aquatic preserves, natural areas, wildlife management areas), sanctuaries, water quality protection areas, and historical areas (**Figure 4.7-2**). In addition, there are areas in State-designated MPAs where fishery activities are prohibited or controlled (**Table 4.7 1**). In total, there are 53 State-designated MPAs within the AOI (**Appendix E, Section 7**). Coastal and marine habitats and associated flora and fauna of these State-designated coastal MPAs are quite variable. For example, an MPA protecting a shipwreck would have the water column, soft sediment benthic habitat, and fish and invertebrates species associated with the structure and seafloor. An MPA for a designated protective speed zone for manatees would have the water column; manatees; seagrass beds providing forage; soft sediment substrates; and associated fishes, flora, and other fauna. The following paragraphs provide a description of the managing State agency and the primary focus of the State designation.

The Florida Department of Environmental Protection manages 36 of these MPAs, most of which were designated for protection of natural heritage areas, and one for sustainable production. The vast majority of these MPAs are Outstanding Florida Waters, although many are also State Parks and aquatic preserves. Outstanding Florida Waters are water features designated by the Florida Department of Environmental Protection as worthy of special protection of their natural attributes and have special restrictions on any new activity that would lower water quality or otherwise degrade the body of water.

The Florida Fish and Wildlife Conservation Commission manages eight of these MPAs, with four MPAs as wildlife management areas and the other four as designated protection zones for the Florida manatee. The Florida Division of Historical Resources designated four MPAs to preserve underwater archaeological sites. Currently, all four designated archaeological MPAs are shipwrecks.

Louisiana has five eligible State-designated MPAs, which includes one refuge and four wildlife management areas, three of which are also game preserves. All of these MPAs are managed by the Louisiana Department of Wildlife and Fisheries.

4.7.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact MPAs within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars), (2) trash and debris, (3) seafloor disturbance, (4) drilling discharges, and (5) accidental fuel spill. In considering the potential impacts to the associated MPAs, it is important to make the distinction between the AOI and the planning areas. The total AOI covers 689,166 km^2 (266,089 mi^2), including 45,630 km^2 (17,618 mi^2) of State waters beyond the planning area boundaries, so the total planning areas in Federal waters considered for MPAs is 643,536 km^2 (248,471 mi^2). The potential direct impacts considered here include the planning areas only and does not include State waters that extend to 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama and 9 nmi (10.4 mi; 16.7 km) offshore Texas and Florida, which are beyond OCS lease block area boundaries and where the proposed BOEM-authorized G&G activities would not occur. This distinction is important because the EPA does not include the Florida Keys and other sensitive shallow-water habitats within State waters 3 or 9 nmi from shore. In these areas outside of the planning areas but within the AOI, only potential indirect impacts propagating into the MPAs from proposed activities are considered.

The MPAs, or portions of the MPAs, within the planning areas include 15 of the 94 MPAs listed by NOAA for the AOI (**Table 4.7-1**) located offshore (**Figure 4.7-1**). The MPAs within the planning areas are in Federal waters and include the De Soto Canyon Conservation Area, East Florida Coast Conservation Area, FKNMS, Florida Middle Grounds HAPC, FGBNMS, Madison-Swanson MPA, McGrail Bank HAPC, Pelagic *Sargassum* Habitat Restricted Area, Pulley Ridge HAPC, Reef Fish Longline and Buoy Gear Reserve Area, Reef Fish Stressed Area, Steamboat Lumps, Stetson Bank HAPC, Tortugas Marine Reserve, and West and East Flower Garden Banks HAPC.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level categories. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For MPAs, the following impact-level criteria have been used to evaluate the level of impact for each IPF.

- **Nominal** impacts to MPAs would include those where little to no measurable impacts are observed or expected. Nominal impacts to MPAs would include those where G&G activities would produce little to no damage to natural communities, would not reduce the multiple resource uses within MPAs, and would not alter the physical, chemical, or biological environment within MPAs.
- **Minor** impacts to MPAs would include those that are detectable but not severe or extensive. Minor impacts to MPAs would include impacts arising from any activity that results in low levels of damage to the ecological function or reduction in the biological productivity of natural communities or multiple resource uses within MPAs.

- **Moderate** impacts to MPAs would be detectable and extensive within the MPA, but not severe or localized. Moderate impacts to MPAs would include impacts arising from any activity that results in moderate damage to the ecological function or reduction in the biological productivity of natural communities or multiple resource uses within MPAs.
- **Major** impacts to MPAs would be detectable, extensive within the MPA, and severe if no mitigation measures were enacted upon the permitted activities. Major impacts to MPAs would include any G&G activity that results in severe destruction of, or damage to, key biological resources in MPAs; or severe extensive damage to the ecological function or reduction in the biological productivity of natural communities or multiple resource uses within MPAs.

4.7.2.1 Impacts of Routine Activities

4.7.2.1.1 Active Acoustic Sound Sources

Because seismic airgun surveys authorized by BOEM are only expected to cover the planning areas and not the entire AOI, only the 10 offshore MPAs could be exposed to direct noise produced by seismic survey activity. Six of the 10 MPAs are within the EPA (i.e., the Madison Swanson MPA, Steamboat Lumps, Pulley Ridge HAPC, De Soto Canyon Close Area, portions of the Tortugas Marine Reserve, and Florida Middle Grounds), one is within the WPA (i.e., the Stetson Bank HAPC), one is within the CPA (i.e., the McGrail Bank HAPC), and two are shared by the WPA and CPA (West and East Flower Garden Banks HAPC and FGBNMS). The other 88 MPAs within the AOI but outside of the planning areas could be exposed to secondary impacts through propagated noise from adjacent seismic airgun and electromechanical sound source surveys.

The G&G activities under the Oil and Gas Program would account for most of the airgun and electromechanical sources (**Table 3.2-7**), and would have the greatest potential for affecting MPAs. Additionally, because of the nature of renewable energy and marine minerals projects (i.e., their limited spatial distribution), activities associated with the Oil and Gas Program have a greater potential to affect MPAs through noise. However, how close various G&G activities may come to MPAs is unknown.

National Marine Sanctuaries

The FGBNMS offshore Texas and Louisiana is located within the WPA and CPA. While seismic surveys employing airgun arrays and hydrophone streamers currently are not prohibited over deepwater MPAs, other G&G activities may not be allowed in designated No Activity Zones. No Activity Zones restrict any bottom-disturbing activities and cover most of the Flower Garden Banks but do not limit noise sources within the No Activity Zone. BOEM will not issue permits for bottom-disturbing activities where prohibited. However, G&G permittees for permits BOEM does issue are required to receive permits from the FGBNMS prior to the start of operations. Permit conditions will include removal of all mooring buoys before and replacement immediately after operations. In addition, the permittee must announce the time that the mooring buoys will not be available in a Notice to Mariners. The NMSA provides several tools for protecting designated NMSs, including the authority to issue regulations for each sanctuary and the system as a whole. The ONMS regulations, codified at 15 CFR part 922, prohibit specific kinds of activities, describe and define the boundaries of the NMSs, and set up a system of permits to allow the conduct of certain types of activities. Permits are required for any action that includes activities otherwise prohibited by sanctuary regulations.

As discussed in **Appendix B, Section 2.1.12**, BOEM will initiate consultation with the ONMS under Section 304(d) of the NMSA. The NMSA and ONMS' regulations have broad definitions of the terms "sanctuary resource" and "injury"; "sanctuary resources" are living and non-living attributes of the sanctuary, and "injury" includes disruption of ecological processes inclusive of physical, physiological, and behavioral modifications. Therefore, sound-producing activities (e.g., seismic surveys) proposed in or near the boundaries of an NMS would require BOEM to initiate consultation with the ONMS in order to consider additional mitigation measures, if any, recommended to reduce or eliminate injury to sanctuary resources. Measures such as setback distances will be determined prior to any sound-producing surveys by BOEM and in consultation with ONMS pursuant to Section 304(d) of the NMSA.

All authorizations for seismic surveys (those involving airguns as an acoustic source) would include a survey protocol that specifies underwater noise mitigation measures for protected species, including an acoustic exclusion zone, ramp-up requirements, visual monitoring by PSOs, and array shutdown requirements as outlined in **Appendix B**. While an NMS may be avoided so no airguns and streamers directly transit within its bounds, noise from 2D seismic and other types of surveys may still reach animals within an NMS. Non-airgun HRG surveys are expected to use electromechanical sources such as side-scan sonars; boomer, sparker, and CHIRP subbottom profilers; and SBESs or MBESs. Some autonomous underwater vehicles can use combinations of sources for HRG data collection. All authorizations for non-airgun HRG surveys would include specific protocol requirements as outlined in **Appendix B**. Recreational resources within an NMS may be affected by seismic noise as well (**Appendix E, Section 7**).

Depending on the type of survey and associated source levels and sound propagation, the distance from seismic survey project areas to an NMS, and sensitive species and habitats contained therein, noise-generating activities from G&G surveys could affect benthic communities (**Chapter 4.5.2.1**), marine mammals (**Chapter 4.2.2.1**), sea turtles (**Chapter 4.3.2.1**), marine and coastal birds (**Chapter 4.6.2.1**), and fisheries resources and EFH (**Chapter 4.4.2.1**), any or all of which may be present within an NMS.

Marine Mammals: As discussed in **Chapter 4.2.2.**, the effects of active acoustic sound sources (e.g., airgun noise) on marine mammals include reduction of prey availability, stress, disturbance, behavioral responses, auditory masking, TTS or PTS (hearing loss), and non-auditory physiological effects. Seismic survey (airgun) noise could disrupt normal activities of sensitive species and, in rare instances, inflict physiological damage. Direct effects may include pathological (i.e., injury), physiological (e.g., stress), and behavioral changes. Given sufficient exposure within an

NMS, marine mammals may vacate the area, experience TTS, experience masking of biologically relevant sounds, or be completely unaffected (**Chapter 4.2.2.1**). From the analysis in **Chapter 4.2.2.1**, impacts to marine mammals from active acoustic sound sources would be **minor** for HRG and shallow-penetration airgun surveys and **moderate** for deep-penetration airgun surveys.

Sea Turtles: As discussed in **Chapter 4.3.2**, the effects of active acoustic sound sources (e.g., airgun noise) on sea turtles include behavioral responses, masking of biologically important sounds, TTS (hearing loss), PTS, and mortality. Seismic survey (airgun) noise could disrupt normal activities of sensitive species and, in rare instances, inflict physiological damage. Direct effects may include pathological (i.e., injury), physiological (e.g., stress), and behavioral changes. Given sufficient exposure within an NMS, sea turtles would vacate the area, experience TTS, experience masking of biologically relevant sounds, or be completely unaffected (**Chapter 4.3.2.1**). Due to the mobile nature of the seismic airgun surveys, the temporary surveying of small areas of the seafloor relative to the overall AOI, the propensity of sea turtles to move away from noise that is affecting them, and the expectation that no lethal impacts or population-level impacts from PTS auditory injuries would occur, impacts to sea turtles from active acoustic sound sources would range from **nominal** to **minor** for HRG surveys and **minor** for airgun surveys (**Chapter 4.3.2.1**).

Fisheries and EFH: As discussed in **Chapter 4.4.2.1**, the effects of active acoustic sound sources (e.g., airgun noise) on fishes include behavioral responses, masking of biologically important sounds, TTS (hearing loss), physiological effects, and mortality. Seismic survey (airgun) noise could disrupt normal activities of sensitive species and, in rare instances, inflict physiological damage. Direct effects may include pathological (i.e., injury), physiological (e.g., stress), and behavioral changes. Given sufficient exposure within an NMS, affected fish species would vacate the area, experience short-term threshold shift, experience masking of biologically relevant sounds, or be completely unaffected (**Chapter 4.4.2.1**). While accounting for the potential to disrupt spawning aggregations or schools of important prey species, the mobile nature of the seismic airgun surveys, the temporary surveying of small areas of the seafloor relative to the overall area, and the propensity of fishes to move away from noise that is affecting them, suggest that the impacts would range from **nominal** (for HRG surveys) to **minor** (for airgun surveys) (**Chapter 4.4.2.1**).

Benthic Communities: Impacts to benthic organisms from noise generated by G&G surveys are not likely to occur except in the unlikely event of airgun use at very close range (e.g., in very shallow water), where sufficient acoustic energy reaches the seafloor to cause physiological damage. As discussed in **Chapter 4.5.2.1**, impacts to soundscape orientation of pelagic larvae will be **nominal** due to the transient and temporary nature of the proposed activities. At the depths of the FGBNMS (>135 m [443 ft]), only **nominal** impacts to benthic communities from G&G survey noise are expected. Based on study results of invertebrate communities following airgun exposure, detectable impacts on hard/live bottom, coral, or chemosynthetic communities are not expected from active acoustic sound sources (**Chapter 4.5.2.1**). Furthermore, only **nominal** localized impacts to benthic communities within the FGBNMS are expected. No overall changes in species composition, community structure, and ecological functioning of communities within the FGBNMS are expected. The only other NMS within the AOI, the FKNMS, is outside the planning areas and is located in shallow coastal waters off South Florida. Impacts to benthic communities, including those found within each NMS of the planning areas and AOI, from active acoustic sound sources would be **nominal**.

Marine and Coastal Birds: With only a few exceptions, marine and coastal birds would not be impacted within NMSs. Seabirds' prey may temporarily exhibit avoidance of an area where surveys are being performed but this is expected to be limited to a very small portion of a bird's foraging range. Consideration has to be given to migrating seabirds and the temporary displacement of species from preferred feeding grounds due to active acoustic surveying activities. Therefore, impacts to marine and coastal birds, including the few species that may use the NMSs of the AOI, from active acoustic sound sources would range from **nominal** to **minor**, depending on timing and location (**Chapter 4.6.2.1**).

Conclusion: In summary, the extent of impacts to sensitive receptors in NMSs would depend largely on their distance from the noise sources associated with G&G surveys. Overall, such impacts from transient activities would be expected to be **nominal** in terms of potential impacts on sensitive populations within each NMS. Seismic survey airgun and electromechanical source noise intruding into a NMS likely would have no more than temporary effects on protected resources. **Nominal** impacts are expected for most NMS resources, including benthic communities and marine and coastal birds, **nominal** to **minor** impacts are expected for fisheries resources and EFH and sea turtles, and **minor** to **moderate** impacts are expected for marine mammals. A first order assessment of chronic noise effects can be found in **Appendix K** and can be applied for assessing the risk associated with long-term ambient noise levels within the FGBNMS.

Offshore Marine Protected Areas

Within the National System of MPAs, nine federally designated offshore MPAs located offshore Texas, Louisiana, and Florida are within the planning areas. Five offshore MPAs (Pulley Ridge, Stetson Bank, McGrail Bank, West and East Flower Garden Banks, and Florida Middle Grounds) are designated and established by NMFS as HAPCs with fishing restrictions applied. Additionally, Madison Swanson MPA and Steamboat Lumps MPA are deepwater marine reserves offshore Florida, established to protect spawning aggregations of groupers. Fishes in the Federal fishery management areas, sea turtles, and marine mammals that may be present could be affected by noise from G&G activities. The impacts from noise produced by seismic activities within these MPAs will be primarily on fishes due to the focus of the management areas. The extent of impacts on fishes in these MPAs would depend largely on their distance and orientation from the noise source and the sensitivity to propagated frequencies. As seismic airgun surveys are not precluded from deepwater MPAs, airgun and electromechanical noise may affect fishes within these areas. Noise generated from G&G activities is expected to produce **minor** impacts on fishes in offshore MPAs if surveys are conducted within the bounds of each MPA. While fishes are the primary resources for which these offshore MPAs were established, other resources such as benthic organisms, marine birds, and marine mammals are present also; these are unlikely to be significantly affected by airgun and electromechanical noise from survey activities, as discussed in the previous section. Impacts to each resource within offshore MPAs are expected to mirror the impacts for resources within the NMS, as discussed earlier.

Other Federal Offshore Marine Protection Areas

Management areas could be affected by noise from G&G activities. The extent of impacts from noise generated by seismic activities on resources of concern in MPAs would depend largely on their distance and orientation from the noise source and their sensitivity to the propagated frequencies. As seismic airgun surveys are not precluded from fishery management areas, airgun and electromechanical noise may affect fishes within these areas. Noise generated by G&G activities are expected to produce **minor** impacts on fishes in fishery management areas if surveys are conducted within the areas. As discussed in the previous section, impacts to each resource within the MPA are expected to mirror the impacts for resources within the NMS.

Coastal Marine Protected Areas

National System coastal/State-designated MPAs located within the AOI are mostly outside and inshore of the planning areas and would not be directly impacted, with the exception of a portion of the Tortugas Marine Reserve located in the EPA. The principal conservation focus of the 88 MPAs outside of the planning areas but within the AOI includes 11 for sustainable production, 4 for cultural heritage, and 73 for natural heritage (**Table 4.7-1**). Twenty of the coastal MPAs have at least 49 percent of their area included in the AOI; the remaining 68 MPAs have smaller areas within or bordering the AOI. Sound propagation in shallow coastal areas can be highly complex with some noise quickly absorbed and other noise augmented through reflection and refraction; therefore, impacts are highly site and source specific. Noise from G&G surveys could affect fishes (**Chapter 4.4.2.1**), marine mammals (**Chapter 4.2.2.1**), sea turtles (**Chapter 4.3.2.1**), and benthic communities (**Chapter 4.5.2.1**) in coastal MPAs. The extent of impacts to fishes is expected to be **minor**. The extent of impacts to sea turtles and marine mammals in coastal MPAs would depend largely on their distance from the noise sources associated with G&G surveys and species' sensitivities to the propagated frequencies. The impacts from G&G survey noise likely will depend on the context in which the sound is received while the animals are utilizing the MPA. Impacts to sea turtles and marine mammals are expected to range from **nominal** to **moderate**, depending on the timing, location, and sound transmission properties of the survey. **Moderate** impacts to marine mammals could result from deep-penetration airgun surveys. Impacts to benthic organisms, primarily invertebrates, in coastal MPAs from noise generated by G&G surveys are expected to be **nominal**.

4.7.2.1.2 Trash and Debris

Most trash generated offshore during G&G activities is associated with galley and food service operations. Although companies operating offshore have developed and implemented trash and debris reduction and improved handling practices in recent years to reduce the amount of offshore trash lost into the marine environment, trash and debris would be generated during G&G activities and could be accidentally lost overboard. A discussion of the effects of debris lost overboard to benthic communities is provided in **Chapter 4.5.2.1**, which indicates that debris from exploratory drilling results in a **nominal** impact to the benthic environment. Debris deposited in areas of extensive soft bottom can provide artificial hard substrate for epifaunal colonization and can attract fishes.

Adherence to NTL 2015-BSEE-G03 would be required for all survey vessels performing work within U.S. jurisdictional waters (i.e., they are required to comply with Federal regulations, including MARPOL 73/78, and all authorizations for shipboard surveys would include guidance for marine debris awareness); only accidental loss of trash and debris is anticipated. Impacts from trash and debris generated by survey vessels, sampling, test well drilling, and other G&G-related activities on MPAs and the resources within would be **nominal**.

4.7.2.1.3 Seafloor Disturbance

A discussion of seafloor disturbances from G&G sampling, drilling, and anchor placement is provided in **Chapter 4.5.2.1**. Activities that could disturb the seafloor include sampling by vibracoring, geologic core, and grab samplers; use of jet probes and piezocone penetrometers; the laying of OBNs, OBC, and vertical cable; the drilling of shallow test wells; and the placement and retrieval of bottom-founded monitoring buoys. Proposed activities under Alternative A include bottom sampling, drilling, and anchoring. Bottom sampling could be conducted in all three planning areas.

BOEM would require site-specific information regarding potential sensitive benthic communities prior to approving any G&G activities involving seafloor-disturbing activities or placement of bottom-founded equipment or structures in the planning areas. No Activity Zones within NMSs restrict any seafloor-disturbing activities and cover most of the Flower Garden Banks. BOEM has designated specific benthic locations, including deepwater benthic communities and biologically sensitive underwater features and areas (NTLs 2009-G40 and 2009-G39, respectively), for avoidance in the planning areas. Additionally, other known hard/live bottom areas, deepwater coral areas, and chemosynthetic community sites are likely areas for avoidance. All authorizations for G&G surveys proposed within or near these areas would be subject to review to facilitate avoidance (**Chapter 2.3.2**). BOEM would use this information to ensure that physical impacts to sensitive benthic communities are avoided. Therefore, seafloor-disturbing impacts to sensitive benthic communities within MPAs are expected to be **nominal**.

4.7.2.1.4 Drilling Discharges

Drilling discharges may occur during the drilling of test wells; however, as discussed in **Chapter 3.3.1.9**, BOEM would require site-specific information prior to approving any G&G activities involving seafloor-disturbing activities, including drilling, in the planning areas. In addition, an NPDES permit would be required from the USEPA prior to any drilling activities. The installation of test wells associated with G&G survey activities is unlikely to be allowed in MPAs. An extensive discussion of impacts of drilling discharges from oil and gas operations on benthic communities is provided in **Chapter 4.5.2**. During the drilling process, discharged drilling fluid and cuttings would accumulate on the seafloor, causing changes in sediment grain size and affecting the benthic community by burial and smothering, anoxia, and sediment toxicity. Excess cement slurry released at the seafloor during casing installation would cause burial and smothering of benthic organisms around the wellbore. Soft bottom sediments disturbed by cuttings, drilling fluids, and cement slurry eventually would be recolonized through larval settlement and migration from adjacent areas (**Chapter 4.5.2**). The areal extent of impacts from drilling discharges during the proposed action would be small; a typical effect radius of 500 m (1,640 ft) would be expected. Therefore, drilling discharge impacts to sensitive benthic communities within MPAs are expected to be **nominal**.

National Marine Sanctuaries

No seafloor-disturbing activities would be permitted in the FKNMS. Seafloor-disturbing activities proposed within the boundaries of the FGBNMS would not be permitted within a No Activity Zone. No Activity Zones restrict any seafloor-disturbing activities and cover most of the FGBNMS. Discharges can be allowed under FGBNMS regulations outside of No Activity Zones (including remaining area within the sanctuary) as long as they are “shunted” to within 10 m (33 ft) of the seafloor. This regulation reduces the likelihood of discharges being transported to sensitive habitats within the sanctuary, but it can result in the accumulation of toxic materials in sediments around the base of the platform (Kennicutt, 1995). Seafloor-disturbing activities proposed within the FGBNMS but outside No Activity Zones, or outside the FGBNMS but near its boundaries, may be assigned a setback distance as condition of a BOEM-issued permit/COA to be determined at the time the action is under review by BOEM and in coordination with the ONMS. Furthermore, if BOEM finds that injury to sanctuary resources are likely to occur as a result of permitted discharges within or near the FGBNMS, BOEM will consult with the ONMS under NMSA Section 304(d). Sanctuary consultation would result in the ONMS providing recommended alternatives to BOEM to reduce or eliminate such impacts. Given levels of restriction and opportunities for mitigation, limited discharges of drilling fluids and cuttings are likely to occur within or in close proximity to NMS waters. The required permitting and consultation process will allow for site-by-site assessment of activities and the mitigation of potential impacts; therefore, **no impacts** to the FKNMS are expected from drilling discharges, and discharge impacts to the FGBNMS are expected to be **nominal**.

Offshore Marine Protected Areas

As discussed in **Chapter 3.3.1.8**, BOEM would require site-specific information prior to approving any G&G activities involving seafloor-disturbing activities, including drilling, in the planning areas. In addition, a NPDES permit would be required from the USEPA prior to any drilling activities. The installation of test wells associated with G&G survey activities would be restricted within No Activity Zones. Outside of No Activity Zones, approval will occur only after BOEM’s review of the required site-specific information, and sensitive habitats would be avoided. Through the permit and review process, there will be limited, and managed, seafloor disturbance within designated fisheries management areas and HAPCs. Therefore, **no impacts** from drilling discharges would be expected to benthic communities, submerged archaeological resources, fisheries resources and EFH, sea turtles, and marine mammals in offshore HAPCs.

Other Federal Fishery Management Areas

If drilling is not precluded in other federally designated offshore MPAs where there are existing restrictions on certain types of fishing activities, drilling discharges could affect resources within those MPAs. Because of the small footprint relative to the total area of the remaining MPAs, impacts from drilling discharges would be expected to be **nominal** in terms of potential impacts on benthic communities, while **no impacts** to submerged archaeological resources, fisheries resources and EFH, sea turtles, and marine mammals are expected from drilling discharges in these MPAs.

Coastal Marine Protected Areas

As discussed in **Chapter 3.3.1.8**, BOEM would require site-specific information prior to approving any G&G activities involving seafloor-disturbing activities, including drilling, in the planning areas. In addition, an NPDES permit would be required from the USEPA prior to any drilling activities. Most coastal MPAs occur onshore, and the offshore portion (which is within the AOI and as such is included) is limited to extreme shallow waters where oil and gas activities are unlikely. Therefore, drilling discharges would not be expected to affect coastal MPAs.

4.7.2.1.5 Routine Activities Impact Conclusions

In summary, the extent of active acoustic sound source impacts to resources in MPAs would depend largely on distance from the noise sources associated with G&G surveys. Overall, such impacts from transient activities would be **nominal** in terms of potential impacts on sensitive populations within each MPA. Seismic survey airgun and electromechanical source noise intruding into an MPA likely would have no more than temporary effects on protected resources characteristic of each MPA. **Nominal** impacts from active acoustic sounds are expected for most MPA resources, including benthic communities, and marine and coastal birds Impacts to marine mammals are expected to range from **minor** to **moderate**, while **nominal** to **minor** impacts are expected for fisheries resources and EFH and sea turtles. Impacts from trash and debris, seafloor disturbance, and drilling discharges are expected to range from **no impact** to **nominal** due to existing regulations and protections in place. Overall, impacts to MPAs from routine activities under Alternative A are expected to range from **no impact** to **moderate**.

4.7.2.2 Impacts of an Accidental Fuel Spill

An accidental event such as a ship collision could result in a release of diesel fuel. Such spills are not expected to be extensive, would dissipate rapidly, and likely would affect only organisms in the immediate vicinity of the accident. Based on USCG spill statistics, a spill scenario that assumes a diesel spill of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. Spills occurring at the ocean surface would disperse and weather; volatile components of the fuel would evaporate. Diesel and other fuels used for operation of survey vessels are light and would float on the surface of the water.

The likelihood of a fuel spill during seismic airgun surveys or other G&G activities in proximity to MPAs is considered remote. Impacts from a diesel fuel spill would depend greatly on the size and location of the spill, meteorological conditions at the time, and speed of employing cleanup plans and equipment. Small fuel spills are unlikely to significantly affect biota, habitats, and submerged cultural resources within NMSs, Federal fishery management areas (offshore MPAs), and coastal MPAs. Adult fishes within an MPA would be less susceptible to the effects of spilled fuel or oil than would eggs and larvae. Limited spills of fuel are unlikely to affect benthic communities, sea turtles, and marine mammals in MPAs because fuel would dissipate rapidly and likely would affect only organisms in the immediate vicinity of the accident. Marine and coastal birds could contact spilled fuel, which could cause injury or mortality. However, while individual birds may be oiled during a diesel spill, such impacts would be unlikely to affect marine and coastal birds at the population level. Threatened and endangered bird species (i.e., Piping Plover, Roseate Tern, and Red Knot), on the other hand, are very susceptible to oiling. In terms of all biological resources potentially affected within MPAs, accidents involving G&G survey vessels and resulting in a fuel spill would range from **nominal** to **moderate** as follows:

- **Moderate:** marine and coastal birds;
- **Nominal** to **minor:** marine mammals, sea turtles, and fish resources and EFH; and
- **Nominal:** all other resources.

4.7.2.3 Cumulative Impacts

4.7.2.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.7.2.1 and 4.7.2.2** determined that activities projected to occur under Alternative A would result in **no impact** to **moderate** impacts to MPAs, depending upon the IPF. The following analysis considers whether those incremental impacts, when added to or acting synergistically with other impact sources from the cumulative impacts scenario, may result in a significant impact.

Cumulative incremental impacts to MPAs from the proposed action, non-OCS oil- and gas-related factors, and the minimization of Outer Continental Shelf G&G-related impacts through stipulations and regulations would be expected to be **nominal** with no anticipated population-level impacts.

4.7.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for MPAs are compared with the IPFs from each of the cumulative scenario components on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The activities that have the potential to affect MPAs include (1) Federal and State oil and gas activity, (2) noise, (3) seafloor disturbance, and (4) pollution. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI.

The G&G activities have been ongoing in the GOM for at least the past 30 years, and it is reasonable to assume they will continue into the future; however, for the purpose of this Programmatic EIS, the cumulative analysis assesses a 10-year timeframe to coincide with the proposed action because it is not expected that G&G activities as a result of this analysis will have lasting effects or extend beyond the 10-year period.

Federal and State Oil and Gas Activity

Oil and gas activity could impact MPAs through aesthetics changes, space-use conflicts, oil spills, and infrastructure emplacement and removals. Impacts from the overall Oil and Gas Program are expected to range from **nominal** to **moderate**. Specific impacts could depend on the nature of the oil- and gas-related activities, ecology of a given MPA and associated communities, and multiple-use activities in a given area. Any oil spills arising from oil and gas activity are likely to be small and localized. In addition, there would likely be response and mitigation efforts subsequent to an oil spill. Any impacts to ecological function of an MPA are likely to be greater than impacts affecting recreational or commercial activities due to the potential for human activities to relocate to alternate sites. Therefore, the impacts of an oil spill on recreational resources are expected to be **negligible** to **minor**. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. For more information on impacts to MPAs by oil and gas activities, refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.12 of the 2017-2022 GOM Multisale EIS.

Noise

Active Acoustic Sound Sources

All G&G survey activities associated with the three Program Areas (i.e., Oil and Gas, Renewable Energy, and Marine Minerals) are included in the proposed action; therefore, G&G activities on the OCS are not included in the cumulative analysis but instead are addressed in the proposed action impact analysis (**Chapter 4.2.2.1**). Cumulative impacts are assessed in this analysis for the cumulative activities that produce active acoustic sound sources, including State waters oil and gas, commercial fishing, cable installation, military, and scientific research activities (**Table 3.4-1**).

Impacts from active acoustic sound sources to NMSs, offshore MPAs, and other Federal fisheries management areas would depend on the distance between the activities and the protected areas. With the use of mitigation measures under Alternative A, **nominal** to **minor** incremental increases in impacts from active acoustic sound sources are expected under the cumulative activities scenario depending on the resources occurring within NMSs, offshore MPAs, and other Federal fisheries management areas.

Seafloor Disturbances

Seafloor-disturbing activities associated with the proposed action over the 10-year period are included in **Table 3.2-7**. The cumulative scenario includes activities that disturb the seafloor by anchoring, trenching, coring, trawling, and bottom sampling from OCS activities, decommissioning, and the Renewable Energy and Marine Minerals Programs. In addition, other activities in the AOI, such as State waters oil and gas, commercial fishing, dredging and material disposal activities, cable installation, military activities, and scientific research, can cause seafloor disturbances (**Table 3.4-1**). The projected area of seafloor disturbance (**Table 3.2-7**) is a very small fraction of the AOI and represents a limited area when compared with the projected seafloor disturbance from the OCS Oil and Gas Program activities during the 10-year period (**Table 3.4-2**). Because of the likely wide separation, the risk of cumulative impacts associated with the proposed action with similar cumulative activities will be **nominal**. While small numbers of bottom samples may be clustered in an area, the seafloor disturbed by each sample is small, and there likely will be a large separation between areas investigated using bottom samples.

As discussed in **Chapter 4.7.2.1**, impacts to MPAs from proposed seafloor-disturbing activities would be **nominal**, primarily due to minimal seafloor disturbances associated with the proposed action, as well as the exclusion and protection requirements associated with MPAs that require review and consultation for activities within and near the boundaries of MPAs. The incremental increase in impacts to MPAs from seafloor disturbances under the cumulative scenario would be **nominal**.

Pollution

Trash and Debris

Trash and debris may originate from several activities onshore and offshore. All mariners operating vessels in the GOM are expected to comply with regulations for the management of waste in inland, coastal, and offshore waters. Trash and debris would be generated during G&G activities that could be accidentally lost overboard, some of which could sink to the seafloor and harm benthic communities or wash up on beaches and shorelines, potentially causing entanglement, ingestion, and aesthetic impacts. Guidance similar to NTL 2015-BSEE-G03 ("Marine Trash and Debris Awareness and Elimination") would be required for all survey vessels performing work within U.S. jurisdictional waters (i.e., they are required to comply with Federal regulations, including MARPOL 73/78, and all authorizations for shipboard surveys would include guidance for marine debris awareness); therefore, only accidental loss of trash and debris is anticipated. As discussed in **Chapter 4.7.2.1**, the proposed action under Alternative A would follow the same regulations and guidance, thus potentially adding a small amount of accidentally released trash and debris and resulting in **nominal** impacts to MPAs under the proposed action. A **nominal** incremental increase in impacts to MPAs from trash and debris is expected under the cumulative scenario.

Drilling Discharges

Drilling discharges under the proposed action are expected to be minimal, resulting from one COST well and two shallow test wells (**Chapter 3.3.1.9**). Cumulative activities that contribute to drilling discharges are the OCS Oil and Gas Program and the oil and gas activities in State waters. Based on the proposed action parameters and the review process, no direct impacts to MPAs would be expected from drilling discharges, and incremental increases to cumulative MPA impacts from drilling discharges under the cumulative scenario would be **nominal**.

4.7.2.3.3 Cumulative Impact Conclusions

Overall, proposed activities would increase levels of noise within the AOI, resulting in sporadic increases in ambient noise levels during proposed G&G operations; however, impacts from active acoustic sound sources are expected to result in **nominal** to **minor** incremental increases in impacts to MPAs under the cumulative scenario. For trash and debris, seafloor disturbances, drilling discharges, and other IPFs (e.g., hypoxia, military activities, and fisheries), the proposed activities would contribute very little to the other activities occurring under cumulative scenario; thus, a **nominal** incremental increase in impacts is expected.

4.7.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.7.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on MPAs.

4.7.3.1 Impacts of Routine Activities

Impacts from active acoustic sound sources, trash and debris, seafloor disturbance, and drilling discharges for Alternative A are evaluated in **Chapter 4.7.2.1**. Additional mitigation measures will reduce the potential direct impacts to MPAs within the planning areas and the nearshore MPAs in State waters within the AOI but outside of the planning areas. The mitigation measures designed to reduce impacts to marine mammals and sea turtles (i.e., expansion of NTL 2016-BOEM-G02, minimum separation distances, seismic restrictions in the EPA, and expanded use of PAM [**Chapter 2.4**]) would reduce impacts to those species occurring in MPAs. The MPA impacts were evaluated to be **nominal** to **moderate**, depending on the resource and IPF for Alternative A. The evaluation below considers the potential impact changes as a result of the mitigation measures included in Alternative B and are expected to remain **nominal** to **moderate** for active acoustic sound sources across all resources. Impacts from trash and debris and seafloor disturbance would remain **nominal**, and impacts from drilling discharges would remain **no impact** to **nominal** for all resources under Alternative B.

4.7.3.1.1 Coastal Waters Seasonal Restrictions

Coastal waters seasonal restrictions (as described in **Chapter 2.4.2**) for airgun surveys would not change the impacts to the FGBNMS, but they could reduce secondary impacts to the

FKNMS. The offshore and coastal MPAs and the fishery management areas (**Figures 4.7-1 and 4.7-2**) located within the restricted area would have reduced impacts from active acoustic sound and trash and debris. Secondary impacts of sound propagation from airguns into coastal MPAs (**Figure 4.7-2**) would be reduced during the closures. Because the restriction does not limit seafloor disturbance or drilling discharges, the impacts from drilling related to G&G activities would remain as similar to those described in Alternative A.

4.7.3.1.2 Expanded PSO Program

Expanding the PSO Program as described in **Chapter 2.4.2** would reduce the impacts to protected marine mammals (including manatees) and sea turtles that could be present in MPAs, resulting in decreased sound impacts. This expansion would not change the levels of impact from the other IPFs (i.e., trash and debris, seafloor disturbance, or drilling discharges).

4.7.3.1.3 Minimum Separation Distances

Active acoustic sound source impacts to species in MPAs located within the Areas of Concern (**Figure 2.2-1**) will be reduced by increasing the separation distances for simultaneous deep-penetration seismic airgun surveys to a distance of 40 km (25 mi). This mitigation would not change the levels of impact from the other IPFs (i.e., trash and debris, seafloor disturbance, or drilling discharges).

4.7.3.1.4 Seismic Restrictions in the Areas of Concern within the EPA

Active acoustic sound source impacts from deep-penetration seismic airgun surveys in the MPAs located within the Areas of Concern in the EPA (**Figure 2.2-1** [portions of Areas 2 and 3, and all of Area 4]) will be reduced. This mitigation would not change the levels of impact from the other IPFs (i.e., trash and debris, seafloor disturbance, or drilling discharges).

4.7.3.1.5 Use of PAM Required

Requiring PAM during seismic surveying when visibility is reduced could reduce impacts to protected marine mammals in MPAs. This mitigation would not change the levels of impact from the other IPFs (i.e., trash and debris, seafloor disturbance, or drilling discharges).

4.7.3.1.6 Routine Activities Impact Conclusions

The evaluation considers the potential impact changes as a result of mitigation measures included in Alternative B; impact levels are expected to remain **nominal** to **moderate** for active acoustic sound sources. **Moderate** impacts to marine mammals could result from deep-penetration airgun surveys. Impacts from trash and debris, seafloor disturbance, and drilling discharges would range from **no impact** to **nominal** for all resources under Alternative B. Overall, impacts to MPAs from routine activities under Alternative B are expected to range from **no impact** to **moderate**.

4.7.3.2 Impacts of an Accidental Fuel Spill

Under Alternative B, impacts from an accidental fuel spill on MPAs and the associated resources would be very similar to those evaluated for Alternative A (**Chapter 4.7.2.2**). The analysis concluded that the likelihood of a fuel spill during G&G activities in proximity to an MPA is remote. The small volume assumed from an accidental fuel spill would have insignificant population effects on MPAs. However, some species occurring within MPAs may be susceptible to oiling, and individuals could be affected.

Alternative B includes seasonal restrictions of G&G activities in coastal waters, reducing the potential impacts from accidental fuel releases on MPAs in proximity to coastal waters. Overall, accidental fuel spill impacts for Alternative B would be the same as Alternative A and would range between **nominal** and **moderate** as follows:

- **Moderate:** marine and coastal birds;
- **Nominal** to **minor:** marine mammals, sea turtles, and fish resources and EFH; and
- **Nominal:** all other resources.

4.7.3.3 Cumulative Impacts

4.7.3.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.7.3.1 and 4.7.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** to **moderate** impacts to MPAs, depending on the IPF and resources occurring within the MPAs.

Mitigation measures for the proposed action under Alternative B are described in **Chapter 2.4** and summarized in **Chapter 4.7.3.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3**). Some of the additional mitigation measures included in Alternative B, such as the expansion of the PSO Program and PAM requirement during periods of reduced visibility, would reduce the associated impacts on marine mammals in and around MPAs. Other mitigation measures associated with this alternative, including seasonal coastal water restrictions for surveying and additional airgun seismic survey restricted areas, will reduce seismic surveying and vessel activities within portions of the AOI to minimize potential impacts from active acoustic sound sources, trash and debris, and an accidental fuel spill. Increasing vessel separation distances during simultaneous airgun seismic surveys under Alternative B could reduce the cumulative MPA impacts common to IPFs from active acoustic sound sources.

4.7.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.7.2.3.2**) would remain the same under Alternative B.

4.7.3.3.3 Cumulative Impact Conclusions

The cumulative impacts on MPAs from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.7.2.3.2** above. While mitigation measures included in Alternative B would reduce the cumulative impacts from the associated IPFs, they would not significantly change the degree of impacts from the proposed action on MPAs. Incremental increase in impacts to MPAs would remain **nominal** to **minor** for Alternative B.

4.7.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.7.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative C on MPAs.

4.7.4.1 Impacts of Routine Activities

Impacts from active acoustic sound sources, trash and debris, seafloor disturbance, and drilling discharges for Alternative A are evaluated in **Chapter 4.7.2.1**. The additional mitigation measures would reduce potential direct impacts to MPAs within the planning areas and the nearshore MPAs in State waters within the AOI but outside of the planning areas.

The evaluation below considers potential impact changes as a result of mitigation measures included in Alternative C; impacts are expected to remain **nominal** to **moderate** for active acoustic sound sources and an accidental fuel spill across all resources. Impacts from trash and debris, seafloor disturbance, and drilling discharges would remain **no impact** to **nominal** for all resources under Alternative C.

4.7.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

Coastal waters seasonal restrictions for airgun surveys would not change the impacts to the FGBNMS, but they could reduce secondary impacts to the FKNMS. The offshore and some coastal MPAs as well as the Fishery Management Areas (**Figures 4.7-1 and 4.7-2**) located within the restricted area would have reduced impacts from active acoustic sound and trash and debris. The secondary impacts of sound propagation from airguns into coastal MPAs (**Figure 4.7-2**) would be reduced from February 1 to May 31, but it would not reduce impacts to a degree that would change the assessed impact level in Alternative A (**nominal** to **moderate**). Because the restriction does not limit seafloor disturbance or drilling discharges, impacts would remain as described in Alternative A (**nominal**).

4.7.4.1.2 Expanded PSO Program

Expanding the NTL would reduce exposure of protected marine mammals (including manatees) and sea turtles that could be present in MPAs to sound, resulting in decreased acoustic impacts. This expansion would not change the levels of impact from the other IPFs (i.e., trash and debris, seafloor disturbance, or drilling discharges).

4.7.4.1.3 Use of PAM Required

Requiring PAM during seismic surveying when visibility is reduced could reduce impacts to protected vocalizing marine mammals within MPAs. Requirement of PSOs in all water depths also would reduce impacts to protected marine mammals within MPAs. However, these mitigation measures would not change the levels of impact from the other IPFs (i.e., trash and debris, seafloor disturbance, or drilling discharges).

4.7.4.1.4 Non-Airgun HRG Survey Protocol

Requiring HRG pre-survey clearance periods for marine mammals and sea turtles would reduce potential impacts to marine mammals and sea turtles in and around NMSs. In addition, requiring a 200-m (656-ft) exclusion monitoring zone for HRG surveys could reduce potential impacts to protected species in and around NMSs, but impacts would remain unchanged in other areas.

4.7.4.1.5 Routine Activities Impact Conclusions

The evaluation considers potential impact changes as a result of mitigation measures included in Alternative C; impacts are expected to remain **nominal** to **moderate** for active acoustic sound sources across all resources. Impacts from trash and debris, seafloor disturbance, and drilling discharges would remain **no impact** to **nominal** for all resources under Alternative C. Overall, impacts to MPAs from routine activities under Alternative C are expected to range from **no impact** to **moderate**.

4.7.4.2 Impacts of an Accidental Fuel Spill

Under Alternative C, impacts from an accidental fuel spill on MPAs and the associated resources would be very similar to those evaluated for Alternative A (**Chapter 4.7.2.1**). The analysis concluded that the likelihood of a fuel spill during G&G activities in proximity to MPAs is remote. The small volume assumed from an accidental fuel spill would have insignificant population effects on MPAs. However, some species occurring within MPAs may be susceptible to oiling, and individuals could be affected.

Alternative C includes seasonal restrictions of G&G activities in coastal waters, reducing potential impacts from accidental fuel releases on MPAs in proximity to coastal waters. Overall, accidental fuel spill impacts for Alternative C would be the same as Alternative A and would range between **nominal** and **moderate**:

- **Moderate:** marine and coastal birds;
- **Nominal** to **minor:** marine mammals, sea turtles, and fish resources and EFH; and
- **Nominal:** all other resources.

4.7.4.3 Cumulative Impacts

4.7.4.3.1 OCS Program G&G Survey Activities

Mitigation measures for the proposed action under Alternative C are described in **Chapter 2.5** and summarized in **Chapter 4.7.4.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3**). The additional mitigation measures in Alternative C may reduce impacts to marine mammals in and around MPAs to less than moderate levels. Overall, proposed activities would increase levels of noise within the AOI, resulting in sporadic increases in ambient noise levels during proposed G&G operations; however, impacts from active acoustic sound sources are expected to result in **nominal** to **minor** incremental increases in impacts to MPAs under the cumulative scenario. For trash and debris, seafloor disturbances, and drilling discharges, the proposed activities would contribute very little to other activities occurring under the cumulative scenario.

4.7.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.7.2.3.2**) would remain the same under Alternative C.

4.7.4.3.3 Cumulative Impact Conclusions

The cumulative impacts on MPAs from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.7.2.3.2** above. While mitigation measures included in Alternative C would reduce the cumulative impacts from the associated IPFs, they would not significantly change the degree of incremental impacts from the proposed action. Incremental increase in impacts to MPAs would remain **nominal** to **minor** for Alternative C.

4.7.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.7.2**). The additional mitigation measures under Alternative D would not reduce the potential active acoustic impacts to MPAs overall as discussed in Alternatives A and C (**Chapters 4.7.2.1 and 4.7.4.1**), and impacts would remain **nominal** to **moderate**. This mitigation would not alter the impact levels to MPAs from trash and debris, seafloor disturbance, or drilling discharges; impacts would remain **no impact** to **nominal**. Under Alternative D, impacts of an accidental fuel spill on MPAs would be as described for Alternatives A and C (**Chapters 4.7.2.2 and 4.7.4.2**) and would remain **nominal** to **moderate**.

4.7.5.1 Impacts of Routine Activities

Impacts from active acoustic sound sources, trash and debris, seafloor disturbance, and drilling discharges are evaluated for Alternatives A and C in **Chapters 4.7.2.1 and 4.7.4.1**. The additional mitigation measure will reduce potential direct impacts to MPAs within the planning areas and the nearshore MPAs in State waters within the AOI but outside of the planning areas. The MPA impacts were evaluated to be **no impact** to **moderate**, depending on species present and IPFs for Alternatives A and C.

Alternative D includes the mitigation measures included in Alternatives A and C, and adds a mitigation measure requiring shutdown for all marine mammals except bow-riding dolphins. Shutdowns for marine mammals, except bow-riding dolphins, and sea turtles could reduce acoustic impacts to these species in and around MPAs, but impacts are expected to remain **nominal** to **moderate** across the AOI as a whole. This mitigation would not change the levels of impact from the other IPFs (i.e., trash and debris, seafloor disturbance, or drilling discharges). Overall, impacts to MPAs from routine activities under Alternative D are expected to range from **no impact** to **moderate**.

4.7.5.2 Impacts of an Accidental Fuel Spill

Under Alternative D, impacts from an accidental fuel spill on MPAs and their associated resources would be very similar to those evaluated for Alternatives A and C (**Chapters 4.7.2.1 and 4.7.4.1**). The analysis concluded that the likelihood of a fuel spill during G&G activities in proximity to MPAs is remote. The small volume assumed from an accidental fuel spill would have insignificant population effects on MPAs. However, some species occurring within MPAs may be susceptible to oiling, and individuals could be affected.

Alternative D includes seasonal restrictions of G&G activities in coastal waters, reducing potential impacts from accidental fuel releases on MPAs in proximity to coastal waters. Overall, accidental fuel spill impacts for Alternative D would be similar to Alternatives A and C and would range between **nominal** to **moderate** as follows:

- **Moderate:** marine and coastal birds;
- **Nominal** to **minor:** marine mammals, sea turtles, and fish resources and EFH; and
- **Nominal:** all other resources.

4.7.5.3 Cumulative Impacts

4.7.5.3.1 OCS Program G&G Survey Activities

Mitigation measures for the proposed action under Alternative D are described in **Chapter 2.6** and summarized in **Chapter 4.7.5.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3**). The additional mitigation measure included in Alternative D will reduce impacts to marine mammals in MPAs, but the overall impacts to MPAs are expected to remain **nominal** to **moderate** across the AOI as a whole.

4.7.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.7.2.3.2**) would remain the same under Alternative D.

4.7.5.3.3 Cumulative Impact Conclusions

The cumulative impacts on MPAs from all ongoing and reasonably foreseeable future activities in the GOM, including other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.7.2.3.2** above. While the additional mitigation measure included in Alternative D will reduce the cumulative impacts from active acoustic sound sources, it will not significantly change the degree of incremental impacts from the proposed action. Overall, proposed activities would increase levels of noise within the AOI, resulting in sporadic increases in ambient noise levels during proposed G&G operations; however, impacts from active acoustic sound sources are expected to result in **nominal** to **minor** incremental increases in impacts to MPAs under the cumulative scenario. For trash and debris, seafloor disturbances, and drilling discharges, the proposed activities would contribute very little to the other activities occurring under the cumulative scenario. Incremental increase in impacts to MPAs would remain **nominal** to **minor** for Alternative D.

4.7.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.7.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative E on MPAs.

4.7.6.1 Impacts of Routine Activities

Impacts for active acoustic sound sources, trash and debris, seafloor disturbance, and drilling discharges are evaluated for Alternatives A and C in **Chapters 4.7.2.1 and 4.7.4.1**. Additional mitigation measures under Alternative E will reduce potential direct impacts to MPAs within the planning areas and the nearshore MPAs in State waters within the AOI but outside of the planning areas.

Alternative E includes the mitigation measures included in Alternatives A and C, and includes a reduction of deep-penetration, multi-client activities by 10 percent or 25 percent, which may reduce acoustic impacts from these activities; however, overall impacts are expected to remain **nominal** to **moderate** for active acoustic sound sources across all resources in MPAs. Impacts from trash and debris, seafloor disturbance, and drilling discharges would remain **no impact** to **nominal** for all resources in MPAs under Alternatives E1 and E2. Overall, impacts to MPAs from routine activities under Alternative E are expected to range from **no impact** to **moderate**, as described in Alternatives A and C.

4.7.6.2 Impacts of an Accidental Fuel Spill

Under Alternative E, impacts from an accidental fuel spill on MPAs and their associated resources would be very similar to those evaluated for Alternatives A and C (**Chapters 4.7.2.1 and 4.7.4.1**). The analysis concluded that the likelihood of a fuel spill during G&G activities in proximity to an MPA is remote. The small volume assumed from an accidental fuel spill would have insignificant population effects on MPAs. However, some species occurring within MPAs may be susceptible to oiling, and individuals could be affected.

Alternative E includes a 10 percent or 25 percent reduction in deep-penetration, multi-client activity line miles that also would reduce the potential for accidental fuel releases. Overall, accidental fuel spill impacts for Alternative E would be the same as Alternatives A and C and would range between **nominal** and **moderate**:

- **Moderate:** marine and coastal birds;
- **Nominal** to **minor:** marine mammals, sea turtles, and fish resources and EFH; and
- **Nominal:** all other resources.

4.7.6.3 Cumulative Impacts

4.7.6.3.1 OCS Program G&G Survey Activities

Mitigation measures for the proposed action under Alternative E are described in **Chapter 2.7** and summarized in **Chapter 4.7.6.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3**). The reduction of deep-penetration, multi-client activities (in line miles) by 10 percent (Alternative E1) or 25 percent (Alternative E2) would reduce the extent, severity, and timing of active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, and trash and debris; therefore, impacts for these IPFs would be incrementally decreased under Alternative E.

Impacts from the proposed action on MPAs are expected to result in **nominal** incremental increases for the cumulative scenario activity components and their associated IPFs.

4.7.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.7.2.3.2**) would remain the same under Alternative E.

4.7.6.3.3 Cumulative Impact Conclusions

The cumulative impacts on MPAs from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.7.2.3.2** above. The additional mitigation measure of decreasing deep-penetration, multi-client activity survey miles by 10 percent (Alternative E1) or 25 percent (Alternative E2) from estimated levels in a calendar year would result in a reduction of potential impacts across the AOI as a whole. While this mitigation measure would reduce the cumulative impacts from the associated IPFs, it would not significantly change the degree of incremental impacts from the proposed action. Incremental increase in impacts to MPAs would remain **nominal** to **minor** for Alternatives E.

4.7.7 Impacts – Alternative F (Alternative C Plus Area Closures)

Impacts to MPAs under Alternative F would be very similar to those described for Alternatives A and C (**Chapters 4.7.2 and 4.7.4**). The following evaluation considers potential impact changes as a result of mitigation measures included in Alternative F.

4.7.7.1 Impacts of Routine Activities

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.7.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative F on MPAs. Additional mitigation measures will reduce the potential direct impacts to MPAs within the four closure areas, including the Tortugas Marine Reserve, Dry Tortugas National Park, and the FGBNMS, and secondary impacts to MPAs within a close distance of the closure areas.

Alternative F includes the mitigation measures included in Alternatives A and C, and includes four area closures where only non-airgun HRG surveys operating at frequencies >200 kHz can operate. The restriction within the closure areas will directly reduce acoustic impacts to pelagic fish in the area and reduce sound impacts, such as auditory injuries and masking, to marine mammals, turtles, and fish communities present in nearby fishery management MPAs, as well as in the FGBNMS, Madison-Swanson MPA, and Steamboat Lumps MPA. Impacts are expected to be

nominal to **minor** for active acoustic sound sources across all resources within the closure area and in nearby fishery management MPAs. While the reduction in activity in the closure areas may reduce the likelihood of impacts from active acoustic sound sources, the resultant effect across an entire resource category would not change, and impacts will remain **nominal** to **moderate** overall. Impacts from seafloor disturbance and drilling discharges would be eliminated in MPAs within the closure areas; however, potential impacts to resources within open MPAs would remain. Therefore, the impacts expected from trash and debris, seafloor disturbance, and drilling discharges for all resources within MPAs would remain **no impact** to **nominal** under Alternative F. Overall, impacts to MPAs from routine activities under Alternative F are expected to range from **no impact** to **moderate**.

4.7.7.2 Impacts of an Accidental Fuel Spill

Under Alternative F, impacts from an accidental fuel spill on MPAs and their associated resources would be very similar to those evaluated for Alternatives A and C (**Chapters 4.7.2.1 and 4.7.4.1**). The analysis concluded that the likelihood of a fuel spill during G&G activities in proximity to an MPA is remote. The small volume assumed from an accidental fuel spill would have insignificant population effects on MPAs. However, some species occurring within MPAs may be susceptible to oiling, and individuals could be affected.

The four area closures in Alternative F (i.e., the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area) would reduce the potential for accidental fuel releases by reducing the associated vessel activity in those areas. Overall, accidental fuel spill impacts to resources within MPAs for Alternative F would be similar to those for Alternatives A and C and would range between **nominal** and **moderate** as follows:

- **Moderate:** marine and coastal birds;
- **Nominal** to **minor:** marine mammals, sea turtles, and fish resources and EFH; and
- **Nominal:** all other resources.

4.7.7.3 Cumulative Impacts

4.7.7.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.7.7.1 and 4.7.7.2** concluded that activities projected to occur under Alternative F would result in **nominal** to **moderate** impacts to MPAs, depending on the IPF and resources occurring within the MPAs.

Mitigation measures for the proposed action under Alternative F are described in **Chapter 2.8** and summarized in **Chapter 4.7.7.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3**). Mitigation measures under Alternative F are similar to Alternative C with the addition of four area closures: CPA Closure Area;

EPA Closure Area; Dry Tortugas Closure Area; and Flower Gardens Closure Area. As discussed in **Chapter 4.7.7.1**, trans-boundary IPFs would be nominally affected by additional MPA closures.

4.7.7.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.7.2.3.2**) would remain the same under Alternative F.

4.7.7.3.3 Cumulative Impact Conclusions

The cumulative impacts on MPAs from all ongoing and reasonably foreseeable future activities in the GOM, including similar other BOEM Program activities (**Figure 3.4-1**), are expected to be **nominal** to **moderate** as described in **Chapter 4.7.2.3.2** above. Additional mitigation closures in Alternative F would eliminate seafloor impacts within specific MPAs, but would not change the overall cumulative impact scenario for MPAs throughout the AOI. Impacts from the proposed action on MPAs are expected to result in **nominal** incremental increases for the cumulative scenario activity components and their associated IPFs for Alternatives A and C (**Chapters 4.7.2.3 and 4.7.4.3**). The additional Alternative F mitigation measure of area closures would result in associated percentage reductions in potential MPA impacts to common IPFs from seafloor disturbance and drilling discharges, but it would not result in a one-to-one reduction in potential impacts from active acoustic sound sources, trash and debris, and an accidental fuel spill due to the distributed nature of these IPFs. Therefore, while this mitigation measure would reduce the cumulative impacts from some associated IPFs, it would not significantly change the degree of incremental impacts to MPAs from the proposed action. Incremental increase in impacts to MPAs would remain **nominal** to **minor** for Alternative F.

4.7.8 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.7.2**). Under Alternative G no new activities would be permitted or authorized. Any G&G activities previously authorized by BOEM under an existing permit or lease would proceed but would not be renewed or reauthorized and, thus, would eventually be phased out.

Impacts for active acoustic sound sources, trash and debris, seafloor disturbance, drilling discharges, and an accidental fuel spill are evaluated for Alternative A in **Chapter 4.7.2.1**. Alternative G would reduce the potential of and/or have **no impact** for overall impacts to MPAs within the AOI because the proposed level of activity likely would not be near MPAs; therefore, impacts are expected to range from **no impact** to **nominal** under Alternative G.

Under Alternative G, impacts from an accidental fuel spill on MPAs and their associated resources would be very similar to those evaluated for Alternative A (**Chapter 4.7.2.1**). The analysis concluded that the likelihood of a fuel spill during G&G activities in proximity to an MPA is remote. The small volume assumed from an accidental fuel spill would have insignificant population effects on MPAs. However, some species occurring within MPAs may be susceptible to oiling, and individuals could be affected. Alternative G reduces the potential impacts from accidental fuel releases to **nominal**, eventually declining to **no impact** as previously permitted/authorized G&G activities are completed, thus reducing associated vessel activity (**Chapter 2.9**).

Impacts from the proposed action on MPAs are expected to result in **nominal** incremental increases for the cumulative scenario activity components and their associated IPFs for Alternative A (**Chapter 4.7.2.3**).

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.7.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.7.2.3.2**) would remain the same under Alternative G. The cessation of G&G activities would result in the loss of an important tool for exploration to identify the location and size of oil and gas prospects, development of renewable energy projects, and exploration for non-energy marine minerals such as sand and gravel (or other sediment) for beach nourishment, coastal restoration, and public works projects. Such a loss would result in increased environmental risk to industry and could potentially lead to increased exploratory drilling or a dramatic reduction in oil and gas activity in the GOM. The cessation of activity for future G&G surveys requiring a permit/authorization from BOEM would not add a substantial increase to the cumulative impacts.

4.7.9 Summary Conclusion

In summary, the IPFs that may impact MPAs within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; and side-scan sonars), (2) trash and debris, (3) seafloor disturbance, (4) drilling discharges, and (5) accidental fuel spills.

Impacts to MPAs are assessed based on the impact levels presented across all resources that may occur within the boundaries of MPAs. Therefore, impacts from active acoustic sound sources range from **nominal** to **moderate** for all alternatives except Alternative G. Impacts from trash and debris, seafloor disturbance, and drilling discharges range from **no impact** to **nominal** for all alternatives. Impacts from Alternative G would be reduced to **nominal**, eventually declining to **no impact** as survey activities are phased out. Accidental fuel spill impacts range from **nominal** to **moderate** for all alternatives except Alternative G, which would be **nominal**, eventually declining to **no impact** as previously permitted/authorized G&G activities are completed, thus reducing associated vessel activity.

4.8 *SARGASSUM* AND ASSOCIATED COMMUNITIES

4.8.1 Description of the Affected Environment

Sargassum mats comprise two species of brown algae: *Sargassum natans* and *S. fluitans*. Each species is entirely pelagic, spending its entire life cycle on the ocean surface. *Sargassum* reproduces by vegetative fragmentation (LaPointe, 1995), and its movement is controlled by surface winds and currents (**Appendix E, Section 8**). *Sargassum* can be found alone or aggregated into large mats or long windrows and can be randomly spread across the ocean surface or found along current--or wind-driven boundaries.

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

In 2010, *Sargassum* was present in the area of surface oiling resulting from the *Deepwater Horizon* explosion, oil spill, and response. During the months following the oil spill, studies documented direct exposure of *Sargassum* to oil throughout the time that surface oil was present. This evidence comes from observations of direct oiling during the spill response and observations of *Sargassum* within the oiling footprint (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). The Final PDARP/PEIS injury assessment estimated the lost area of *Sargassum* that resulted from direct oiling and the foregone growth that resulted from *Deepwater Horizon* oil exposure was up to 23 percent of the *Sargassum* in the northern GOM (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). The total loss of *Sargassum*, including foregone area from lost growth, was estimated to be 11,100 km^2 (4,286 mi^2) (*Deepwater Horizon* Natural Resource Damage Assessment Trustees, 2016).

Once the flow of oil ceases, pelagic habitat would quickly return to normal. Pelagic habitat far from shore is far from land-based sources of pollution also. Only part of the *Sargassum* stocks would be affected; algae not affected by the spill would continue to grow normally and repopulate the habitat. Because *Sargassum* has a seasonal cycle of growth in summer and reduction in winter, winter populations following a catastrophic oil spill may be similar to populations of any other year. With this pattern, recovery from the effects of a catastrophic oil spill is expected within 1 to 2 growing seasons. For example, after the *Deepwater Horizon* explosion, oil spill, and response, *Sargassum* populations had returned to comparable abundance the following summer (Powers et al., 2013). Additional information pertaining to this resource and NMFS' determination of the effects of the *Deepwater Horizon* explosion, oil spill, and response may be found in the Final PDARP/PEIS (*Deepwater Horizon* Natural Resource Damage Assessment Trustees, 2016).

Pelagic *Sargassum* mats provide habitat for fauna, including >100 species of fish and >100 species of invertebrates such as crabs, shrimp, and mollusks, as well as 4 species of sea turtles and many marine birds (Coston-Clements et al., 1991). Epiphytic algae (a group of microscopic algae that grow on the surface of marine plants), encrusting hydroids, bryozoans, and tubeworms also are associated with these communities.

The habitat and community provided by *Sargassum* mats are important to the life histories of many species of pelagic, littoral, and benthic fishes, providing them with substrate, protection from predation, and access to food in the open sea (Dooley, 1972). Wells and Rooker (2004a) documented the abundance of estuarine and pelagic fish species, indicating *Sargassum* may serve as an important means of transport for larval and juvenile species between offshore and inshore waters.

Four species of sea turtles, specifically post-hatchling and early juvenile life stages, have been documented in association with *Sargassum* in the GOM: loggerhead, green, hawksbill, and Kemp's ridley. Sea turtles have been observed actively foraging within the mats, resting and drifting while concealed by the mats, or diving below the mats (Witherington et al., 2012). *Sargassum* also has been identified as a critical habitat for the loggerhead sea turtle (*Caretta caretta*) (*Federal Register*, 2014b).

The invertebrate community that inhabits *Sargassum* includes mobile and sessile species. Common invertebrates include hydroids, anthozoans, flatworms, bryozoans, polychaetes, gastropods, nudibranchs, bivalves, cephalopods, pycnogonids, isopods, amphipods, copepods, decapod crustaceans, insects, and tunicates. Shrimps and crabs compose the bulk of invertebrates and are a major food source for *Sargassum*-associated fishes (Dooley, 1972).

4.8.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact *Sargassum* within the AOI include (1) vessel traffic, (2) vessel discharges, (3) trash and debris, and (4) accidental fuel spill. As discussed in **Chapter 4.8.1**, *Sargassum* can be found in mats of varying size and length, and it is temporally and spatially patchy throughout the GOM.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level categories. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For *Sargassum* and associated communities, the following impact-level criteria have been used to evaluate the level of impact for each IPF.

- **Nominal** impacts to *Sargassum* and associated communities would include those where little to no measurable impacts are observed or expected. No serious damage to *Sargassum* and associated fauna is expected to occur. Nominal impacts also would include limited, short-term physical displacement (e.g., breaking up of mats, *Sargassum* being pushed aside).
- **Minor** impacts to *Sargassum* and associated communities would include those that are detectable but not severe or extensive. Minor impacts to *Sargassum* also would include short-term physical displacement of *Sargassum* mats that would not adversely affect the population or associated fauna.
- **Moderate** impacts to *Sargassum* and associated communities would be detectable and extensive but not severe. Moderate impacts to *Sargassum* would include serious mechanical damage from G&G-related vessel propellers to *Sargassum* and injury to associated fauna. Moderate impacts also would include extended physical displacement of *Sargassum* mats. The viability or continued existence of affected *Sargassum* populations would not be threatened, although some impacts may be irreversible.
- **Major** impacts to *Sargassum* would be detectable, extensive, and severe. Major impacts to *Sargassum* and associated communities would include severe mechanical damage from propellers sufficient to cause extensive mortality to *Sargassum* plants and associated communities; such damage would be sufficient to adversely affect the population. Major impacts to *Sargassum* also would include long-term (or permanent) physical displacement of the species to the extent that the long-term survivability of the species may be adversely affected.

4.8.2.1 Impacts of Routine Activities

4.8.2.1.1 Vessel Traffic

Under Alternative A, all G&G survey activities are performed from vessels, except remote-sensing surveys conducted via aircraft and satellites; therefore, most survey activities could impact *Sargassum* and associated communities from vessel traffic. The primary potential impact to *Sargassum* and associated communities from vessel traffic associated with G&G surveys is the physical displacement of *Sargassum* mats as vessels and towed equipment pass through large mats. Towed equipment may temporarily snag *Sargassum* and may require retrieval of equipment as needed to clean off *Sargassum*, depending on the amount of fouling. *Sargassum* will collect on cables and slide down the cable to a collection point, creating a cluster that causes drag and vibration on the equipment and cables. The subsurface equipment (e.g., airguns and HRG sources) is less likely to become fouled than the surface towed equipment (e.g., receivers, streamers, and hydrophones). Once the vessel has passed, displaced *Sargassum* mats likely would re-form via surface winds, ocean currents, and gyres. Mechanical damage to *Sargassum* from propellers is not expected to be extensive because much of the *Sargassum* would be pushed aside as the vessel passes. *Sargassum* could become impinged in cooling water intakes on vessels. Based on this analysis, impacts to *Sargassum* and associated communities from G&G vessel traffic would be **nominal**. Vessel traffic in the GOM is relatively high, and G&G survey vessels would add minimal additional traffic.

Species associated with, or dependent on, *Sargassum* mats as habitat could be affected by vessel traffic moving through the mats. Sea turtles within *Sargassum* mats are at risk for survey vessel collision; however, collision risk from G&G vessel traffic does not differ from the risk associated with any other vessel movement within the AOI (**Chapter 4.3.2**). For larger sea turtles, regulations and guidance (e.g., NTL 2016-BOEM-G01, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting") would further mitigate this risk. Smaller sea turtles, fish, and invertebrate species associated with *Sargassum* mats likely would not be affected by G&G survey vessel traffic. At the slow operating speeds of a G&G survey (<4 kn [5 mph]), most organisms would be displaced by the vessel hull, pushing them out of harm's way.

4.8.2.1.2 Vessel Discharges

Under Alternative A, all G&G survey activities are performed from vessels, except remote-sensing surveys conducted via aircraft and satellites; therefore, most survey activities could impact *Sargassum* and associated communities by vessel discharges. Vessel discharges include bilge, ballast, and sanitary and domestic waste (**Chapter 3.3.1.6**). All routine discharges will be conducted in accordance with all established regulations and standards, including 33 CFR § 151.10, 33 CFR part 151 subpart D, 40 CFR part 140, 33 CFR part 159, and 33 U.S.C. §§ 1251 *et seq*. Given the widespread distribution of *Sargassum* and the size of the AOI, operational discharges likely would affect a very small percentage of the population. Exotic, and potentially harmful, organisms may be transferred and introduced to the GOM from ballast water discharges (SAFMC, 2002; Trott et al., 2011). *Sargassum* may provide an environment where a new species could thrive and a mechanism of transportation to new habitats as *Sargassum* moves from the Atlantic Ocean into the Caribbean Sea and eventually into the GOM.

Because *Sargassum* distribution is widespread as well as temporally and spatially patchy throughout the AOI, it could come in contact with operational discharges; however, the waxy coating on *Sargassum* may prevent any effect from a short-term exposure to discharges (USDOI, BOEM, 2012a). Considering the ratio of the affected area (immediately surrounding the survey vessel) to the entire AOI, and even to the larger area inhabited by *Sargassum*, only a small percentage of the total *Sargassum* population would directly contact operational discharges; therefore, impacts are expected to be **nominal**.

Species associated with or dependent upon the *Sargassum* mats as habitat are not expected to be affected by vessel discharges.

4.8.2.1.3 Trash and Debris

All survey vessels performing work within U.S. jurisdictional waters are required to comply with Federal regulations and implement MARPOL 73/78. Within MARPOL Annex V, "Regulations for the Control of Pollution by Garbage from Ships," as implemented by 33 CFR part 151, are requirements designed to protect the marine environment from various types of garbage generated on board vessels. In addition, all authorizations for shipboard surveys would include guidance for marine debris awareness (NTL 2015-BSEE-G03, "Marine Trash and Debris Awareness and Elimination"). Therefore, the amount of trash and debris dumped offshore should be minimal as only accidental loss of trash and debris is anticipated, some of which could float on the sea surface.

The G&G survey activities generate trash composed of paper, plastic, wood, glass, and metal. Most trash is associated with galley and food service operations. However, over the last several years, companies operating offshore have developed and implemented trash and debris reduction and improved handling practices to reduce the amount of offshore trash lost into the marine environment. These trash management practices include replacing Styrofoam cups and dishes with ones made of paper and ceramic, recycling offshore trash, and transporting and storing supplies and materials in bulk containers when feasible. These changes have resulted in a reduction of accidental loss of trash and debris from vessels.

Human-generated litter, including plastics and debris, is found in the surface waters of all the world's oceans and is documented in the GOM within pelagic *Sargassum* mats (Wei et al., 2012). Several mechanisms, including surface currents and wind, concentrate pelagic *Sargassum* and anthropogenic debris (especially tar and plastics) in surface convergence zones (Thiel and Gutow, 2005). While trash and debris may collect within *Sargassum* mats, such debris has not been documented to affect the algae. Because *Sargassum* has a temporally and spatially patchy distribution throughout the AOI, only a portion of the entire population would come in contact with trash and debris. No measureable impact would occur to *Sargassum*; therefore, impacts would be **nominal**.

Species associated with, or dependent on, *Sargassum* mats as habitat could be affected by trash and debris within the mats. Hatchling sea turtles may be found within *Sargassum* mats, which are rich in prey and provide shelter (Hirth, 1997; USDOC, NMFS and USDOI, FWS, 2008). *Sargassum* habitat is designated as critical habitat for the Northwest Atlantic Ocean DPS of the loggerhead sea turtle (*Federal Register,* 2014c). Trash and debris within the mats may be mistaken as food or may cause entanglement. The complete analysis of potential impacts to sea turtles is provided in **Chapter 4.3.2**. Many commercially and recreationally important fish species associate with *Sargassum* at some point during their life cycle and could be affected through ingestion of or entanglement in trash and debris (**Chapter 4.4.2**). Invertebrate communities within *Sargassum* mats would not be negatively affected by trash and debris. Sessile invertebrate attachment to biotic versus abiotic substrata depends on biological factors such as temperature, feeding biology, and reproductive biology as well as characteristics of the substratum such as complexity, surface, and size. Mobile invertebrates typically are highest on macroalgae (*Sargassum*) and lowest on abiotic substrata (Thiel and Gutow, 2005); however, certain species may prefer abiotic substrata (Winston, 1982).

4.8.2.1.4 Routine Activities Impact Conclusions

Because the majority of G&G survey activities are performed using vessels, such activities could impact *Sargassum* and associated communities. Vessel traffic and its associated towed equipment can break apart free-floating mats of *Sargassum* in the survey area; vessel discharges may have an effect on water quality in the immediate area, which could indirectly affect *Sargassum* and associated communities. In addition, release of trash and debris could impact *Sargassum* and associated communities. Impacts from all associated IPFs to *Sargassum* and associated communities under Alternative A would be **nominal**.

4.8.2.2 Impacts of an Accidental Fuel Spill

An accidental event could result in the release of diesel or other fuel by a survey vessel. Based on USCG spill statistics, a spill scenario that assumes a diesel spill volume of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. Spills occurring at the ocean surface would disperse and weather; volatile components of the fuel would evaporate rapidly. Diesel and other fuel used for operation of survey vessels is less dense than water and would float on the sea surface. A small portion of the heavier fuel components could adhere to *Sargassum* and particulate matter in the upper portion of the water column and sink; *Sargassum* mats also could become vectors for oiling of inhabitants.

An accidental fuel spill could occur offshore or nearshore, and the impact to the *Sargassum* and associated communities would depend on the amount of fuel spilled, the presence and amount of *Sargassum*, and the proximity of *Sargassum* directly contacted by the fuel spill (i.e., prior to any evaporation, dissipation, or weathering). *Sargassum* grows in the northwest GOM during spring of each year, making the area a major nursery area for *Sargassum* that supplies the Atlantic population (Gower and King, 2011). Thus, a fuel spill occurring in this region during the growing season likely will have a greater effect on the species than a fuel spill that occurs elsewhere at a different time.

The yearly cycle of *Sargassum* reproduction in this area ensures that the species is resilient and able to recover annually without overall population-level effects (USDOI, BOEM, 2012a).

Powers et al. (2013) showed that drifting *Sargassum* and its faunal associates could be negatively impacted by oil; however, they did not study the effects of diesel and other fuel specifically. The likelihood of a vessel collision occurring is quite low, and a resultant fuel spill is even less likely. If an accidental spill occurred, the area of impact likely would be a very small portion of the AOI because of the relatively small fuel spill size (1.2 to 7.1 bbl). Diesel remaining on the sea surface is expected to last for a day or less and have limited spatial extent. In addition, due to the widespread as well as temporally and spatially patchy distribution of *Sargassum*, most fuel spills would only contact a very small portion of the *Sargassum* population for a very short time, resulting in **nominal** impacts.

Species associated with, or dependent on, *Sargassum* mats as habitat could be affected by an accidental release of diesel or other fuel. Sea turtles within a *Sargassum* mat affected by a fuel spill may come in direct contact with the contaminant through ingestion of fouled prey, inhalation of air before diving, or exposure to sensitive tissues. Diesel and other fuel can adhere to sea turtle skin or shells. Sea turtles surfacing within or near an accidental release likely would inhale petroleum vapors, causing respiratory stress. Ingested diesel fuel, particularly the lighter fractions, can be acutely toxic to sea turtles (**Chapter 4.3.2.2**). Fish eggs and larvae are most sensitive to oil spills (SAFMC, 2012), and those associated with a *Sargassum* mat affected by a fuel spill would be impacted. Pelagic and epipelagic adults that forage at the ocean surface or within *Sargassum* mats affected by a fuel spill would be most likely to be affected (**Chapter 4.4.2.2**). Diesel and other fuel may be toxic to invertebrates in *Sargassum* mats. Mobile invertebrates may avoid contaminated *Sargassum* by relocating; however, those that come in direct contact with diesel or other fuel likely would be impacted. Overall, the impact would be **nominal** given the relatively small size expected of an accidental fuel spill and the spatial extent of *Sargassum* coverage.

4.8.2.3 Cumulative Impacts

4.8.2.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.8.2.1 and 4.8.2.2** determined that activities projected to occur under Alternative A would result in **nominal** impacts to *Sargassum* and associated communities. The following analysis considers whether those incremental impacts, when added to or acting synergistically with other impact sources from the cumulative impacts scenario, may result in a significant impact.

Cumulative incremental impacts to *Sargassum* and associated communities from the proposed action, when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response and the minimization of Outer Continental Shelf G&G-related impacts through stipulations and regulations, would be expected to be **nominal** with no anticipated population-level impacts.

4.8.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for *Sargassum* are compared with the IPFs from each of the cumulative scenario components on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The IPFs for these cumulative activities that have the potential to affect *Sargassum* include (1) Federal and State oil and gas activity (2) vessel traffic; (3) vessel discharge; (4) trash and debris; (5) eutrophication; and (6) climate change. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI.

Federal and State Oil and Gas Activity

Several oil and gas activities 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 IPFs that could be reasonably expected to impact *Sargassum* populations in the GOM. All of these IPFs 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 that could occur at any given location. Impacts to the overall population of the *Sargassum* community are therefore expected to be **nominal** from either routine activities or reasonably foreseeable accidental events. The incremental impact of oil and gas activity on the population of *Sargassum* would be **nominal** when considered in the context of cumulative impacts to the population. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. For more information on impacts to *Sargassum* and associated communities by oil and gas activities, refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.5 of the 2017-2022 GOM Multisale EIS.

Vessel Traffic

As discussed in **Chapter 4.8.2.1**, impacts from G&G survey-related vessel traffic on *Sargassum* and associated communities would be **nominal** due to the minimal additional vessels associated with G&G survey activities and the nature of the interaction between *Sargassum* and vessels.

Table 3.3-3 provides the number of estimated vessels required by survey type and Program Area for the proposed action, including 19,689 trips for support vessels and 993 trips for survey vessels. For cumulative vessel traffic, **Table 3.4-2** provides a summary of projected support vessel operations anticipated for the Oil and Gas Program; support vessel trips will range from 828,000 to 1,096,000 trips for the 10-year span of the cumulative scenario. **Tables 3.4-7 and 3.4-8** provide vessel trip data for all vessels in the GOM. Exact numbers of cumulative vessel traffic associated with renewable energy and marine minerals support activities are not known, but they are expected to be relatively small and spatially and temporally limited. Vessels are associated with all the activities under the cumulative scenario (**Chapter 3.4**). Overall, the contribution of vessel traffic from proposed G&G activities would be relatively small compared with the existing vessels in the AOI.

As discussed in **Chapter 4.8.2.1**, vessels could impact *Sargassum* communities by their passage, damage from propellers, and possible impingement in cooling water intakes, but they are expected to affect a small localized portion of the overall *Sargassum* community. The additional vessels used for G&G surveys are not expected to contribute significantly to existing vessel traffic in the AOI. Therefore, cumulative impacts to *Sargassum* and associated communities from vessel traffic would result in a **nominal** incremental increase in the impact to *Sargassum* and associated communities under the cumulative scenario.

Vessel Discharges

As discussed in **Chapter 4.8.2.1**, impacts from G&G survey-related vessel discharges on *Sargassum* and associated communities would be **nominal** due to the temporally and spatially patchy distribution of *Sargassum*, the short-term and spatial extent of vessel discharges, and the adherence to regulations and standards.

Associated activities described in the cumulative scenario (**Chapter 3.4**) include the use of vessels and associated vessel discharges. Some activities utilize stationary platforms, barges, or drill ships that can produce similar effects to *Sargassum* and associated communities from runoff, sanitary facilities, and cooling water discharges. All discharges are strictly regulated, and offshore operators must adhere to regulations and standards for treating and managing discharges, thereby reducing the effect of discharges on water quality. The additional vessels used for G&G surveys are not expected to contribute significantly to existing vessel discharges in the AOI.

Because *Sargassum* is widely distributed, it could come in contact with operational discharges; however, the waxy coating on *Sargassum* may prevent any effect from a short-term exposure to discharges (USDOI, BOEM, 2012a). Considering the ratio of the affected area (immediately surrounding the discharging vessel) to the entire AOI, and even to the larger area inhabited by *Sargassum*, a small percentage of the total *Sargassum* population would come in contact with operational discharges. Furthermore, the additional vessels used for G&G surveys are not expected to contribute significantly to existing vessel discharges occurring in the AOI. Therefore, cumulative impacts to *Sargassum* and associated communities from vessel discharges would result in a **nominal** incremental increase in the impact.

Trash and Debris

As discussed in **Chapter 4.8.2.1**, impacts on *Sargassum* and associated communities from trash and debris generated by G&G survey-related activities would be **nominal** due, in part, to adherence to existing requirements and guidance (e.g., NTL 2015-BSEE-G03 and MARPOL 73/78).

Cumulative activities described in **Chapter 3.4** could introduce trash and debris into the marine environment. The offshore oil and gas industry's adherence to laws and regulations has greatly reduced their share of trash and debris released in the GOM. The amount of trash and debris produced by G&G survey activities would be minimal, as only accidental loss of trash and debris is anticipated and additional vessels used for G&G surveys are not expected to contribute significantly to existing vessel traffic in the AOI. Therefore, cumulative impacts to *Sargassum* and associated communities from trash and debris would result in a **nominal** incremental increase in the impact under the cumulative scenario.

Eutrophication

Declining coastal water conditions in the Gulf of Mexico due to eutrophication could result in landscape -evel impacts to *Sargassum.* Increased nutrient loading can lead to increased turbidity from plankton growth (e.g., in the summer). Turbidity could result in a decrease in *Sargassum* production and result in stress to the organisms utilizing 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.

Climate Change

Impacts associated with possible climate change impacts remain unknown for a habitat with such a wide-ranging distribution. Increased temperatures could result in benefits to *Sargassum* by increasing the range where the plants could be found and by increasing growth rates. This could result in beneficial impacts like increased sequestration of nutrients and more potential habitat for colonization and increased larval survival. However, it is possible that growth rates could increase to a point where the fouling of beaches and shipping lanes in the GOM and the Atlantic Ocean could become problematic, resulting in moderate to major impacts to coastal communities. Additionally, stratification of the water column and changes in current patterns due to a changing climate could alter access to nutrients and move *Sargassum* into areas not previously observed. Finally, organisms that colonize *Sargassum* could be impacted as pH levels fluctuate, resulting in negative impacts. Combined, this would result in impacts ranging from **beneficial** to **major** and would be expected to vary by location, given the distribution of *Sargassum.* As such, impacts of climate change to *Sargassum* are not easily estimated.

4.8.2.3.3 Cumulative Impact Conclusions

The incremental impact of a proposed action on the population of *Sargassum* would be **nominal** when considered in the context of cumulative impacts to the population. Furthermore, regulations and practices would minimize the impacts from the proposed activities. Impacts from changing water quality and climate change would be much more influential on *Sargassum* than G&G operations and would still occur without their presence.

4.8.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.8.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on *Sargassum* and associated communities.

4.8.3.1 Impacts of Routine Activities

Additional mitigation measures under Alternative B that would not change the extent, severity, or timing of G&G activities, and therefore related impacts to *Sargassum* and associated communities, include the minimum separation distance for simultaneous surveys, expansion of NTL 2016-BOEM-G02 (inclusion of manatees and application to all deep-penetration seismic airgun surveys in all water depths), and the expanded use of PAM. As such, these mitigation measures will not be addressed in the following discussion.

4.8.3.1.1 Coastal Waters Seasonal Restrictions

Alternative B would include a seasonal restriction area from (a) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath) and (b) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the UME in the northern GOM (**Figure 2.2-1 and Chapter 2.4.3**). No airgun surveys would be authorized within the closure area during this time.

The additional seasonal restriction for Federal coastal waters under Alternative B would change the timing of seismic airgun surveys in coastal areas and reduce vessel traffic, vessel discharges, and trash and debris from these surveys in coastal areas during certain times of the year compared with Alternative A. As discussed in **Chapter 4.8.2.1**, impacts from vessel traffic, vessel discharges, and trash and debris to *Sargassum* and associated communities under Alternative A are expected to be **nominal**. A change in survey timing in the additional closure area could reduce the impacts to *Sargassum* found in coastal areas. However, the impacts to *Sargassum* and associated communities would be expected to remain **nominal** because the additional closure is not of sufficient duration to reduce impact levels. During the closure periods, the largest concentration of *Sargassum* remains outside the seasonal restriction area. Additionally, once *Sargassum* is inside the seasonal restriction area, it is reaching the end of its lifecycle and most likely will be deposited on a beach.

4.8.3.1.2 Seismic Restrictions in the Areas of Concern within the EPA

Additional restrictions under Alternative B include prohibiting deep-penetration seismic airgun surveys within the portion of the Areas of Concern (**Chapter 2.4.2**) falling within the EPA. This restriction does not apply to surveys related to currently leased blocks, any portion of the area encompassed by EPA Lease Sale 226, or OCS lease blocks adjacent to permitted survey areas but within an otherwise off-limit area.

The additional area closure in portions of the EPA under Alternative B would change the location of seismic airgun surveys and could result in a localized reduction of vessel traffic, vessel discharges, and trash and debris from these surveys compared with Alternative A. As discussed in **Chapter 4.8.2.1**, impacts from vessel traffic, vessel discharges, and trash and debris to *Sargassum* and associated communities are expected to be **nominal**. A change in survey location restrictions in the additional area could reduce impacts to *Sargassum* in these areas because these surveys would not occur there. Impacts to *Sargassum* and associated communities would be expected to remain **nominal**.

4.8.3.1.3 Routine Activities Impact Conclusions

Because the majority of G&G survey activities are performed using vessels, such activities could impact *Sargassum* and associated communities. Vessel traffic and its associated towed equipment can break apart free-floating mats of *Sargassum* in the survey area; vessel discharges may affect water quality in the immediate area, which could indirectly affect *Sargassum* and associated communities. In addition, release of trash and debris could impact *Sargassum* and associated communities. Impacts from all associated IPFs to *Sargassum* and associated communities under Alternative B would be **nominal**.

4.8.3.2 Impacts of an Accidental Fuel Spill

Under Alternative B, impacts of an accidental fuel spill on *Sargassum* and associated communities would be very similar to those analyzed for Alternative A in **Chapter 4.8.2.2**. The analysis concluded that a small fuel spill at the sea surface would result in **nominal** impacts. Alternative B would change the timing of certain surveys because of additional coastal seasonal restrictions and limits on concurrent seismic airgun surveys. Additionally, certain surveys would not be conducted within portions of the EPA. However, fuel spills from seismic survey vessels could occur in the closure areas during times outside the closure period. Also, fuel spills from other (non-seismic) survey vessels could occur during the closure period or in the EPA. A change in survey timing or type because of limits on concurrent seismic airgun surveys or a restriction of survey type would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential impacts to *Sargassum* and associated communities would be the same as under Alternative A (**nominal**).

4.8.3.3 Cumulative Impacts

4.8.3.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.8.3.1 and 4.8.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** impacts to *Sargassum* and associated communities.

Mitigation measures for the proposed action under Alternative B are described in **Chapter 2.4** and summarized in **Chapter 4.8.3.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3**). Multiple mitigation measures under Alternative B would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to *Sargassum* and associated communities also would not change. Mitigation measures under Alternative B that would change the timing and extent of activities in the proposed action include a seasonal restriction for the operation of airguns in Federal coastal waters, and prohibiting deep-penetration seismic airgun surveys within portions of the EPA (**Chapter 2.4.2**).

4.8.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.8.2.3.2**) would remain the same under Alternative B.

4.8.3.3.3 Cumulative Impact Conclusions

The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A (**Chapter 4.8.2.3**). The cumulative scenario would remain unchanged for Alternative B, and the associated impacts would remain the same. Alternative B would change the timing of seismic airgun surveys in certain areas; however, these coastal seasonal restrictions would not appreciably change the cumulative impacts described under Alternative A. The incremental impact of this proposed alternative on the population of *Sargassum* would be **nominal** when considered in the context of cumulative impacts to the population. Impacts from changing water quality and climate change would be much more influential on *Sargassum* than G&G-related activities and would still occur without such activities.

4.8.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.8.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative C on *Sargassum* and associated communities.

4.8.4.1 Impacts of Routine Activities

Additional mitigation measures under Alternative C that would not change the extent, severity, or timing of G&G activities, and therefore related impacts to *Sargassum* and associated communities, include the expanded use of PAM for seismic airgun surveys, the expanded use of PSOs, expansion of NTL 2016-BOEM-G02 (inclusion of manatees) for seismic airgun surveys, the pre-survey clearance period, and the expansion of NTL 2016-BOEM-G02 to include HRG surveys using airguns. As such, those mitigation measures will not be addressed in the following discussion.

4.8.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

Alternative C includes a seasonal restriction in Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31. No airgun surveys would be authorized within the closure area during this time.

The additional seasonal restriction for Federal coastal waters under Alternative C would change the timing of seismic airgun surveys in coastal areas and reduce vessel traffic, vessel discharges, and trash and debris from these surveys in coastal areas during certain times of the year compared with Alternative A. As discussed in **Chapter 4.8.2.1**, impacts from vessel traffic, vessel discharges, and trash and debris to *Sargassum* and associated communities are expected to be **nominal**. A change in survey timing in the additional closure area could reduce the impacts to *Sargassum* found in coastal areas, as these surveys would not occur within Federal coastal waters between February 1 and May 31. However, the impacts to *Sargassum* would be expected to remain **nominal** because the additional closure is not of sufficient duration to reduce impact levels.

4.8.4.1.2 Routine Activities Impact Conclusions

Because the majority of G&G survey activities are performed using vessels, such activities could impact *Sargassum* and associated communities. Vessel traffic and its associated towed equipment can break apart free-floating mats of *Sargassum* in the survey area; vessel discharges may affect water quality in the immediate area, which could indirectly affect *Sargassum* and associated communities. In addition, release of trash and debris could impact *Sargassum* and associated communities. Impacts from all associated IPFs to *Sargassum* and associated communities under Alternative C would be **nominal**.

4.8.4.2 Impacts of an Accidental Fuel Spill

Under Alternative C, impacts of an accidental fuel spill on *Sargassum* would be very similar to those analyzed for Alternative A in **Chapter 4.8.2.2**. The analysis concluded that a small fuel spill at the sea surface would result in **nominal** impacts. Alternative C would change the timing of certain surveys because of additional coastal seasonal restrictions and limits on concurrent seismic airgun surveys. Additionally, certain surveys will not be conducted within portions of the EPA. However, fuel spills from seismic survey vessels could occur in the closure areas during times outside the closure period. Also, fuel spills from other survey vessels (non-seismic) could occur during the closure period or in the EPA. A change in survey timing or survey type because of limits on concurrent seismic airgun surveys or a restriction of survey type would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential impacts to *Sargassum* and associated communities would be the same as under Alternative A (**nominal**).

4.8.4.3 Cumulative Impacts

4.8.4.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.8.4.1 and 4.8.4.2** concluded that activities projected to occur under Alternative C would result in **nominal** impacts to *Sargassum* and associated communities, depending on the IPF.

Mitigation measures for the proposed action under Alternative C are described in **Chapter 2.5** and summarized in **Chapter 4.8.4.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3**). Most mitigation measures under Alternative C would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to *Sargassum* and associated communities also would not change. The mitigation measures under Alternative C that would change the timing and extent of activities in the proposed action are a seasonal restriction for operation of airguns in Federal coastal waters.

4.8.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.8.2.3.2**) would remain the same under Alternative C.

4.8.4.3.3 Cumulative Impact Conclusions

The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A (**Chapter 4.8.2.3**). The cumulative scenario would remain unchanged for Alternative C, and the associated impacts would remain the same. Alternative C would change the timing of seismic airgun surveys in certain areas; however, these coastal seasonal restrictions would not appreciably change the cumulative impacts described under Alternative A. The incremental impact of this proposed alternative on the population of *Sargassum* would be **nominal** when considered in the context of cumulative impacts to the population. Impacts from changing water quality and climate change would be much more influential on *Sargassum* than G&G-related activities and would still occur without such activities.

4.8.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.8.2**). The additional mitigation measure under Alternative D would not alter impact levels to *Sargassum* and associated communities from vessel traffic, vessel discharges, or trash and debris, as described in Alternatives A and C (**Chapters 4.8.2.1 and 4.8.4.1**), and would remain **nominal**. Under Alternative D, impacts of an accidental fuel spill on *Sargassum* and associated communities would be as described for Alternatives A and C (**Chapters 4.8.2.2 and 4.8.4.2**) and would remain **nominal**.

4.8.5.1 Impacts of Routine Activities

Mitigation measures under Alternative D include all measures provided under Alternatives A and C but exclude bow-riding dolphins from the marine mammal shutdown protocols during seismic surveys. Therefore, as discussed under Alternatives A and C (**Chapters 4.8.2.1 and 4.8.4.1**), none of the mitigation measures provided under Alternative D, except for the seasonal restriction for the operation of airguns in coastal waters, would change the extent or severity of G&G activities and the impacts to *Sargassum* and associated communities.

The seasonal restriction for Federal coastal waters under Alternative D would change the timing of seismic airgun surveys in coastal areas and reduce the vessel traffic, vessel discharges, and trash and debris from these surveys in coastal areas during certain times of the year compared with Alternative A. As discussed in **Chapter 4.8.2.1**, impacts from vessel traffic, vessel discharges, and trash and debris to *Sargassum* and associated communities are expected to be **nominal**. A change in survey timing in the additional closure area could reduce the impacts to *Sargassum* found in coastal areas, as these surveys would not occur within coastal waters between February 1 and May 31. However, the impacts to *Sargassum* and associated communities would be expected to remain **nominal** because the additional closure is not of sufficient duration to reduce impact levels. Overall, impacts to *Sargassum* and associated communities from routine activities under Alternative D are expected to be **nominal**.

4.8.5.2 Impacts of an Accidental Fuel Spill

Under Alternative D, impacts of an accidental fuel spill on *Sargassum* and associated communities would be very similar to those analyzed for Alternative A in **Chapter 4.8.2.2**. The analysis concluded that a small fuel spill at the sea surface would result in **nominal** impacts. Alternative D mitigation measures would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential impacts to *Sargassum* and associated communities would be the same as under Alternative A and would be **nominal**.

4.8.5.3 Cumulative Impacts

4.8.5.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.8.5.1 and 4.8.5.2** concluded that activities projected to occur under Alternative D would result in **nominal** impacts to *Sargassum* and associated communities, depending on the IPF.

4.8.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.8.2.3.2**) would remain the same under Alternative D.

4.8.5.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative D are described in **Chapter 2.6** and summarized in **Chapter 4.8.5.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3**). The mitigation measures are the same as described for Alternative C, with the addition of shutdown protocols during seismic operations for all marine mammals except bow-riding dolphins. The addition of shutdown protocols for all marine mammals except bow-riding dolphins under Alternative D would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to *Sargassum* and associated communities also would not change, and **nominal** incremental increases are expected when considered in the context of cumulative impacts to the population. Impacts from changing water quality and climate change would be much more influential on *Sargassum* than G&G-related activities and would still occur without such activities.

4.8.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.8.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative E on *Sargassum* and associated communities.

4.8.6.1 Impacts of Routine Activities

The reduction of deep-penetration, multi-client activities by 10 percent or 25 percent under Alternative E would reduce the extent and severity of vessel traffic, vessel discharges, and trash and debris to *Sargassum* and associated communities. Impacts for these IPFs, therefore, would decrease incrementally under Alternative E from the analysis in Alternative A (**Chapter 4.8.4.1**); the overall level would be expected to remain **nominal**.

4.8.6.2 Impacts of an Accidental Fuel Spill

Under Alternative E, impacts of an accidental fuel spill on *Sargassum* and associated communities would be very similar to those analyzed for Alternative A in **Chapter 4.8.2.2**. The analysis concluded that a small fuel spill at the sea surface would result in **nominal** impacts. Alternative E reduces survey activities; therefore, impacts also would decrease incrementally. A change in the number of surveys would not substantially change the risk of a small fuel spill.

Overall, the risk of a small fuel spill and the potential impacts to *Sargassum* and associated communities would be the same as under Alternative A and would be **nominal**.

4.8.6.3 Cumulative Impacts

4.8.6.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.8.6.1 and 4.8.6.2** concluded that activities projected to occur under Alternative E would result in **nominal** impacts to *Sargassum* and associated communities, depending on the IPF.

4.8.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.8.2.3.2**) would remain the same under Alternative E.

4.8.6.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative E are described in **Chapter 2.7** and summarized in **Chapter 4.8.6.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3**). The reduction of deep-penetration, multi-client activities (in line miles) by 10 percent (Alternative E1) or 25 percent (Alternative E2) would reduce the extent, severity, and timing of vessel traffic, vessel discharges, and trash and debris; therefore, impacts for these IPFs would be incrementally decreased under Alternative E. The incremental impact of this proposed alternative on the population of *Sargassum* would be **nominal** when considered in the context of cumulative impacts to the population. Impacts from changing water quality and climate change would be much more influential on *Sargassum* than G&G-related activities and would still occur without such activities.

4.8.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.8.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative F on *Sargassum* and associated communities.

4.8.7.1 Impacts of Routine Activities

Alternative F would require area closures in the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area for seismic airgun survey operations. The closure areas under Alternative F would not change the extent or severity of vessel traffic, vessel discharges, and trash and debris generated from G&G activities in the majority of the AOI as a whole. Consequently, the impacts to *Sargassum* and associated communities would be unchanged under Alternative F compared with Alternative A (**Chapter 4.8.2.1**). Thus, the impacts to *Sargassum* and associated communities would be expected to remain **nominal**.

4.8.7.2 Impacts of an Accidental Fuel Spill

Under Alternative F, impacts of an accidental fuel spill on *Sargassum* and associated communities would be very similar to those analyzed for Alternative A in **Chapter 4.8.2.2**. The analysis concluded that a small fuel spill at the sea surface would result in **nominal** impacts. A change in the location of surveys would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential impacts to *Sargassum* and associated communities would be the same as under Alternative A and would be **nominal**.

4.8.7.3 Cumulative Impacts

4.8.7.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.8.7.1 and 4.8.7.2** concluded that activities projected to occur under Alternative F would result in **nominal** impacts to *Sargassum* and associated communities, depending on the IPF.

4.8.7.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.8.2.3.2**) would remain the same under Alternative F.

4.8.7.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative F are described in **Chapter 2.8** and summarized in **Chapter 4.8.7.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3**). Mitigation measures under Alternative F are similar to Alternative C with the addition of four area closures: CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area. Most mitigation measures under Alternative F would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to *Sargassum* and associated communities also would not change. The additional closures would reduce the extent and severity of impacts, and therefore would decrease incrementally under Alternative F. Furthermore, as discussed under Alternative C (**Chapter 4.8.4.3**), the area closures and restrictions would not appreciably change the cumulative impacts, and **nominal** incremental increases would be expected when considered in the context of cumulative impacts to the population. Impacts from changing water quality and climate change would be much more influential on *Sargassum* than G&G-related activities and would still occur without such activities.

4.8.1 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.8.2**). Alternative G reduces the extent or severity of vessel traffic, vessel discharges, trash and debris, and an accidental fuel spill generated from G&G activities in the majority of the AOI; consequently, the impact levels to *Sargassum* and associated communities would be **no impact**. Overall, impacts to *Sargassum* and associated communities from activities under Alternative G are expected to range from **no impact** to **nominal**. Under Alternative G, impacts of an accidental fuel spill on *Sargassum* and associated communities would be very similar to those analyzed for Alternative A in **Chapter 4.8.2.2**. The analysis concluded that a small fuel spill at the sea surface would result in **nominal** impacts. Alternative G ceases survey activities; therefore, impacts would decrease substantially. Overall, the risk of a small fuel spill and the potential impacts to *Sargassum* and associated communities would be **nominal** and would eventually be **no impact** once previously permitted activities cease.

It is expected, however, that without G&G surveys there could be an increase in exploratory drilling activity. In this case, impacts to *Sargassum* could be **nominal**. A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.8.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.8.2.3.2**) would remain the same under Alternative G.

Overall, the impacts to *Sargassum* and associated communities would result in **no impact** to **nominal** incremental increases in impacts for Alternative G, when considered in the context of cumulative impacts to the population. Impacts from changing water quality and climate change would be much more influential on *Sargassum* than G&G-related activities and would still occur with or without such activities.

4.8.2 Summary Conclusion

In summary, the IPFs that may impact *Sargassum* within the AOI include (1) vessel traffic, (2) vessel discharges, (3) trash and debris, and (4) accidental fuel spill.

Impacts to *Sargassum* and associated communities are assessed as **nominal** for Alternatives A through F based on the widespread patchy distribution of *Sargassum* mats and the propensity of *Sargassum* mats to be undisturbed by physical displacement. Impacts to species that utilize *Sargassum* as habitat for all or some of their life cycle (e.g., fish, sea turtles, and invertebrates) would be spatially limited and short term. No serious damage to *Sargassum* and associated communities is expected to occur for all alternatives. Impacts under Alternative G could be increased over time from **no impact** to **nominal**, depending on whether there was an increase in exploratory drilling activity.

4.9 COMMERCIAL FISHERIES

4.9.1 Description of the Affected Environment

The AOI supports regionally and nationally important commercial fisheries. Information presented in this chapter is primarily summarized from the most recently published *Fisheries Economics of the United States, 2014* (USDOC, NMFS, 2016d). Commercial fisheries and the fishing industry is an important component of the economy of the GOM (**Appendix E, Section 9**). In 2014, the seafood industry in the five Gulf Coast States supported nearly 191,000 jobs (**Table 4.9-1**), and the GOM's seafood industry generated $24.3 billion in sales. Florida generated the highest employment (93,000 jobs), sales ($18.3 billion), income ($3.4 billion), and value added impacts ($6.1 billion). Louisiana and Texas had the highest landings revenue in 2014, with $451 million and $278 million, respectively (USDOC, NMFS, 2016d).

Table 4.9-2 shows commercial landings (in thousands of pounds) of key species or species groups within the GOM, including blue crab, groupers, menhaden, mullets, oysters, red snapper, shrimp, stone crab, and tunas (USDOC, NMFS, 2016d). Fishers in the GOM region landed 1.1 billion pounds of finfish and shellfish in 2014 (USDOC, NMFS, 2016d). The main commercial fishing gears used within the AOI and along the Gulf Coast are bottom trawls, purse seines, gill nets, pots/traps, and longlines (bottom and pelagic) (**Table 4.9-3**). Commercial landings can show seasonal patterns in fish abundance or the effects of legislative closures, but do not provide actual locations of fishing activity. Such information must be inferred from species-specific habitat preferences and the particular gear used. For example, yellowfin tuna are caught with surface longlines beyond the continental shelf, and red snapper are caught with hook-and-line near reefs or other structures in inner and middle shelf waters.

Two methods used to protect specific habitats and control commercial fishing effort are designating closed areas (space) or closing fisheries (by time: temporary, seasonal, or permanent). Permanent fishery or area closures are year-round, whereas seasonal and rolling closures are usually only at certain times of the year. Locations of selected seasonal and area closures to commercial fishing in Federal waters of the AOI are shown in **Figure 4.9-1** and listed in **Table 4.9-4**. To notify the public of fishery or site closures, NMFS publishes the regulations, which are usually associated with a Fishery Management Plan (FMP) amendment or management action, in the *Federal Register*.

There currently are no aquaculture facilities in Federal waters of the GOM. However, the 2016 Aquaculture Final Rule (*Federal Register*, 2016e) was approved to implement an FMP for regulation aquaculture in the GOM (GMFMC, 2009). Species allowed for aquaculture include the following federally managed species native to the GOM and not genetically engineered (GMFMC, 2009; *Federal Register*, 2016e): cobia, King mackerel, Spanish mackerel, red drum, spiny lobster, and some species of GOM reef fish (listed in Appendix A of 50 CFR § 622.105(b)). Minimum depth for aquaculture cages is 25 m (82 ft), and maximum depth for anchored cages is 100 m (328 ft) (GMFMC, 2009). Water current speeds should be between 5 and 100 cm/s (0.2 and 3.3 ft/s) (GMFMC, 2009). Proposed aquaculture systems may consist of cages, net pens, enclosures, or other structures. Approval for permitting aquaculture facilities will be conducted on a case-by-case basis (*Federal Register*, 2016e). Each aquaculture facility will have a restricted access zone. Restricted access zone boundaries will be clearly marked with floating devices (i.e., buoys). No recreational or commercial fishing, other than aquaculture, may occur within the restricted access zone (*Federal Register*, 2016e). BOEM is not aware of any currently pending aquaculture permits.

The *Deepwater Horizon* explosion, oil spill, and response had various impacts on the commercial fishing industry in the GOM. The initial closure of 17,648 km^2 (6,814 mi^2) occurred on May 2, 2010, 12 days after the initial explosion. As the oil spill continued and spread due to currents and winds, the closure was expanded to include areas off Louisiana, Mississippi, Alabama, and Florida based on oil slick modeling (USDOI, BOEM, 2012a). At its peak on June 2, 2010, the fishery closure encompassed 229,271 km^2 (88,522 mi^2), or approximately 37 percent of the Federal EEZ. The last of the closed areas was reopened on April 19, 2011 (USDOC, NOAA, 2011).

Carroll et al. (2016) describes the short-term impacts of the *Deepwater Horizon* explosion, oil spill, and response on the GOM commercial fishing industry. From May through December 2010, there were reductions in landings for most species, including shrimp, oysters, menhaden, blue crab, and pelagic finfish. This impacted harvesters, dealers, processors, distributors, marketers, and restaurants in the GOM seafood supply chain. Austin et al. (2014a) and Austin et al. (2014b) employed ethnographic methods and data analysis to analyze the impacts of the *Deepwater Horizon* explosion, oil spill, and response on various industries, including the seafood industry. These studies point out how the short-term impacts of the *Deepwater Horizon* explosion, oil spill, and response on the seafood industry were exacerbated by existing trends (such as increasing import competition) and seafood safety concerns. The longer-term impacts of the *Deepwater Horizon* explosion, oil spill, and response will depend on the impacts to fish populations (refer to **Chapter 4.1**). Fodrie and Heck (2011) concluded there was no substantial shift in species composition for some nearshore fish species in the GOM after the spill. In addition, commercial landings for most species have not substantially changed during recent years (USDOC, NMFS, 2016d). Additional information pertaining to this resource and NMFS' determination of the effects of the *Deepwater Horizon* explosion, oil spill, and response may be found in the Final PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016).

4.9.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact commercial fisheries within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars), (2) vessel traffic, (3) stand-off distance, (4) seafloor disturbance, (5) entanglement, and (6) accidental fuel spill.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level categories. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For commercial fisheries, the following impact-level criteria have been used to evaluate the level of impact for each IPF.

- **Nominal** impacts to commercial fisheries would include those where little to no measurable impacts are observed or expected. There would not be any interruption of commercial fishing activities, gear damage, or detectable impacts to commercial fish resources.
- **Minor** impacts to commercial fisheries would include those that are detectable but not severe or extensive. Minor impacts to commercial fisheries would include localized, short-term interruption of commercial fishing activities or localized gear damage with no detectable effect on commercial fish landings. Minor impacts also would include localized, minor impacts on fish resources with no detectable effect on commercial fisheries landings.
- **Moderate** impacts to commercial fisheries would be detectable, short term, and extensive but not severe; or severe but localized. Moderate impacts to commercial fisheries would include extensive but infrequent interruption of commercial fishing activities, damage to fishing gear sufficient to result in detectable decreases in commercial fisheries landings, and extensive but not severe impacts on fish resources (i.e., not sufficient to result in sizable decreases in commercial fisheries landings).
- **Major** impacts to commercial fisheries would be detectable, extensive, and severe. Major impacts to commercial fisheries would include extensive, frequent interruption of commercial fishing activities; damage to fishing gear sufficient to result in sizable decreases in commercial fisheries landings; and extensive, severe impacts on fish resources (i.e., sufficient to result in sizable decreases in commercial fisheries landings).

4.9.2.1 Impacts of Routine Activities

4.9.2.1.1 Active Acoustic Sound Sources

The spatial and temporal characteristics of active acoustic sound source utilization vary depending on the type of activity. As discussed in **Chapter 4.4.2.1**, HRG surveys may take several days and cover smaller areas, whereas seismic surveys (i.e., 2D, 3D, 4D, WAZ, or VSP) may occur throughout significant portions of the AOI and continue for weeks or months. Therefore, proposed G&G activities include various types of seismic and non-seismic surveys that could affect economically valuable commercial fisheries and fishing operations throughout the AOI. The spatial and temporal (e.g., seasonal fishing activity) characteristics of individual commercial fisheries are important to assess impact.

Physiological and behavioral impacts caused by active acoustic sound sources can occur in invertebrates, depending on the species (**Chapter 4.4.2.1**). For some invertebrates, behavioral and physiological impacts could indirectly influence catchability. However, available studies of the effects of G&G sound sources on economically important invertebrates suggest that behavioral responses are very limited (**Chapter 4.4.2.1**) (La Bella et al., 1996; Andriguetto-Filho et al., 2005; Parry and Gason, 2006). Given these results, commercial fisheries using pots/traps, dredges, and otter trawls to catch invertebrates likely would not be significantly affected by exposure of these animals to seismic sound.

Sound is used by fishes in a variety of ways (Zelick et al., 1999; Fay and Popper, 2000), as summarized in **Appendix J**. A detailed discussion of direct and indirect effects of sound on fishes is presented in **Chapter 4.4.2.1**. Sound produced from anthropogenic sources (e.g., airguns, echosounders) can directly affect fishes in a variety of ways, ranging from changes in behavior to mortality. Direct effects such as auditory masking or TTS may impede a fish's ability to detect biologically relevant sounds, thereby adversely impacting fitness. Thus, anthropogenic sound sources could interfere with normal behaviors or impact the survival of individuals or populations (e.g., feeding, predator detection, finding mates, spawning). These direct effects could lead to indirect effects such as changes in the catchability of commercial fish stocks. In particular, anthropogenic sound could cause fishes to alter their movements, including avoidance of certain areas, affecting the ability of fishers to locate and capture them, which could increase the potential for changes to commercial fishery landings and revenue to fishers.

Available studies indicate that fish catches can be impacted by seismic airgun sounds and may increase, decrease, or remain the same (Skalski et al., 1992; Løkkeborg and Soldal, 1993; Engås et al., 1996; Løkkeborg et al., 2012). Data indicate catch rates return to normal within several days of sound cessation, suggesting the effects are temporary. The change in fish catch depends on the species being fished, fishing gear used, and fishing location (Løkkeborg et al., 2012; Hawkins et al., 2014). Limited information is available about the response of commercially important fish to seismic survey sounds, in part because of the difficulty observing the behavior of fish populations at the temporal and spatial scales at which commercial fishing activities are conducted.

Impacts from active acoustic sound sources to fish behavior are discussed in **Chapter 4.4.2.1**. Sounds generated by some types of seismic survey equipment could affect the behavior and availability of the prey of commercially important fishes. Several studies indicate that seismic surveying temporarily decreases local abundances of some fishes, while other fishes move to deeper depths (Chapman and Hawkins, 1969; Dalen and Knutsen, 1987; Engås et al., 1996; Slotte et al., 2004). Conversely, sound might not elicit any behavioral responses unless they mimic biologically relevant characteristics of sounds similar to those produced by predators or prey (Plachta and Popper, 2003; Doksæter et al., 2009; Jorgenson and Gyselman, 2009; Peña et al., 2013). Fishes (captive and free-swimming) exposed to seismic sound initially exhibit a startle response, then potentially habituate to the sound, and after a period of time resume normal behavior (McCauley et al., 2000; Wardle et al., 2001; Fewtrell and McCauley, 2012). Thus, reaction to sound is species-specific and depends on the level and type of sound being produced.

Exposure to seismic sound can startle fish and, for some commercially important species, cause them to move to deeper depths or away from a seismic sound source. Additionally, exposure to seismic sound can cause behavioral responses that change the availability of commercially important fish species to traditional fishing gear for a period of time. The spatial scale of behavioral responses to seismic sound is not well understood, but it can extend up to 50 km (31 mi) from a seismic sound source (Slotte et al., 2004). Behavioral effects are variable and depend on species, habitat, previous exposure, and current motivation (**Chapter 4.4.2.1**). Data indicate that behaviors (e.g., feeding, spawning, migration) of commercially exploited pelagic and demersal fish stocks would be affected only temporarily. Given the limited spatial and temporal characteristics of seismic airguns used under the proposed activity scenario, whether in HRG or non-HRG surveys (refer to **Chapter 4.4.2.1**), and the results of limited seismic sound exposure studies on fishes, potential impacts to commercial fisheries resources likely would be **minor**, with no population-level effects, under Alternative A. Indirectly, catch rates could decline but would be expected to return to normal levels following the cessation of the seismic operation (Engås et al., 1996; Engås and Løkkeborg, 2002). Therefore, there could be a localized and temporary decrease or increase, depending on the gear type, in catchability of one or more commercial fish species. Catchability of fishes contained within aquaculture enclosures likely will not be impacted by seismic airguns. Given the range of fish responses to gear (catch increases and decreases) and the temporary nature of the behavioral effects associated with seismic airguns, G&G activities are expected to result in **minor** impacts to commercial fisheries under Alternative A.

As discussed in **Chapter 4.4.2.1**, electromechanical sound sources such as echosounders, subbottom profilers, side-scan sonars, and MBESs used in non-airgun HRG surveys could affect the behavior of some fish species (Nestler et al., 1992; Mann et al., 1997; Popper et al., 2004) and not others (Doksæter et al., 2009, 2012; Sivle et al., 2012). Sonar can cause TTS in fish, but studies have shown that the occurrence of TTS varies among species, and the severity of TTS can vary among individuals of the same species, depending on age and developmental stage (Popper et al., 2007; Halvorsen et al., 2012b, 2013). Sonar at intensities and durations considerably higher and longer than what is normally expected (193 and 195 dB re 1 μPa SPL_{rms}) can cause TTS in some species (Popper et al., 2007; Halvorsen et al., 2013). Current research suggests that recovery from TTS occurs within 24 hours (Halvorsen et al., 2012b, 2013). Therefore, impacts from electromechanical sources could influence the behavior and hearing abilities of some commercial fisheries resources. The effects are expected to be localized and temporary, with no population-level effects. Catchability of fishes contained within aquaculture enclosures likely will not be impacted by non-airgun HRG sound sources. Therefore, impacts associated with electromechanical sounds, such as acoustic sound sources used in non-seismic HRG surveys, are expected to result in **nominal** impacts to commercial fishery resources under Alternative A.

4.9.2.1.2 Vessel Traffic

Vessel traffic generated by each type of G&G survey proposed within the AOI is shown in **Table 3.3-3**, and the types of surveys and activity level scenarios are described in **Chapter 3.3.1.3**.

Under Alternative A, vessel traffic could increase slightly in specific areas; however, vessel traffic is not expected to cause any additional impact to commercial fishery resources, including commercial fisheries landings. Vessel traffic will not increase in the vicinity of aquaculture facilities because each facility will have a restricted access zone in which no other activities will occur (*Federal Register*, 2016e). Impacts are expected to be **nominal** because vessel traffic is relatively high in the AOI, and G&G activities have been ongoing in the area. Additionally, commercial fisheries and G&G operators are accustomed to cooperatively utilizing the same waters, and advance notice of seismic survey activity is provided to fishers by seismic survey operators.

4.9.2.1.3 Stand-Off Distance

Due to the limited maneuverability of seismic survey vessels towing airgun streamers, stand-off distances are implemented. For safety reasons, stand-off distances are meant to keep other vessel traffic at certain distances from the seismic surveys. Neither a seismic vessel towing an array nor a fishing vessel towing fishing gear are particularly maneuverable; therefore, communication between the industries is necessary to avoid accidents. Typical stand-off distance protocols are described in **Chapter 3.3.1.5**.

The direct effects of a stand-off distance are the temporary loss of access to fishing grounds and loss of fishing time. Stand-off distances associated with G&G activities may require commercial fishers to retrieve nets or lines earlier than usual to avoid seismic survey vessels or cause them to wait until the seismic vessels have moved past the fishing grounds. If commercial fishers temporarily lose access to fishing grounds or suspend fishing activity, they may experience reductions in quantity and quality of catch, which could affect revenue. Interruption of fishing could be further exacerbated if numerous seismic vessels are conducting surveys through fishing grounds or in optimal fishing locations (e.g., fishing grounds or seasons), thus delaying the deployment of fishing gear in locations that maximize catch. Stand-off distances will not affect aquaculture facilities because each facility will have its own restricted access zone in which no other activities will occur (*Federal Register*, 2016e).

Vessel traffic associated with G&G activities would increase in specific areas, thereby increasing the potential for temporary interactions of seismic vessels and commercial fishing vessels through stand-off distances. Seismic survey operators are required to advise fishers when they will be active in an area. Given the small area typically occupied by the stand-off distance for seismic vessels, the short duration of the impact at any given location, and the advance notice provided by seismic survey operators, space-use conflicts between G&G activities and commercial fishing operations within the AOI will be limited. Under Alternative A, G&G activities and associated stand-off distances are not expected to have any indirect effects on commercial fishery operations unless these activities cause commercial fishers to leave an impacted fishery to concentrate on alternative fishing activities. Commercial fisheries continually evolve, so it is difficult to gauge whether conflicts in area use with seismic operations would cause some fishers to leave a fishery. Most commercial fishers already participate in various commercial fisheries, so stand-off distances likely would not cause any significant changes in fishing effort distribution.

Existing space-use conflicts (e.g., competing fisheries, commercial fishing and OCS development) are an important consideration in marine spatial planning (Crowder and Norse, 2008; Ehler and Douvere, 2009). Seismic survey activity in a fishing area would preclude use of that area to fishers while the survey vessel is operating. When fishing grounds are inaccessible because of stand-off distance requirements, there would be a **minor** incremental increase in impacts to commercial fisheries. Although stand-off distances associated with the proposed G&G activities could affect a limited amount of commercial fishing within the AOI, impacts are expected to be intermittent, localized, and temporary. Impacts to commercial fisheries landings arising from stand-off distances are expected to be **minor** under Alternative A.

4.9.2.1.4 Seafloor Disturbance

Bottom fisheries (i.e., dredges, otter trawls, and bottom longlines) in the AOI are among the most valuable commercial fisheries. The main effect associated with seafloor disturbance is long-term change in benthic community structure. The projected area of seafloor disturbance from G&G activities is a small area (**Table 3.2-7**). Depending on the amount and frequency of G&G surveys that could disturb the seafloor in a specific area, G&G activities could change biodiversity, cause habitat fragmentation, and reshape benthic community structure (albeit on very small spatial scale), which could adversely and indirectly affect commercial bottom fisheries. Such effects have been documented in trawling and dredging operations (Barnette, 2001). Benthic communities have been significantly affected by commercial and recreational fishing activities, which are estimated by Watling and Norse (1998) to trawl approximately 53 percent (14.8 million km^2 [5.7 million mi^2]) of the world's continental shelf annually.

Seafloor disturbance related to G&G activities under Alternative A could indirectly affect some commercial fishing activities within the AOI. Although estimating the economic impacts at the regional level (if any) is difficult, these activities could impact specific commercial fisheries in the AOI. Seafloor disturbances related to G&G activities would not occur at aquaculture facilities because each facility will have its own restricted access zone in which no other activities will occur (*Federal Register*, 2016e). Intermittent, temporary, and short-term changes in benthic communities likely would occur as a result of G&G benthic sampling and coring activity (**Chapter 4.5.2.1**). However, these types of G&G activities would be conducted on a very limited basis, and the total area affected represents a small area (**Table 3.2-7**). In addition, BOEM conducts site-specific reviews of plans, pipeline applications, structure-removal applications, and ancillary activity applications in order to prevent routine bottom-disturbing activities from occurring within specified buffer distances from live bottom (low-relief) areas.

The total areal extent of seafloor disturbance expected under the proposed action is a very small area of seafloor (**Table 3.2-7**). However, there is a chance that a particular seafloor disturbance, no matter how small, may occur within a productive fishing area. Seafloor disturbance and its impact to commercial fishery operations and landings under Alternative A are expected to be limited and localized, but potentially overlapping with productive fishing grounds and/or shipwrecks that function as artificial reefs and coral habitat; therefore, impacts are expected to be **minor** under Alternative A.

4.9.2.1.5 Entanglement

Vessel traffic associated with G&G activities would increase in specific areas, thereby increasing the potential for direct interference with commercial fishing operations. Direct impacts to commercial fisheries associated with G&G activities would include entanglement or damage to benthic and pelagic fishing gear.

Commercial fishery gears such as pots/traps, gillnets, and longlines (pelagic and bottom) are classified as passive gear. These gear types usually are set and left unattended for hours or days. Therefore, an increase in vessel traffic and towed survey gear (e.g., streamers) could increase the chances that fishing gear would be disturbed or damaged (e.g., buoys and lines cut) by seismic vessels, especially at night. Entanglement related to G&G activities would not occur at aquaculture facilities because each facility will have its own restricted access zone in which no other activities will occur (*Federal Register*, 2016e). The G&G survey activities would be expected to result in increased risk for entanglement of fishing gear with seismic gear, particularly in nearshore waters (<4.8 km [3 mi] from shore) where benthic and demersal inshore fisheries are operating.

Commercial fishery operations that use fishing gear placed on the seafloor have the potential for entanglement or damage within the AOI. Most passive gears are marked by surface buoys. However, the buoys of longlines and traps may mark only the terminal ends of gear. These types of gear would be susceptible to damage or entanglement from G&G bottom-founded equipment (e.g., OBCs, anchors, receivers, certain geotechnical surveys [**Appendix F, Section 1.1.3**]). Under Alternative A, seafloor disturbance caused by bottom-sampling activities could affect unmarked fishing gear or segments of gear deployments used by bottom-associated commercial fishing operations.

Entanglement and its impact to commercial fishery operations and landings under Alternative A could overlap with fishing grounds. Stand-off distances and advanced notification from seismic survey operations will reduce direct interactions between fishing gear and seismic survey equipment (**Chapter 4.9.2.3.3**). Additionally, fishing gear will have surface markers. Commercial fisheries and G&G operators are accustomed to cooperatively utilizing the same waters and are familiar with the operations and equipment of each other’s industries. Thus, fishing equipment could be damaged, but the potential for impacts are reduced by several measures, and any impacts would be spatially localized and temporary. For example, one measure to mitigate the impacts of damaged fishing equipment is the Fishermen's Contingency Fund Program, which was created to compensate fishers for economic and property losses as a result of oil and gas industry activities on the OCS (Sharp and Sumaila, 2009; USDOC, NMFS, 2013e). According to NMFS, claims were approved for $188,168 in FY 2010, $126,608 in FY 2011, and $63,588 in 2012 (USDOC, NMFS, 2013e). Therefore, impacts to commercial fisheries arising from entanglement are expected to range from **nominal** to **minor** under Alternative A.

4.9.2.1.6 Routine Activities Impact Conclusions

Overall, impacts from proposed activities to commercial fisheries are expected to range from **nominal** to **minor**. Airgun sound sources, seafloor disturbance, and stand-off distances may result in **minor** impacts; entanglement risks may result in **nominal** to **minor** impacts; and HRG sound sources and vessel traffic impacts would be **nominal**. Overall, impacts to commercial fisheries from routine activities under Alternative A are expected to range from **nominal** to **minor**.

4.9.2.2 Impacts of an Accidental Fuel Spill

An accidental event could result in the release of diesel or other fuel by a survey vessel, but such an event has a remote probability of occurring. For the purposes of this analysis, a vessel collision is assumed to release 1.2 to 7.1 bbl of diesel fuel.

In the event of a fuel spill from a seismic vessel, commercially important fishes could be exposed to water-soluble fractions of spilled diesel. Surface-feeding fishes are most likely to be exposed. For example, tuna and swordfish, commercially important species, sometimes associate with floating *Sargassum* habitat or surface waters, and dolphinfish often consume small fishes associated with *Sargassum*. Given the size of the diesel spill, the extent of surface fouling would be limited. Under the expected spill scenario developed in **Chapter 3.3.2**, a diesel fuel spill would be expected to remain in surface waters, subjected to evaporation and dispersion; a portion of the spill may sink. A small release of diesel fuel likely would not have any direct impact to commercial fishery landings in the AOI. Although a small fuel spill is not likely to pose a serious threat to fishery landings, consumers may not buy fish or shellfish from the affected area. Misperceptions like this could result in a temporary drop in revenue to local commercial fishers. However, potential for impacts are reduced by several measures, including the Fisherman's Contingency Fund Program, as discussed earlier. Therefore, impacts to commercial fisheries resources from an accidental fuel spill would be **nominal** under Alternative A.

4.9.2.3 Cumulative Impacts

4.9.2.3.1 OCS Program G&G Survey Activities

The G&G survey activities would occur in the context of the overall OCS Program. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue.

Oil and gas activities associated with the OCS Program, such as 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. Oil spills could cause fishing closures and have other impacts on the supply and demand for seafood. However, oil spills would likely be small and localized. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access. For more information on impacts to commercial fisheries by oil and gas activities, refer to Chapter 4.10 of the 2017-2022 GOM Multisale EIS.

4.9.2.3.2 Activities Other Than OCS Program G&G Survey Activities

This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for commercial fisheries are compared with the IPFs from each of the cumulative scenario components on activities that coincide spatially and temporally with the proposed action. The activities that have the potential to affect fisheries resources and EFH include (1) Federal and State oil and gas activities, (2) noise, (3) vessel traffic, (4) stand-off distance, (5) seafloor disturbance, and (6) entanglement. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI.

Federal and State Oil and Gas Activities

Federal oil and gas activities associated with the OCS Program, such as 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. Oil spills could cause fishing closures and have other impacts on the supply and demand for seafood. However, oil spills would likely be small and localized. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access. For more information on impacts to commercial fisheries by oil and gas activities, refer to refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.10 of the 2017-2022 GOM Multisale EIS.

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 the overall OCS Program, although the affected species may be different. Accidental spills in State waters would most likely affect coastal and inshore fisheries due to proximity to the shorelines (e.g., shrimp, menhaden, oysters, and blue crab). The early life stages of these targets are generally more vulnerable to oil exposure and could be affected if a spill coincides with a spawning event or if a spill impacts nursery habitat. For example, oysters and blue crab are primarily located in State waters and thus could be impacted by the associated State oil and gas routine and accidental impacts. The OCS Oil and Gas activities such as 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. Oil spills could cause fishing closures and have other impacts on the supply and demand for seafood. However, oil spills would likely be small and localized. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access.

Noise

Active Acoustic Sound Sources

Active acoustic sound sources related to oil and gas development have been ongoing in the GOM for decades and are likely to continue in the future. As described in **Chapter 4.9.2.1**, active acoustic sound produced by seismic surveys conducted under the proposed action can influence fish behavior in ways that may impact commercial fishing catch or effort, but data suggest their effects are temporary (Skalski et al., 1992; Løkkeborg and Soldal, 1993; Engås et al., 1996; Løkkeborg et al., 2012). Catchability of fishes contained within aquaculture enclosures likely will not be impacted.

The G&G activities associated with the proposed action will not be conducted within State waters. However, other agencies can permit G&G activities that include active sound sources (e.g., seismic airguns and side-scan sonars for oil and gas activities in State waters). Sound produced by these surveys may propagate into coastal waters, but will be significantly reduced in intensity proportional to the distance of seismic survey vessels from State waters and will, in most cases, add an insignificant amount to sound generated by similar sound sources operating in State waters. Seismic sound propagating into State waters from G&G activities is not likely to have a meaningful impact on commercial fishing when compared with sound caused by seismic vessels operating in State waters.

Other major factors that contribute active acoustic sound sources are shown in **Table 3.4-1**. Impacts to commercial fisheries from similar sound sources under the G&G proposed action are discussed in **Chapter 4.9.2.1**. Active acoustic sound sources have been ongoing in the AOI for multiple decades and are likely to continue in the future. Anthropogenic sound levels in the marine environment are increasing, and impacts to fish behavior and hearing capabilities may subsequently impact commercial fishing (Slabbekoorn et al., 2010; Radford et al., 2014). However, overall increases in sound are difficult to assess because of the lack of baseline data from individual sound sources and the ambient sound conditions (Hawkins et al., 2014). Impacts to fisheries catch have been noted in several instances, although impacts are shown to be temporary (Skalski et al., 1992; Løkkeborg and Soldal, 1993; Engås et al., 1996; Løkkeborg et al., 2012).

Vessel Traffic

Commercial fishermen also encounter space-use conflicts with recreational, commercial, and military vessels that temporarily restrict access to fishing areas. 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 GOM, particularly near major ports.

Support vessel traffic is a key part of most OCS Program activities. Increased vessel traffic in particular areas could negatively affect commercial fishing effort or gear deployment/retrieval. Under the proposed action for activities within BOEM's jurisdiction, seismic vessels and other support vessel traffic will operate primarily in Federal waters, but vessels will cross State waters when transiting to and from shore. While departing from and returning to port, oil and gas vessels will not be engaged in BOEM-managed G&G activities, and therefore can navigate to avoid active fishing vessels and deployed fishing gear. Vessel traffic that may result from oil and gas activities is shown in **Table 3.4-2**. Vessel traffic from the proposed action is discussed in **Chapter 3.3.1.3**.

Stand-Off Distance and Space-Use Conflicts

Space-use conflicts with commercial fishing can arise from operations such as service-vessel traffic, non-OCS-related seismic surveys, pipeline emplacement, drilling, aquaculture operations, 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 occurs. 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 GOM, where production structure 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. The overall number of production structures also serves more of a beneficial role for reef fish, although the corresponding decommissioning of these structures negatively impact commercial fishing for reef species. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access.

Certain activities under the OCS Program are managed to provide an area, called the stand-off distance, around the activity to help avoid interactions between fishing vessels and oil and gas vessels that would be hazardous to vessels, crew, and gear. Stand-off distance may result from other major factors including Federal and State oil and gas drilling and production, deepwater ports, dredged material disposal, military activities, and coastal restoration programs, and can cause similar impacts to those from seismic surveys from G&G activities. Stand-off distances are expected to cause temporary loss of access to fishing grounds and loss of fishing time. Stand-off distances from non-OCS-related G&G activities will have less of an impact when seismic survey vessels are not operating (e.g., in coastal or State waters).

Loss of access to fishing grounds or delays in setting fishing gear in optimal locations may result in reduced quantity and quality of catch, which ultimately could affect commercial fishing revenue. Access to fishing grounds occasionally may be limited due to stand-off distances from seismic activity; however, aquaculture facilities will not be affected by stand-off distances.

Seafloor Disturbance and Entanglement

One of the biggest impacts to commercial fishermen is from entanglement in seafloor appurtenances (**Table 3.4-1**; e.g., drilling rigs, bottom-founded meteorological buoys, wind turbines, and cables), specifically bottom fisheries (i.e., fish traps, bottom longline, and bottom and mid-water gillnets). Support vessel traffic or other OCS Program activities could result in entanglement of fishing gear (**Chapter 3.4.1**).

Other seafloor activities would result in the destruction and/or alteration of habitat and disturbance of benthic communities (e.g., fishes and invertebrates such as flounders, shrimps, and crabs and their habitats). In many locations within the AOI, benthic habitat has already been severely impacted by commercial fishing operations; any additional impacts arising from additional seafloor-disturbing activities could further reduce available habitat for bottom fishes and invertebrates (Barnette, 2001). A number of cumulative action scenario activities would result in additional seafloor disturbance (e.g., oil and gas exploration and development, marine minerals use, geosequestration, and LNG terminals).

State waters oil and gas activities disturb the seafloor by anchoring, trenching, coring, and bottom sampling. In addition, it is extremely unlikely that effects such as increased turbidity resulting from seafloor-disturbing activities conducted external to State waters would be transported into State waters by ocean physical processes. Seafloor disturbances that are contributed by other major factors include oil and gas development in Federal and State waters, marine minerals use, dredged material disposal, military activities, and extreme climatic events.

BOEM would require site-specific information regarding seafloor and fishing resources prior to approving most of the activities involving seafloor-disturbing activities or placement of bottom-founded equipment or structures in the AOI. BOEM would use this information to ensure that impacts to benthic communities are avoided and impacts to fisheries resources are evaluated; therefore, benthic communities would be protected from impacts from oil and gas development, marine minerals use, renewable energy development, geosequestration, and LNG import terminals. Further, the level of activity in the time period analyzed in this Programmatic EIS for cumulative scenario activities is not anticipated to cause extensive seafloor disturbance when compared with the entire AOI.

4.9.2.3.3 Cumulative Impact Conclusions

Overall, activities associated with the proposed action would increase the levels of vessel traffic and noise within the AOI, resulting in sporadic increases in ambient noise levels during proposed G&G operations. Impacting factors associated with the cumulative scenario that may affect commercial fisheries in the AOI include active acoustic sound, vessel traffic, stand-off distance, seafloor disturbance, and entanglement. Many of these IPFs may occur simultaneously during some projected operations under the OCS Program.

Spatial distribution of activities projected under the proposed action during the project period are most concentrated within deepwater regions of the CPA and WPA, and less concentrated within continental shelf waters (**Table 3.2-1**). Very little activity is projected to occur within the EPA. Temporally, activity levels associated with the proposed action vary by activity type and year (**Tables 3.2-1 through 3.2-5**). Overall, proposed activities are expected to result in nominal to minor incremental increases to the cumulative impacts to commercial fisheries. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access.

4.9.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.9.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on commercial fisheries.

4.9.3.1 Impacts of Routine Activities

Additional mitigation measures under Alternative B that would not change the extent, severity, or timing of G&G activities include the expansion of NTL 2016-BOEM-G02 (inclusion of manatees and application to all deep-penetration seismic airgun surveys in all water depths) and the expanded use of PAM. Because these mitigation measures will not impact commercial fisheries, they will not be addressed in the following discussion.

4.9.3.1.1 Coastal Waters Seasonal Restrictions

Alternative B would require seasonal restrictions for seismic airgun survey operations from (a) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath) and (b) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the UME in the northern GOM (**Figure 2.2-1 and Chapter 2.4.3**). The impacts of active acoustic sound sources, vessel traffic, and exclusions zones would be reduced, but only within coastal waters during the seasonal restrictions described above. The closure area would be 13.1 percent of the area of the AOI. The purpose of this mitigation measure is to protect marine mammals within the closure areas from the IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some coastal fish species (**Tables 4.4-1, 4.4-2, and 4.4-4**) as the effects on free-swimming and captive (i.e., aquaculture) fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced in the coastal seasonal restriction area. Furthermore, this may indirectly benefit commercial fisheries because a reduction in the impact to fish hearing and behavior could result in a reduction in the indirect impacts to commercial catch rates (discussed in detail in **Chapter 4.9.2.1**). Another benefit would be a reduction in vessel traffic and exclusion zones from seismic surveys during the closure period, which subsequently will reduce the potential for damage to fishing gears or loss of access of fishing grounds. However, seismic surveys still will occur outside the area, the closure timeframe is temporary, and the closure area is small compared with the size of the AOI. Thus, while a change in survey timing in the coastal seasonal restriction area would slightly reduce the impacts of active acoustic sound sources, vessel traffic, stand-off distances, and entanglement from seismic airguns surveys on commercial fisheries, it would not change the overall impact level. Therefore, impacts of active acoustic sound sources from airguns, stand-off distance, and seafloor-disturbing activities are expected to remain **minor** for commercial fisheries under Alternative B. The mitigation measure does not apply to sound sources from non-airgun HRG surveys or vessel traffic; therefore, the impacts will remain **nominal** for commercial fisheries under Alternative B. Impacts from entanglement would remain **nominal** to **minor**.

4.9.3.1.2 Minimum Separation Distances

Alternative B would establish a 40-km (25-mi) separation distance between simultaneously operating deep-penetration seismic airgun surveys within the Areas of Concern (**Chapter 2.4.2**) to limit ensonification of specific areas of the AOI at the same time. When outside the Areas of Concern, the separation distance will be 30 km (19 mi). However, the separation distance requirement does not apply to multiple ships operating in a coordinated survey such as a WAZ survey, and it need not be maintained if unsafe or due to weather conditions.

Applicable routine IPFs for commercial fisheries are active acoustic sound sources, vessel traffic, stand-off distance, and entanglement. Limits on concurrent seismic airgun surveys under Alternative B could change the timing of seismic surveys in certain areas. The locations cannot be predicted in advance, but would depend on the schedule, planned coverage of individual surveys, and ports to be used for support activities. Seismic surveys still will be conducted; therefore, a change in survey timing because of limits on concurrent seismic airgun surveys would not alter impacts from active acoustic sound sources (including seismic airguns and electromechanical sounds), vessel traffic, stand-off distance, seafloor-disturbing activities, and entanglement. Impacts of active acoustic sound sources, stand-off distance, and seafloor-disturbing activities are expected to remain **minor** for commercial fisheries under Alternative B. The mitigation measure does not apply to sound sources from non-airgun HRG surveys or vessel traffic, so impacts will remain **nominal** for commercial fisheries under Alternative B. Impacts from entanglement would remain **nominal** to **minor**.

4.9.3.1.3 Seismic Restrictions in the Areas of Concern within the EPA

Additional restrictions under Alternative B include prohibiting deep-penetration seismic airgun surveys within the portion of the Areas of Concern (**Chapter 2.4.2**) falling within the EPA. This restriction does not apply to surveys related to currently leased blocks, any portion of the area encompassed by EPA Lease Sale 226, or OCS lease blocks adjacent to permitted survey areas but within an otherwise off-limit area.

A restriction on seismic surveys within a portion of the AOI could result in reduced impacts from active acoustic sound sources, vessel traffic, stand-off distance, seafloor-disturbing activities, and entanglement due to the reduced area of activity. The purpose of this mitigation measure is to protect marine mammals within the closure areas from IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some oceanic fish species (refer to **Appendix E, Section 9**) in the closure area, as the effects on free-swimming and captive (i.e., aquaculture) fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced in the region. Furthermore, this may indirectly benefit commercial fisheries because a reduction in the impact to fish hearing and behavior could result in a reduction of the impacts to commercial fisheries catch rates (discussed in detail in **Chapter 4.9.2.1**). Another benefit would be a reduction in vessel traffic, stand-off distances, seafloor-disturbing activities, and entanglement from seismic surveys in the restricted areas that would subsequently reduce the potential for damage to fishing gear or loss of access to fishing grounds. The impacts of active acoustic sound sources, vessel traffic, stand-off distance, seafloor-disturbing activities, and entanglement from seismic airgun surveys would be reduced, but only within the portion of the Areas of Concern falling within the EPA. The size of the closure area is small compared with the AOI, and the majority of deep-penetration seismic airgun surveys will occur in the WPA and CPA, where seismic surveys will not be restricted. Thus, there will not be a substantial reduction in seismic survey activity in the AOI, and the overall impacts on commercial fisheries would remain **nominal** to **minor** under Alternative B.

4.9.3.1.4 Routine Activities Impact Conclusions

Impacts to commercial fisheries arising from active acoustic sound sources, stand-off distance, and seafloor-disturbing activities are expected to remain **minor** under Alternative B. The mitigation measures do not apply to sound sources from non-airgun HRG surveys or vessel traffic; therefore, the impacts will remain **nominal** for commercial fisheries under Alternative B. Impacts from entanglement would remain **nominal** to **minor**. Overall, impacts to commercial fisheries from routine activities under Alternative B are expected to range from **nominal** to **minor**.

4.9.3.2 Impacts of an Accidental Fuel Spill

Under Alternative B, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. Alternative B would change the timing of certain surveys because of additional coastal seasonal restrictions; however, spills from seismic survey vessels could occur in the closure areas during times outside the closure period, and spills from other survey vessels could occur during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Therefore, impacts would be very similar to those analyzed for Alternative A in **Chapter 4.9.2.2**. Impacts to commercial fisheries resources from an accidental fuel spill or small diesel fuel spill would be **nominal** under Alternative B.

4.9.3.3 Cumulative Impacts

4.9.3.3.1 OCS Program G&G Survey Activities

The G&G survey activities would occur in the context of the overall OCS Program. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy or marine minerals will continue. Oil and gas activities associated with the OCS Program, such as drilling activities and service-vessel traffic, can cause space-use conflicts with fishermen. **Chapter 4.9.3.3.1** provides more information regarding the cumulative impacts of the OCS Program.

4.9.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.9.2.3.2**) would remain the same under Alternative B.

4.9.3.3.3 Cumulative Impact Conclusions

The mitigation measures under Alternative B do not change the cumulative outcomes described in Alternative A (**Chapter 4.9.2.3**). There would be a **minor** incremental increase in impacts to commercial fisheries from active acoustic sound sources and stand-off distances as well as a **nominal** incremental increase in impacts to commercial fisheries from vessel traffic, seafloor disturbance, entanglement, and accidental fuel spill. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access.

4.9.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.9.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative C on commercial fisheries.

4.9.4.1 Impacts of Routine Activities

Additional mitigation measures under Alternative C that would not change the extent, severity, or timing of G&G activities, and therefore related impacts to commercial fisheries, include the expanded use of PAM for seismic airgun surveys, the expanded use of PSOs for seismic airgun surveys and HRG surveys, expansion of NTL 2016-BOEM-G02 (inclusion of manatees) for seismic airgun surveys, expansion of NTL 2016-BOEM-G02 to include HRG surveys using airguns, and a pre-survey clearance period for HRG surveys. As such, these mitigation measures will not be addressed in the following discussion.

4.9.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

Alternative C would require seasonal restrictions for seismic airgun survey operations in Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31 (**Figure 2.3-1**). The impacts of active acoustic sound sources, vessel traffic, and stand-off distance would be reduced, but only within coastal waters between February 1 and May 31. The closure area is 13.1 percent of the area of the AOI. The purpose of this mitigation measure is to protect marine mammals within the closure area from IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some coastal fish species (**Tables 4.4-1, 4.4-2, and 4.4-4**), as the effects on free-swimming and captive (i.e., aquaculture) fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced in the coastal seasonal restriction area. Furthermore, this may indirectly benefit commercial fisheries because a reduction in the impact to fish hearing and behavior could result in a reduction of the indirect impacts to commercial fisheries catch rates (discussed in detail in **Chapter 4.9.2.1**). Another benefit would be a reduction in vessel traffic and stand-off distance from seismic surveys during the closure period that would reduce the potential for damage to fishing gear or loss of access of fishing grounds. However, seismic surveys still will occur outside this area, the closure timeframe is temporary, and the closure area is small compared with the size of the AOI. Thus, while a change in survey timing in the coastal seasonal restriction area would slightly reduce the impacts of active acoustic sound sources, vessel traffic, stand-off distance, seafloor-disturbing activities, and entanglement from seismic airgun surveys on commercial fisheries, it would not change the overall impact levels, and impacts range from **nominal** to **minor** depending on the IPF.

4.9.4.1.2 Routine Activities Impact Conclusions

Impacts of active acoustic sound sources, stand-off distance, and seafloor-disturbing activities are expected to remain **minor** for commercial fisheries under Alternative C. The mitigation measure does not apply to sound sources from non-airgun HRG surveys or vessel traffic; therefore, the impacts will be **nominal** for commercial fisheries under Alternative C. Impacts from entanglement would remain **nominal** to **minor**. Overall, impacts to commercial fisheries from routine activities under Alternative C are expected to range from **nominal** to **minor**.

4.9.4.2 Impacts of an Accidental Fuel Spill

Under Alternative C, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. Alternative C would change the timing of certain surveys because of additional coastal seasonal restrictions. However, spills from seismic survey vessels could occur in the closure areas during times outside the closure period, and spills from other survey vessels could occur during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Therefore, impacts would be very similar to those analyzed for Alternative A in

Chapter 4.9.2.2. Impacts to commercial fisheries resources from an accidental fuel spill or small diesel fuel spill would be **nominal** under Alternative C.

4.9.4.3 Cumulative Impacts

4.9.4.3.1 OCS Program G&G Survey Activities

The G&G survey activities would occur in the context of the overall OCS Program. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. Oil and gas activities associated with the OCS Program, such as drilling activities and service-vessel traffic, can cause space-use conflicts with fishermen. **Chapter 4.9.3.3.1** provides more information regarding the cumulative impacts of the OCS Program.

4.9.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.9.2.3.2**) would remain the same under Alternative C.

4.9.4.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative C are described in **Chapter 2.5** and summarized in **Chapter 4.9.4.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3**). Most mitigation measures under Alternative C would not change the extent, severity, or timing of activities in the proposed action, and therefore would not change the resultant impacts to commercial fishing. Under Alternative C, the mitigation measure that would change the timing and extent of activities in the proposed action is a seasonal restriction from February 1 to May 31 for operation of airguns in Federal and State coastal waters shoreward of the 20-m (66-ft) isobath within the AOI. The mitigations under Alternative C do not change the cumulative outcomes described in Alternative A (**Chapter 4.9.2.3**); there would be a **minor** incremental increase in impacts to commercial fisheries from active acoustic sound sources and stand-off distances, and a **nominal** incremental increase in impacts to commercial fisheries from vessel traffic, seafloor disturbance, entanglement, and accidental fuel spills. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access.

4.9.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.9.2**). The additional mitigation measure under Alternative D would not reduce potential active acoustic impacts discussed in Alternatives A and C (**Chapters 4.9.2.1 and 4.9.4.1**) and would remain **nominal** to **minor** depending on the source type. The mitigation would not alter impact levels to commercial fisheries from vessel traffic, stand-off distances, seafloor disturbance, or entanglement and would remain **nominal** to **minor** depending on the IPF. Under Alternative D, impacts of an accidental fuel spill on commercial fisheries would be as described for Alternatives A and C (**Chapters 4.9.2.2 and 4.9.4.2**) and would remain **nominal**.

4.9.5.1 Impacts of Routine Activities

The additional mitigation measure under Alternative D, exclusion of bow-riding dolphins from marine mammal shutdown protocols, would not change the extent, severity, or timing of IPFs outlined in Alternatives A and C. The mitigation measure does not apply to commercial fisheries or the associated IPFs; therefore, impacts of active acoustic sound sources, stand-off distance, and seafloor-disturbing activities from seismic airgun surveys are expected to remain **minor** under Alternative D. Impacts from non-airgun HRG surveys and vessel traffic will be **nominal** under Alternative D, while impacts from entanglement will range from **nominal** to **minor**. Overall, impacts to commercial fisheries from routine activities under Alternative D are expected to range from **nominal** to **minor**.

4.9.5.2 Impacts of an Accidental Fuel Spill

Alternative D would not add additional mitigation measures that would reduce the risk of an accidental fuel spill. Therefore, the impacts of the IPFs would be very similar to those analyzed for Alternative A in **Chapter 4.9.2.2**. Impacts to commercial fisheries resources from an accidental fuel spill or small diesel fuel spill would be **nominal** under Alternative D.

4.9.5.3 Cumulative Impacts

4.9.5.3.1 OCS Program G&G Survey Activities

The G&G survey activities would occur in the context of the overall OCS Program. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. Oil and gas activities associated with the OCS Program, such as drilling activities and service-vessel traffic, can cause space-use conflicts with fishermen. **Chapter 4.9.3.3.1** provides more information regarding the cumulative impacts of the OCS Program.

4.9.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.9.2.3.2**) would remain the same under Alternative D.

4.9.5.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative D are described in **Chapter 2.6** and summarized in **Chapter 4.9.5.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3**). The mitigation measures are the same as described for Alternative C with the addition of shutdown protocols during seismic operations for all marine mammals except bow-riding dolphins. The addition of shutdown protocols for all marine mammals except bow-riding dolphins under Alternative D would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to commercial fisheries also would not change. The mitigation measures under Alternative D do not change the cumulative outcomes described in Alternative A (**Chapter 4.9.2.3**); there would be a **minor** incremental increase in impacts to commercial fisheries from active acoustic sound sources and stand-off distances, and a **nominal** incremental increase in impacts to commercial fisheries from vessel traffic, seafloor disturbances, entanglement, and accidental fuel spill. The exact impacts would depend on the locations of activities, species affected, intensity of commercial fishing activity in the affected area, and substitutability of any lost fishing access.

4.9.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.9.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative E on commercial fisheries.

4.9.6.1 Impacts of Routine Activities

The reduction of deep-penetration, multi-client activities by 10 percent or 25 percent would reduce the extent, severity, and timing of active acoustic sound sources, vessel traffic, stand-off distance, seafloor disturbance, and entanglement compared with Alternative A. The analysis in Alternative A concluded that impacts from active acoustic sound sources, vessel traffic, stand-off distance, seafloor disturbance, and entanglement would range from **nominal** to **minor**. The reduction in activity would not change the overall impacts for these IPFs and, thus, the impacts would remain **nominal** to **minor** for commercial fisheries under Alternatives E1 and E2.

As discussed in **Chapter 4.9.2.1**, impacts of active acoustic sound sources are expected to be **minor** for commercial fisheries under Alternative A. Under Alternatives E1 and E2, there would be a 10 percent or 25 percent reduction in activities, respectively, for deep-penetration, multi-client activities, which could reduce the impacts of acoustic sound sources on commercial fisheries. However, seismic airgun surveys still will be conducted throughout the AOI, and the majority of commercial fish resources still will be impacted by airguns. The effects will likely still include displacement of fish or extensive disruption of free-swimming or captive (i.e., aquaculture) fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) that may adversely affect some populations. Furthermore, this may continue to indirectly affect commercial fisheries because impacts to fish hearing and behavior could result in a reduction in commercial fisheries catch rates (discussed in detail in **Chapter 4.9.2.1**). Therefore, a reduction in deep-penetration, multi-client activities will not change the overall impacts under Alternatives E1 and E2. The impacts of active acoustic sound sources from seismic airguns are expected to be **minor** for commercial fisheries under Alternatives E1 and E2. The mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will be **nominal** for commercial fisheries under Alternatives E1 and E2.

Under Alternatives E1 and E2, there would be a 10 percent or 25 percent reduction in activities, respectively, for deep-penetration, multi-client activities. However, many activities will continue, and seismic and HRG surveys will continue throughout the AOI. Impacts to commercial fisheries still are likely to be detectable, with the potential for localized short-term interruption of commercial fishing activities or gear damage in areas where activity is concentrated. Alternative E1 would not change the impacts to commercial fisheries landings arising from vessel traffic (**nominal**), stand-off distance (**minor**), and entanglement (**nominal** to **minor**). Alternative E2, a reduction of deep-penetration, multi-client surveys by 25 percent, would result in a decrease in large airgun arrays that have greater stand-off distances and the highest potential for entanglement with commercial fishing operations; therefore, impacts from stand-off distances and entanglement under Alternative E2 would be reduced to **nominal**.

Operational reductions under Alternatives E1 and E2 would not reduce bottom-sampling activities requiring the placement of anchors, nodes, cables, or other bottom-founded equipment used to support these types of surveys (**Chapter 2.7**). A particular seafloor disturbance, no matter how small, may occur within a productive fishing area as discussed under Alternative A. Therefore, seafloor disturbance and its impact to commercial fishing operations and landings are expected to remain limited and localized, with the potential to overlap with productive fishing grounds. Therefore, impacts are expected to remain **minor** under Alternatives E1 and E2. Overall, impacts to commercial fisheries from routine activities under Alternative E are expected to range from **nominal** to **minor** depending on the IPF and level of percent reduction in activities.

4.9.6.2 Impacts of an Accidental Fuel Spill

Under Alternatives E1 and E2, impacts of an accidental fuel spill on commercial fisheries would be very similar to those analyzed for Alternative C in **Chapter 4.9.4.2**. Alternatives E1 and E2 would reduce the number of deep-penetration, multi-client surveys by 10 percent or 25 percent, respectively, but this reduction would not substantially change the risk of a small fuel spill because the majority of activities will continue to take place. A small diesel spill is expected to disperse and weather rapidly, with evaporation of volatile components. Impacts would depend on the size and location of the spill in addition to the meteorological conditions. Impacts to commercial fisheries resources from an accidental or small diesel fuel spill would be **nominal** under Alternatives E1 and E2.

4.9.6.3 Cumulative Impacts

4.9.6.3.1 OCS Program G&G Survey Activities

The G&G survey activities would occur in the context of the overall OCS Program. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. Oil and gas activities associated with the OCS Program, such as drilling activities and service-vessel traffic, can cause space-use conflicts with fishermen. **Chapter 4.9.3.3.1** provides more information regarding the cumulative impacts of the OCS Program.

4.9.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.9.2.3.2**) would remain the same under Alternative E.

4.9.6.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative E are described in **Chapter 2.7** and summarized in **Chapter 4.9.6.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3**). The reduction of deep-penetration, multi-client activities (in line miles) by 10 percent (Alternative E1) or 25 percent (Alternative E2) would reduce the extent, severity, and timing of active acoustic sound sources, vessel traffic, stand-off distances, seafloor disturbance, and entanglement; therefore, impacts for these IPFs would be incrementally decreased under Alternative E. However, the incremental decrease in impacts to commercial fisheries is not to the extent that overall cumulative impacts would change from the outcomes described in Alternative A. There would be a **minor** incremental increase in impacts to commercial fisheries from active acoustic sound sources and stand-off distances, and a **nominal** incremental increase in impacts to commercial fisheries from vessel traffic, seafloor disturbances, entanglement, and accidental fuel spills.

4.9.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.9.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative F on commercial fisheries.

4.9.7.1 Impacts of Routine Activities

4.9.7.1.1 Closure Areas

Alternative F would require area closures in the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area (**Figure 2.8-1**). The closures apply to all G&G activities, which would reduce the impacts of active acoustic sound sources, vessel traffic, stand-off distance, seafloor disturbance, and entanglement on commercial fisheries. The analysis in Alternative A concluded that impacts from these IPFs on commercial fisheries would range from **nominal** to **minor**. The purpose of this mitigation measure is to protect marine mammals within the closure areas. This mitigation measure would provide an ancillary benefit to some coastal and oceanic fish species (refer to **Appendix E, Section 9**), as the effects on free-swimming and captive (i.e., aquaculture) fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced following a reduction in active acoustic sound sources (e.g., seismic airgun and electromechanical sounds). This may also indirectly benefit commercial fisheries because a reduction in the impact to fish hearing and behavior could result in a reduction in the indirect impacts to commercial fisheries catch rates (discussed in detail in **Chapter 4.9.2.1**). Another benefit would be a reduction in vessel traffic, stand-off distance, and entanglement from seismic surveys during the closure period, which will reduce the potential for damage to fishing gear or loss of access of fishing grounds. Lastly, a reduction in seafloor-disturbing activities could benefit certain demersal fish species (refer to **Appendix E, Section 9**) and may reduce indirect impacts to bottom fisheries. However, impacts from active acoustic sound sources, vessel traffic, stand-off distance, seafloor disturbance, and entanglement still will occur throughout the AOI. The sum of all closure areas is small compared with the size of the AOI, and impacts will only be reduced within the closure areas. Thus, there will not be a substantial reduction in seismic survey activity in the AOI; the overall impacts on commercial fisheries would not change under Alternative F and would remain **nominal** to **minor**.

4.9.7.1.2 Routine Activities Impact Conclusions

Impacts of active acoustic sound sources, stand-off distance, and seafloor-disturbing activities from seismic airgun surveys are expected to remain **minor**, and impacts from non-airgun HRG surveys and vessel traffic will remain **nominal** under Alternative F for commercial fisheries. Impacts from entanglement would range from **nominal** to **minor**. Overall, impacts to commercial fisheries from routine activities under Alternative F are expected to range from **nominal** to **minor**.

4.9.7.2 Impacts of an Accidental Fuel Spill

Under Alternative F, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. Alternative F would change the location where survey vessels could conduct G&G activities; however, spills from seismic airgun surveys, non-airgun HRG surveys, and other G&G activities could still occur within the AOI. The sum of the closure areas is small compared with the size of the AOI, and impacts will be reduced but only within the closure areas. Thus, impacts of an accidental fuel spill on commercial fisheries would be very similar to those analyzed for Alternative A in **Chapter 4.9.2.2**. Impacts to commercial fisheries resources from an accidental fuel spill or small diesel fuel spill would be **nominal** under Alternative F.

4.9.7.3 Cumulative Impacts

4.9.7.3.1 OCS Program G&G Survey Activities

The G&G survey activities would occur in the context of the overall OCS Program. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy or marine minerals will continue. Oil and gas activities associated with the OCS Program, such as drilling activities and service-vessel traffic, can cause space-use conflicts with fishermen. **Chapter 4.9.3.3.1** provides more information regarding the cumulative impacts of the OCS Program.

4.9.7.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.9.2.3.2**) would remain the same under Alternative F.

4.9.7.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative F are described in **Chapter 2.8** and summarized in **Chapter 4.9.7.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3**). Mitigation measures under Alternative F are similar to Alternative C with the addition of four area closures: CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area. Most mitigation measures under Alternative F would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to commercial fisheries also would not change the cumulative outcomes described in Alternative A (**Chapter 4.9.2.3**). There would be a **minor** incremental increase in impacts to commercial fisheries from active acoustic sound sources and stand-off distances, and a **nominal** incremental increase in impacts to commercial fisheries from vessel traffic, seafloor disturbances, entanglement, and accidental fuel spill.

4.9.8 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.9.2**), except that the entanglement IPF is not included as part of Alternative G because no OBC surveys will occur.

Under Alternative G, no new permits/authorizations will be issued for G&G activities. Previously authorized activities still would occur under existing agreements or permits/authorizations, but would drop off quickly. The VSP (2D only) and SWD surveys would continue at the level of activity in **Table 2.9-1**. The VSP surveys cover fewer line miles and shorter distances, use less sound energy, and usually are completed in a few days (**Appendix F, Section 1.1.5**). Thus, impacts from active acoustic sound sources, vessel traffic, stand-off distances, seafloor disturbance, and entanglement would not change immediately, but would decrease over time. Impacts from other routine activities also would decrease over time. Therefore, impacts from activities on commercial fisheries would remain similar to Alternatives A and C in the near term (**nominal** to **minor**). As activity levels decrease, a substantial reduction in active acoustic survey activities (non-VSP and SWD) likely would reduce impacts from all activities on commercial fisheries to **no impact** to **nominal**. Overall, impacts to commercial fisheries from activities under Alternative G are expected to remain **nominal** to **minor** but gradually decreasing to **no impact** to **nominal**.

Under Alternative G, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. No new permits/authorizations will be issued for G&G activities. Previously authorized activities still would occur under existing agreements or permits/authorizations, but would drop off quickly. However, VSP surveys will continue to be permitted. Thus, impacts of an accidental fuel spill on commercial fisheries would be very similar to those analyzed for Alternatives A and C in **Chapters 4.9.2.2 and 4.9.4.2**. Impacts to commercial fisheries from an accidental fuel spill or small diesel fuel spill would be **nominal**, declining to **no impact**.

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.9.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.9.2.3.2**) would remain the same under Alternative G.

The cease of activity for future G&G surveys requiring a permit/authorization from BOEM would substantially decrease the cumulative impacts from all IPFs. However, VSP and SWD surveys are expected to continue under Alternative G. Therefore, following cessation of the majority of activities, there would be a **nominal** incremental contribution to impacts to commercial fisheries from active acoustic sound sources, vessel traffic, stand-off distances, seafloor disturbances, entanglement, and accidental fuel spill under Alternative G.

4.9.9 Summary Conclusion

In summary, the IPFs that may impact commercial fisheries within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; and side-scan sonars), (2) vessel traffic, (3) stand-off distance, (4) seafloor disturbance, (5) entanglement, and (6) accidental fuel spill.

Impacts to commercial fisheries are assessed as **minor** for airgun surveys for all alternatives except Alternative G, which would be **nominal**, eventually declining to **no impact**, because a limited number of surveys will result in fewer changes in catch rates from fish displacement. Impacts are expected to be intermittent and temporary. Because fishing equipment could be damaged, the potential for impacts is reduced by several measures, and any impacts would be spatially localized and temporary; impacts from entanglement are assessed as **nominal** to **minor** for all alternatives except Alternative E2, which would be **nominal**, and Alternative G, which would be **no impact**. Impacts from stand-off distance are assessed as **minor** for all alternatives except Alternatives E2 and G. Under Alternative E2 (25% reduction in line miles of deep-penetration seismic airgun surveys), a decrease in impacts to **nominal** from **minor** is expected for stand-off distance impacts because these types of surveys typically have the larger stand-off distance requirements and airgun arrays. Under Alternative G, impacts would be **nominal**, eventually declining to **no impact**. Impacts from seafloor disturbance are assessed as **minor** for all alternatives, except Alternative G (**nominal** declining to **no impact**). The impacts from non-airgun HRG sound sources, vessel traffic, and an accidental fuel spill are assessed as **nominal** for Alternatives A through F due to the limited and localized activities; however, G&G activities could overlap with productive fishing grounds. Under Alternative G, impacts would be **nominal** and eventually decline to **no impact**.

4.10 RECREATIONAL FISHERIES

4.10.1 Description of the Affected Environment

Saltwater recreational fisheries in States adjacent to the AOI are among the most valuable in the U.S. In 2014, total fishing trip and durable equipment expenditures were $11.5 billion, and major expenditures included boat expenses ($5.8 billion), fishing tackle ($2.2 billion), vehicle expenses ($1.0 billion), second home expenses ($138 million), and other equipment ($941 million) (USDOC, NMFS, 2016d). In 2014, western Florida ranked first ($7.5 billion), Texas ranked fifth ($1.8 billion), and Louisiana ranked sixth ($1.6 billion) nationally in sales impacts from total expenditures related to recreational fishing (USDOC, NMFS, 2016d). Among the Gulf Coast States, the number of trips, jobs, sales, income, and value-added impacts from recreational fishing were highest in Florida (west coast) in 2014 (**Table 4.10-1**).

Recreational fishing is a year-round activity throughout the AOI and can be classified as a nearshore or offshore effort, depending on the size of the vessel and its fishing location (distance from shore); the majority of the activity takes place in nearshore waters. Nearshore recreational fishing (<4.8 km [3 mi]) consists of anglers fishing from private vessels and along beaches, marshes, or man-made structures (e.g., jetties, docks, piers), while offshore fishing consists of anglers fishing from larger vessels (i.e., private, rental, charter, or party) in offshore waters (>4.8 km [3 mi]). Of the total number of recreational trips in 2014, the majority of recreational fishing trips were from Florida (72.2%), while other Gulf Coast States accounted for 10.4 percent (Louisiana), 0.3 percent (Alabama), and 7.0 percent (Mississippi) (USDOC, NMFS, 2016d). The Marine Recreation Program did not collect fishing effort data in 2014 for Texas. Refer to **Table 4.10-2** for the total number of GOM fishing trips taken between 2005 and 2014.

Marine fishes depend on and utilize many different types of habitats (e.g., seagrass, salt marsh, soft bottom, hard bottom) for feeding, spawning, and nursery grounds. Therefore, recreational anglers have many options to target various species in these habitats. The choice of fish species targeted by recreational anglers depends on the season, fishing location, and seasonal movement of particular species. For example, bottom fishing for snapper, grunts, and porgies increases during summer, while grouper fishing is best during winter. **Table 4.10-3** provides harvest and release numbers of key species and species groups from 2003 to 2012.

Organized saltwater fishing tournaments are popular amateur and professional events held throughout the AOI from Texas to Florida (**Table 4.10-4**). Recreational fishing tournaments are held year-round, but most take place in summer during weekends. Depending on the fishing tournament and its rules, participants have the option to target inshore (e.g., red drum, spotted seatrout, and snook) or offshore (e.g., dolphinfish, wahoo, and kingfish) categories, or to enter both categories. Throughout the AOI, many fishing tournaments are annual events; however, identifying every possible tournament is difficult because some tournaments are only held once and sponsorship can change from year to year.

Impacts from the *Deepwater Horizon* explosion, oil spill, and response, including oiled shorelines and the closing of areas to recreation, resulted in losses to the public's use of natural resources for outdoor recreation. The Final PDARP/PEIS includes an assessment of "lost recreational use" that focuses on two broad categories of recreation: shoreline use and boating (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016). Both categories include recreational fishing (e.g., boating includes any non-commercial boating activity, and shoreline use includes other recreational activities such as swimming, sunbathing, surfing, walking, and kayaking). The following text summarizes the impacts to recreational fishing that were noted within the broader context of "lost recreational use," as the Final PDARP/PEIS does not provide a separate analysis of impacts on recreational fishing.

Impacts of the *Deepwater Horizon* explosion, oil spill, and response started in May 2010 and lasted through at least November 2011. The Final PDARP/PEIS estimates that the public lost just under 17 million user days of fishing, boating, and beach-going experiences because of the oil spill. Total recreational use damages due to the oil spill are estimated to be $693.2 million, with uncertainty ranging from $527.6 million to $858.9 million. This lost value does not include losses to private businesses/individuals or tax revenue to municipalities. Recreational losses due to the oil spill affected sites in Texas, Louisiana, Mississippi, Alabama, and Florida; however, residents throughout the U.S. were included as part of the affected public.

The most direct impact on recreational fishing activities in the AOI was due to fishing closures in oil-impacted areas. At the oil spill's peak on June 2, 2010, 37 percent of the Federal EEZ was closed to fishing. Between 2009 and 2010, the number of recreational angler trips in State and Federal waters (excluding inland) off Louisiana, Mississippi, Alabama, and Florida cumulatively decreased by 37 percent in the March/April, 24 percent in the May/June, and 36 percent in the July/August (USDOC, NMFS, 2013f). A 123 percent increase in angler trips was noted between 2009 and 2010 in September/October, but activity decreased again in November/December (34%). Recreational angler trips after the spill showed growth compared with pre-spill years. The cumulative number of angler trips in State and Federal waters (excluding inshore) off Louisiana, Mississippi, Alabama, and Florida increased from 6.1 million trips in 2011 to 7.1 million trips in 2012 and 10.2 million trips in 2013, an increase of 67 percent from 2011 and an increase of 38 percent from the 7.4 million trips taken by anglers before the spill in 2009 (USDOC, NMFS, 2013f).

Recreational fish landings (in State and Federal waters [excluding inshore] of Louisiana, Mississippi, Alabama, and Florida) for most species only fell slightly between 2009 and 2011, but substantial declines were recorded for offshore species such as gray snapper (30% decrease), red snapper (31% decrease), king mackerel (63% decrease), and red grouper (26% decrease) (USDOC, NMFS, 2013f). In 2013, a substantial increase from 2011 was observed for gray snapper (approximately 100%), red snapper (98%), king mackerel (72%), and red grouper (60%). Long-term effects of the *Deepwater Horizon* explosion, oil spill, and response on recreational fisheries are difficult to quantify given that oil is more toxic to fish eggs and larvae than to adults. Long-term impacts on any particular species may take many years for the effects on one year's cohorts to be realized. Recreational fisheries also are highly dependent on local tourism and the socioeconomic status of the Gulf Coast States. However, in general, recreational fishing activity stabilized subsequent to the short-term fluctuations following the *Deepwater Horizon* explosion, oil spill, and response (USDOC, NMFS, 2016d). Additional information pertaining to this resource and NMFS' determination of the effects of the *Deepwater Horizon* explosion, oil spill, and response can be found in the Final PDARP/PEIS (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016).

4.10.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact recreational fisheries within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; side-scan sonars), (2) vessel traffic, (3) stand-off distance, and (4) accidental fuel spill.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level categories. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For recreational fisheries, the following impact-level criteria have been used to evaluate the level of impact for each IPF.

- **Nominal** impacts to recreational fisheries would include those with little to no measurable impacts observed or expected.

- **Minor** impacts to recreational fisheries would include those that are detectable but not severe or extensive. Minor impacts to recreational fisheries would include localized, short-term interruption of recreational fishing activities as well as localized, less than severe impacts on fish resources with minimal decreases in recreational fisheries landings.
- **Moderate** impacts to recreational fisheries would be detectable and extensive but not severe. Moderate impacts to recreational fisheries would include extensive but infrequent interruption of recreational fishing activities and extensive but not severe impacts on fish resources (i.e., not sufficient to result in sizable decreases in recreational fisheries landings).
- **Major** impacts to recreational fisheries would be detectable, extensive, and severe. Major impacts to recreational fisheries would include extensive, frequent interruption of recreational fishing activities and extensive, severe impacts on fish resources (i.e., sufficient to result in sizable decreases in recreational fisheries landings).

4.10.2.1 Impacts of Routine Activities

Active Acoustic Sound Sources

The spatial and temporal characteristics of active acoustic sound sources vary depending on the type of activity. As discussed in **Chapter 4.4.2.1**, HRG surveys may take several days and cover smaller areas, whereas seismic (i.e., 2D, 3D, 4D, WAZ, and VSP) surveys may occur throughout significant portions of the AOI for weeks, months, or even up to a year. Depending on the equipment and technique, airgun seismic pulses typically are fired from one or two vessels and are emitted at intervals of 5 to 60 seconds. Under the proposed activity scenario, surveys using these types of equipment would be conducted throughout the AOI, but the majority of activity will take place in the deepwater regions of the WPA and CPA.

Sound is used by fishes in a variety of ways, as outlined in **Chapter 4.4.2.1**. In general, fishes use sound to obtain an instant image of their surroundings in terms of biotic (living) and abiotic (environmental) sources. Many bony fishes can communicate with sound, and some fishes use sound during mating and territorial interactions. Potential direct effects on fishes from anthropogenic sounds (e.g., airguns and echosounders) include changes in hearing abilities (masking or TTS), behavioral changes, injury, and mortality (discussed in detail in **Chapter 4.4.2.1 and Appendix J**).

Reef Fishes: Sounds generated from G&G equipment likely would not cause mortality to reef fishes such as groupers and snappers because Alternative A includes the use of ramp-up as part of the survey protocol. Research suggests that exposure to noise from seismic airguns and electromechanical sounds (e.g., side-scan sonars and echosounders) would not produce serious injury or mortality to reef fishes. Song et al. (2008) and Kane et al. (2010) found that sound generated from seismic and sonar devices showed no tissue damage to fishes. Halvorsen et al. (2011a, 2011b) reported that Chinook salmon was affected by sounds generated from simulated pile-driving procedures, but specimens showed complete recovery under laboratory conditions shortly after exposure. Enger (1981) and McCauley et al. (2003) reported that Atlantic cod and pink snapper exhibited small losses of sensory cells after being exposed to high-intensity sounds, but fishes recovered shortly after exposure as well. The information on the effects of sonar indicates that behavior of certain species does not change when exposed to sound from these devices (Doksæter et al., 2009, 2012; Sivle et al., 2012). Based on these studies and due to the mitigation measures in place, sounds produced by airguns for seismic surveys and electromechanical sources for HRG surveys likely would not cause injury or mortality to reef fishes such as groupers and snappers under Alternative A. In general, impacts to fish hearing and behavior are more likely. However, changes in fish behavior and hearing will not occur in all fish species, and effects will be temporary (**Chapter 4.4.2.1**; Popper et al., 2005). Therefore, there will be little to no measurable impacts to reef fishes. Impacts on reef fishes, as a component of recreational fisheries, would be **nominal** under Alternative A.

Coastal Fishes: Fishes found along coastal beaches and inlets are among the most popular fishes pursued by recreational anglers. In general, anglers fish inshore, outside of the AOI (USDOC, NMFS, 2011); however, the majority of fishing activity occurs along nearshore coastal areas (<4.8 km [3 mi] from shore), which may be affected by sound generated by seismic equipment. Popular recreational fishes harvested along coastal beaches and nearshore waters include bluefish, pompano, cobia, spotted seatrout, pinfishes, drums, Spanish mackerel, and Atlantic croaker. Although these inshore fishes generally are found in much shallower waters than reef fishes (e.g., groupers, snappers), there is no scientific evidence to suggest that they are more vulnerable to active acoustic sound generated by seismic and HRG surveys. Based on available data and due to the mitigation measures in place, sounds produced by airguns for seismic surveys and electromechanical sources for HRG surveys likely would not cause injury or mortality to inshore and coastal fishes under Alternative A. In general, impacts to fish hearing and behavior are more likely. However, changes in fish behavior and hearing will not occur in all fish species, and effects will be temporary (**Chapter 4.4.2.1**; Popper et al., 2005). Therefore, there will be little to no measurable impacts to coastal fishes. Impacts to coastal fishes, as a component of recreational fisheries, would be **nominal** under Alternative A.

Pelagic Fishes: Recreational anglers often target pelagic species such as tuna, billfishes, and sharks throughout the offshore waters of the AOI. Seismic sounds may temporarily affect the catchability of recreationally targeted species, but it is very unlikely that these types of sounds would cause mortality in tuna, billfishes, and pelagic sharks. In general, these fishes display highly migratory behavior and are adapted to swim continuously. Therefore, the chance of these fishes being exposed to seismic sounds at a level that could cause mortality is extremely unlikely. Furthermore, ramp-up procedures are expected to minimize potential impacts to migratory fishes. Based on available data and due to the mitigation measures in place, sounds produced by airguns for seismic surveys and electromechanical sources for HRG surveys likely would not cause injury or mortality to pelagic fishes. In general, impacts to fish hearing and behavior are more likely. However, changes in fish behavior and hearing will not occur in all fish species, and effects will be temporary (**Chapter 4.4.2.1**; Popper et al., 2005). Therefore, there will be little to no measurable impacts to pelagic fishes. Impacts to pelagic fishes, as a component of recreational fisheries, would be **nominal** under Alternative A.

Recreational Fishing Activity: Anthropogenic sound generated from seismic activity under Alternative A could indirectly affect recreational fishing activities within the AOI. There is little scientific evidence to suggest that seismic sound would result in immediate mortality or physiological effects causing long-term injury in fishes. Nevertheless, effects such as changes in hearing abilities or behavior that indirectly cause localized short-term interruptions of recreational fishing activities may be expected, and slight decreases in recreational fisheries landings may occur. Given the absence of serious injury or mortality to recreational fishes and the low potential for behavioral changes from active acoustic sound exposure to airguns for seismic surveys and electromechanical sources for HRG surveys, potential impacts likely would be intermittent and temporary. Exposure to active acoustic sound sources (e.g., seismic airgun and electromechanical sounds) from G&G activities under Alternative A is expected to produce **nominal** impacts to recreational fisheries activities.

Vessel Traffic

Vessel traffic generated by each type of G&G survey proposed within the AOI is shown in **Table 3.3-3**. The types of surveys and activity level scenarios are described in **Chapter 3**. Furthermore, existing vessel activity within the GOM is described in **Chapter 3.4.3**.

Under Alternative A, vessel traffic could increase slightly in specific areas, and resultant impacts from vessel traffic would be stand-off distances. Generally, most recreational anglers fish (usually trolling, drifting, or bottom fishing) according to specific habitats (bottom profile) or water conditions. Catch rates may be adversely affected by vessel traffic as they depend on the number of fishes, location, and fishing technique. Because recreational anglers generally are in small maneuverable boats using rod-and-reel or electric reels with easily retrievable lengths of line in the water, avoiding large survey vessels would be relatively easy. Inshore fisheries (i.e., estuaries and bays) are not expected to be affected by vessel issues because they are outside of the AOI. The exception would be coastal inlets since support vessels will use the inlets as they leave and return to ports. Effects are likely to be localized at several locations, intermittent in frequency of occurrence and temporary in nature. Impacts to recreational fishing are not expected to increase under Alternative A because vessel traffic is relatively high in the AOI and G&G activities have been ongoing in the area. Therefore, vessel traffic and resultant stand-off distances are expected to produce **nominal** impacts to recreational fishing under Alternative A.

Stand-Off Distance

During seismic airgun surveys, operators typically attempt to maintain a stand-off distance to protect towed streamers from other vessel traffic. The extent of the stand-off distance would depend on the equipment and number of streamers. Typical stand-off distance protocols are described in **Chapter 3.3.1.5**.

The primary direct effects of stand-off distances to recreational fisheries would be loss of access to fishing grounds and loss of fishing time. Given the amount of area occupied by the stand-off distance for these vessels, temporary space-use conflicts may occur between G&G activities and recreational fishing operations within the AOI. Because of the stand-off distance, recreational fishers may have to retrieve lines earlier than usual to avoid seismic vessel surveys or wait until the seismic vessel has moved past the fishing grounds and it is safe to reenter. Under Alternative A, G&G activities and associated stand-off distances are expected to have no indirect effects on recreational fishery operations unless these activities cause recreational anglers to concentrate their fishing efforts on other species or areas. Impacts to recreational fisheries associated with stand-off distance under Alternative A are expected to be **nominal** under Alternative A.

4.10.2.1.1 Routine Activities Impact Conclusions

Overall, impacts from proposed activities to recreational fisheries are expected to be **nominal**. Impacts from active acoustic sound sources, vessel traffic, and stand-off distances would be intermittent and temporary in duration or frequency.

4.10.2.2 Impacts of an Accidental Fuel Spill

An accidental event could result in the release of fuel or diesel by a survey vessel. Based on USCG spill statistics, a spill scenario that assumes a diesel spill volume of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. Spills occurring at the ocean surface would disperse and weather; volatile components of the fuel would evaporate. Fuel and diesel used for operation of survey vessels is light and would float on the water surface. A small proportion of the heavier fuel components could adhere to particulate matter in the upper portion of the water column and sink. Particulate matter contaminated with diesel fuel could reach the seafloor within or outside the AOI, depending on spill location, water depth, ambient currents, and sinking rate.

Recreational fishing activity is not expected to be precluded from the area around the fuel source; spilled diesel would evaporate and disperse within a day. Given the relatively small size of the fuel spill and the rapid loss of most spilled fuel through evaporation and dispersion, a small diesel fuel spill at the surface would have little to no effect on recreational fisheries. An accidental fuel spill is expected to result in **nominal** impacts to recreational fisheries under Alternative A.

4.10.2.3 Cumulative Impacts

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for recreational fisheries are compared with the IPFs from each of the cumulative scenario components in order to focus this cumulative analysis on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The G&G activity IPFs included in the cumulative assessment are the same as those assessed under routine activities and an accidental fuel spill. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI.

4.10.2.3.1 OCS Program G&G Survey Activities

The G&G survey activities would occur in the context of the overall OCS Program. In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue.

These activities will have a **nominal** impact on recreational fisheries because they will be temporary and have a limited geographical extent.

4.10.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The activities other than the OCS Program's G&G survey activities that have the potential to affect recreational fisheries include (1) Federal and State oil and gas activity, (2) noise, (3) vessel traffic, and (4) stand-off distance.,

Federal and State Oil and Gas Activities

Federal and State oil and gas activities would cause impacts to fish populations and space-use conflicts. The overall number of production structures also serves more of a beneficial role for reef fishing, although the corresponding decommissioning of these structures negatively impacts recreational fishing. However, most recreational fishing in the Gulf of Mexico occurs close to shore where similar effects may occur in State waters. Oil spills can also lead to localized fishing closures that could directly impact fishermen's access to fish resources. An oil spill would likely be small and localized, leaving recreational fishermen numerous alternative fishing sites. The exact impacts would depend on the locations of oil spills, species affected, intensity of recreational fishing activity in the affected area, and substitutability of any lost fishing access. In addition, recreational fishing activity recovered fairly quickly in the aftermath of the *Deepwater Horizon* explosion, oil spill, and response, which was much larger than any reasonably foreseeable spill from a proposed lease sale.

In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy and marine minerals will continue. For more information on impacts to recreational fisheries by oil and gas activities, refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.11 of the 2017-2022 GOM Multisale EIS.

Noise

Other major factors that contribute active acoustic sound sources are shown in **Table 3.4-1**. Primary underwater noise sources that could adversely affect recreational fisheries include those arising from military operations (i.e., sonars, explosives, and other active sound sources). A sizeable portion of the EPA includes military areas (**Chapter 3.4.3.6**). These military use areas include designated danger areas, restricted areas, and closure areas that limit access by vessel traffic, including recreational fishing activity, during specific times or prior to/during specific activities or operations; in some instances, areas may be completely closed to all vessel traffic. Impacts from sound-producing military operations, including behavioral changes and avoidance by recreationally important fish species, are expected at select military use locations, with likely impacts being intermittent, temporary, and short term. Because of the spatial and temporal characteristics of military exercises that produce active acoustic sound and the nature of the sound sources (e.g., explosion, single pulse, and limited multiple pulses), coupled with the exclusion of recreational fishing vessels from areas where military operations are planned or being conducted, impacts to recreational fisheries from military uses under the cumulative scenario are expected to be **negligible**.

Vessel traffic noise from the remaining cumulative scenario sources (e.g., oil and gas exploration and development, commercial fishing, and shipping and marine transportation) would also contribute to ambient noise levels throughout the AOI. Under the cumulative activities scenario, these vessel and equipment noise sources are expected to produce a **negligible** impact to recreational fisheries.

Active acoustic sound sources would be used in support of all of BOEM’s program areas, i.e., oil and gas, renewable energy, and marine minerals. Active acoustic sound sources employed under the Oil and Gas Program may occur throughout the entire AOI, with broad areas being surveyed continuously for extended periods of time (i.e., weeks or months). Active acoustic sound sources for renewable energy and marine minerals activities would only occur close to shore and would be of shorter survey duration.

Anthropogenic sound levels in the marine environment are increasing, and impacts fish behavior and hearing capabilities and may impact recreational fishing (Slabbekoorn et al., 2010; Radford et al., 2014). However, assessing overall increases in sound is difficult because of the lack of baseline data from individual sound sources and the ambient sound conditions (Hawkins et al., 2014). Some impacts to recreational fishing are possible, but likely are temporary. Seismic surveys are not conducted homogenously over the entire AOI or the 10-year period; they are spatially and temporally limited, and their impacts are not likely to increase over time.

Vessel Traffic

Vessel traffic within the AOI is expected to increase under the cumulative scenario. Vessel traffic may result from other major factors as shown in **Table 3.4-1**. Over the past several years, documented increases in commercial vessel activity in U.S. east coast ports have been noted.

Other cumulative activities including oil and gas development, marine minerals use, renewable energy development, geosequestration, LNG import terminals, commercial fishing, military range complexes and civilian space program use, and dredged material disposal are also expected to contribute to increases in total vessel activity levels in the AOI. Impacts from vessel traffic associated with the cumulative scenario are expected to produce **negligible** to **minor** impacts to recreational fisheries.

Vessel traffic is expected to increase in specific areas, particularly where amateur and professional recreational fishing tournaments are being conducted. Vessel traffic or vessel disturbance issues have the potential to affect several recreational fishing activities within the AOI, although a precise determination of the economic impacts is problematic.

In spite of the increasing levels of commercial vessel activity within the AOI, there are no meaningful vessel traffic impacts evident from the cumulative activities scenario. In addition, there is no evidence of vessel traffic levels approaching a threshold level where recreational fisheries might be meaningfully affected.

Support vessel traffic is a key part of most OCS Program activities (**Chapter 3.4**). Although recreational fishing and OCS activities have coexisted for many years within the AOI, support vessel traffic may interrupt some recreational fishing activity such as bottom fishing or trolling (**Chapter 4.10.2.1**). Recreational fishers generally are in small maneuverable boats using rod-and-reel or electric reels with easily retrievable lengths of line in the water, so avoiding large survey vessels would be relatively easy. Impacts would be temporary, localized to areas of vessel traffic, and not expected to increase over time.

Stand-off Distance

Several activities expected to occur under the cumulative impacts scenario may utilize exclusion zones. Stand-off distances may result from factors as shown in **Table 3.4-1**. Drilling operations to be conducted as part of oil and gas development, vessel approach and departure fairways used as part of LNG import terminals, and shipping and marine transportation vessel traffic corridors would exclude private vessel operations within prescribed distances from transiting vessels or operations.

Certain activities are managed to provide an area, called the stand-off distance, around the activity to help avoid interactions between fishing vessels and oil and gas vessels that would be hazardous to vessels, crew, and gear. Stand-off distances under the OCS Program would be similar to those in the proposed action and could cause temporary loss of access to fishing grounds and loss of fishing time. Loss of access to fishing grounds or delays in setting fishing gear in optimal locations may reduce quantity and quality of catch. However, the majority of fishing will be done in State waters, where impacts from stand-off distances will be minimal.

4.10.2.3.3 Cumulative Impact Conclusions

Overall, activities associated with the proposed action would increase levels of vessel traffic and noise within the AOI, resulting in sporadic increases in ambient noise levels during proposed G&G operations. Sources of noise associated with the cumulative scenario that may affect recreational fisheries in the AOI include active acoustic sound, vessel traffic, stand-off distance, and an accidental fuel spill. Many of these IPFs may occur simultaneously during some proposed operations under the OCS Program.

Activities under the proposed action during the project period are most concentrated within deepwater regions of the CPA and WPA, and less concentrated within continental shelf waters (**Table 3.2-1**). Very little activity is projected to occur within the EPA. Temporally, activity levels associated with the proposed action vary by activity type and year (**Tables 3.2-1 through 3.2-5**). The exact impacts to recreational fisheries would depend on the locations of activities, species affected, intensity of recreational fishing activity in the affected area, and substitutability of any lost fishing access. Overall, proposed activities are expected to result in **nominal** incremental cumulative increases in impacts to recreational fisheries relative to other G&G survey activities, federal and state oil and gas activities, noise, vessel traffic, and stand-off distances.

4.10.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.10.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative B on recreational fisheries.

4.10.3.1 Impacts of Routine Activities

Additional mitigation measures under Alternative B that would not change the extent, severity, or timing of G&G activities, and therefore related recreational fisheries, include the expansion of NTL 2016-BOEM-G02 (inclusion of manatees and application to all deep-penetration seismic airgun surveys in all water depths) and the expanded use of PAM. As such, these mitigation measures will not be addressed in the following discussion.

4.10.3.1.1 Seasonal Restriction for Federal Coastal Waters

Alternative B would require seasonal restrictions for seismic airgun survey operations from (a) March 1 to April 30 in Federal coastal waters shoreward of the 20-m (66-ft) isobath (and a 5-km [3-mi] buffer extending seaward from the 20-m [66-ft] isobath) and (b) from January 1 to April 30 within the portion of these coastal waters falling within the boundaries of the UME in the northern GOM (**Figure 2.2-1 and Chapter 2.4.3**). Impacts of active acoustic sound sources, vessel traffic, and stand-off distance would be reduced, but only within coastal waters between January 1 and April 30. The closure area would be 13.1 percent of the area of the AOI. The purpose of this mitigation measure is to protect marine mammals within the closure areas from IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some coastal fish species (**Tables 4.4-1, 4.4-2, and 4.4-4**) as the effects on fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) would be reduced in the coastal seasonal restriction area. Furthermore, this may indirectly benefit recreational fisheries because a reduction in the impact to fish hearing and behavior could result in a reduction of the indirect impacts to recreational fisheries catch rates. Another benefit would be a reduction in vessel traffic and stand-off distance from seismic surveys during the closure period that will reduce the potential for damage to fishing gear or loss of access of fishing grounds. However, seismic surveys still will occur outside this area, the closure timeframe is temporary, and the closure area is small compared with the size of the AOI. Thus, while a change in survey timing in the coastal seasonal restriction area would slightly reduce the impacts of active acoustic sound sources, vessel traffic, and stand-off distance from seismic airguns surveys on recreational fisheries, it would not change the overall impact level. Therefore, impacts are expected to be **nominal** for recreational fisheries under Alternative B. The mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will be **nominal** for recreational fisheries under Alternative B.

4.10.3.1.2 Minimum Separation Distances

Alternative B would establish a 40-km (25-mi) separation distance between simultaneously operating deep-penetration seismic airgun surveys within the Areas of Concern (**Chapter 2.4.2**) to limit ensonification of specific areas of the AOI at the same time. When outside the Areas of Concern, the separation distance shall be 30 km (19 mi). However, the separation distance requirement does not apply to multiple ships operating in a coordinated survey such as a WAZ survey, and it need not be maintained if unsafe or due to weather conditions. Through the adaptive management approach outlined in **Chapter 2**, this separation distance may be modified based on newly available information and in consideration of any other surveys requested or authorized to operate concurrently (if any).

Applicable routine IPFs for recreational fisheries are active acoustic sound sources, vessel traffic, and stand-off distance. Limits on concurrent seismic airgun surveys under Alternative B could change the timing of seismic surveys in certain areas. The locations cannot be predicted in advance but would depend on the schedule, planned coverage of individual surveys, and ports to be used for support activities. Seismic surveys still will be conducted; therefore, a change in the survey timing because of limits on concurrent seismic airgun surveys would not alter the impacts from active acoustic sound sources (including seismic airguns and electromechanical sounds), vessel traffic, and stand-off distance. Impacts are expected to be **nominal** for recreational fisheries under Alternative B.

4.10.3.1.3 Seismic Restrictions in the EPA

Additional restrictions under Alternative B include prohibiting deep-penetration seismic airgun surveys within the portion of the Areas of Concern (**Chapter 2.4.2**) falling within the EPA. A restriction on seismic surveys within a portion of the AOI could reduce impacts from active acoustic sound sources, vessel traffic, and stand-off distance due to the reduced area of activity. The purpose of this mitigation measure is to protect marine mammals within the closure areas from the IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some oceanic fish species (refer to **Appendix E, Section 10**) in the closure area, as the effects on fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced in that region. Furthermore, this may indirectly benefit recreational fisheries because a reduction in the impact to fish hearing and behavior should result in a reduction in the impacts to recreational fisheries catch rates. Another benefit would be a reduction in vessel traffic and stand-off distance from seismic surveys during the closure period, which will reduce the potential for damage to fishing gears or loss of access of fishing grounds. The impacts of active acoustic sound sources, vessel traffic, and stand-off distance from seismic airgun surveys would be reduced, but only within the portion of the Areas of Concern falling within the EPA. The size of the closure area is small compared with the AOI, and the majority of deep-penetration seismic airgun surveys will occur in the WPA and CPA where seismic surveys will not be restricted. Thus, there will not be a substantial reduction in seismic survey activity in the AOI, and the overall impacts on recreational fisheries would not change under Alternative B. Therefore, impacts are expected to be **nominal** for recreational fisheries under Alternative B. The mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will be **nominal** for recreational fisheries under Alternative B.

4.10.3.1.4 Routine Activities Impact Conclusions

Assessment of each mitigation measure included in Alternative B concluded that some reduction in impacts may occur; however, consideration of the impact-level criteria, the AOI as a whole, and the 10-year timeframe results in no change in impact level of the overall impacts under Alternative B. Overall, impacts to recreational fisheries from routine activities under Alternative B are expected to be **nominal**.

4.10.3.2 Impacts of an Accidental Fuel Spill

Under Alternative B, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. Alternative B would change the timing of certain surveys because of additional coastal seasonal restrictions. However, spills from seismic survey vessels could occur in the closure areas during times outside the closure period, and spills from other survey vessels could occur during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Therefore, impacts of the IPFs would be very similar to those analyzed for Alternative A in **Chapter 4.9.2.2**. An accidental fuel spill would be expected to result in **nominal** impacts to recreational fisheries under Alternative B.

4.10.3.3 Cumulative Impacts

4.10.3.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.10.3.1 and 4.10.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** impacts to recreational fisheries, depending on the IPF. When taken in the context of the cumulative scenario, the proposed action would have a nominal incremental impact to recreational fisheries.

Mitigation measures for the proposed action under Alternative B are described in **Chapter 2.4** and summarized in **Chapter 4.10.3.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3**). Most of the mitigation measures under Alternative B would not change the extent, severity, or timing of activities in the proposed action, and therefore would not change the resultant impacts to recreational fisheries. Mitigation measures under Alternative B that would change the timing and extent of activities in the proposed action include a seasonal restriction for operation of airguns in Federal coastal waters, a minimum separation distance requirement for simultaneous seismic operations, and the prohibition of deep-penetration seismic airgun surveys within portions of the EPA (**Chapter 2.4.2**).

4.10.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.10.2.3.2**) would remain the same under Alternative B.

4.10.3.3.3 Cumulative Impact Conclusions

The proposed action activities considered in the assessment of cumulative impacts are the same in Alternatives A and B. Seasonal restriction of airgun operation in Federal coastal waters under Alternative B probably would cause a shift in schedules for seismic surveys using airguns but not necessarily a reduction in the number and extent of surveys conducted in Federal coastal waters. Prohibition of deep-penetration seismic airgun surveys in the EPA also would not appreciably impact the number and extent of such surveys under Alternative B because most seismic exploration activity to be conducted during the 10-year analysis period will be conducted in the WPA and CPA, where approximately 99 percent of oil and gas activities take place. Because there is little to no change between Alternatives A and B in the proposed action and because of the limited effect of Alternative B mitigation measures on the occurrence and extent of IPFs, recreational fisheries would not be impacted by additional measures in Alternative B beyond that described for Alternative A. Therefore, the mitigations under Alternative B do not change the cumulative outcomes described in Alternative A (**Chapter 4.10.2.3**). The exact impacts would depend on the locations of activities, species affected, intensity of recreational fishing activity in the affected area, and substitutability of any lost fishing access.

4.10.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.10.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative C on recreational fisheries.

4.10.4.1 Impacts of Routine Activities

Additional mitigation measures under Alternative C that would not change the extent, severity, or timing of G&G activities, and therefore related impacts to recreational fisheries, include the expanded use of PAM for seismic airgun surveys, the expanded use of PSOs for seismic airgun surveys and HRG surveys, expansion of NTL 2016-BOEM-G02 (inclusion of manatees) for seismic airgun surveys, expansion of NTL 2016-BOEM-G02 to include HRG surveys using airguns, and a pre-survey clearance period for HRG surveys. As such, these mitigation measures will not be addressed in the following discussion.

4.10.4.1.1 Seasonal Restriction for all Coastal Waters (February 1 to May 31)

Alternative C would require seasonal restrictions for seismic airgun survey operations in Federal coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31 (**Figure 2.3-1**). The impacts of active acoustic sound sources, vessel traffic, and stand-off distance would be reduced, but only within coastal waters between February 1 and May 31. The closure area is 13.1 percent of the area of the AOI. The purpose of this mitigation measure is to protect marine mammals within the closure area from the IPFs associated with deep-penetration seismic airgun surveys. This mitigation measure would provide an ancillary benefit to some coastal fish species (**Tables 4.4-1, 4.4-2, and 4.4-4**), as the effects on fish hearing and behavior (discussed in detail in **Chapter 4.4.2.1**) will be reduced in the coastal seasonal restriction area. Furthermore, this may indirectly benefit recreational fisheries because a reduction in the impact to fish hearing and behavior could result in a reduction of the indirect impacts to recreational fisheries catch rates. Another benefit would be a reduction in vessel traffic and exclusion zones from seismic surveys during the closure period, which will reduce the potential for damage to fishing gear or loss of access of fishing grounds. However, seismic surveys still will occur outside this area, the closure timeframe is temporary, and the closure area is small compared with the size of the AOI. Thus, while a change in survey timing in the coastal seasonal restriction area would slightly reduce the impacts of active acoustic sound sources vessel traffic and the stand-off distance from seismic airgun surveys on recreational fisheries, it would not change the overall impact level. Impacts are expected to be **nominal** for recreational fisheries under Alternative C. The mitigation measure does not apply to sound sources from non-airgun HRG surveys; therefore, the impact from electromechanical sources will be **nominal** for recreational fisheries under Alternative C.

4.10.4.1.2 Routine Activities Impact Conclusions

Assessment of each mitigation measure included in Alternative C concludes that some reduction in impacts may occur; however, consideration of the impact-level criteria, AOI, and 10-year timeframe results in no change in impact level of the overall impacts under Alternative C. Overall, impacts to recreational fisheries from routine activities under Alternative C are expected to be **nominal**.

4.10.4.2 Impacts of an Accidental Fuel Spill

Under Alternative C, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. Alternative C would change the timing of certain surveys because of additional coastal seasonal restrictions. However, spills from seismic survey vessels could occur in the closure areas during times outside the closure period, and spills from other survey vessels could occur during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Therefore, impacts of the IPFs would be very similar to those analyzed for Alternative A in **Chapter 4.10.2.2**. An accidental fuel spill would be expected to result in **nominal** impacts to recreational fisheries under Alternative C.

4.10.4.3 Cumulative Impacts

4.10.4.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.10.4.1 and 4.10.4.2** concluded that activities projected to occur under Alternative C would result in **nominal** impacts to recreational fisheries. When taken in the context of the cumulative scenario, the proposed action would have a nominal incremental impact to recreational fisheries.

4.10.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.10.2.3.2**) would remain the same under Alternative C.

4.10.4.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative C are described in **Chapter 2.5** and summarized in **Chapter 4.10.4.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3**). Most mitigation measures under Alternative C would not change the extent, severity, or timing of activities in the proposed action, and therefore would not change the resultant impacts to recreational fishing. Under Alternative C, the mitigation measure that would change the timing and extent of activities in the proposed action is a seasonal restriction from February 1 through May 31 for operation of airguns in all coastal waters shoreward of the 20-m (66-ft) isobath within the AOI. The mitigations under Alternative C do not change the cumulative outcomes described in Alternative A (**Chapter 4.10.2.3**). The exact impacts would depend on the locations of activities, species affected, intensity of recreational fishing activity in the affected area, and substitutability of any lost fishing access.

4.10.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.10.2**). The additional mitigation measure under Alternative D would not reduce potential active acoustic impacts discussed in Alternatives A and C (**Chapters 4.10.2.1 and 4.10.4.1**), and impacts would remain **nominal**. The mitigation would not alter impact levels to recreational fisheries from vessel traffic or stand-off distance and would remain **nominal**. Under Alternative D, impacts of an accidental fuel spill on recreational fisheries would be as described for Alternatives A and C (**Chapters 4.10.2.2 and 4.10.4.2**) and would remain **nominal**.

4.10.5.1 Impacts of Routine Activities

The additional mitigation measure under Alternative D (i.e., the exclusion of bow-riding dolphins from marine mammal shutdown protocols) would not change the extent, severity, or timing of the IPFs outlined in Alternatives A and C. Therefore, impacts would be **nominal** for recreational fisheries under Alternative D.

4.10.5.2 Impacts of an Accidental Fuel Spill

Alternative D would not add mitigation measures that would reduce the risk of an accidental fuel spill. Therefore, the impacts of the IPFs would be very similar to those analyzed for Alternatives A and C in **Chapters 4.10.2.2 and 4.10.4.2**. Impacts to recreational fisheries resources from an accidental fuel spill or small diesel spill would be **nominal** under Alternative D.

4.10.5.3 Cumulative Impacts

4.10.5.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.10.5.1 and 4.10.5.2** concluded that activities projected to occur under Alternative D would result in **nominal** impacts to recreational fisheries, depending on the IPF. When taken in the context of the cumulative scenario, the proposed action would have a nominal incremental impact to recreational fisheries.

4.10.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.10.2.3.2**) would remain the same under Alternative D.

4.10.5.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative D are described in **Chapter 2.6** and summarized in **Chapter 4.10.5.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3**). The mitigation measures are the same as described for Alternative C with the addition of shutdown protocols during seismic operations for all marine mammals except bow-riding dolphins. The addition of shutdown protocols for all marine mammals except bow-riding dolphins under Alternative D would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to recreational fisheries also would not change. Therefore, the mitigation measures under Alternative D do not change the cumulative outcomes described in Alternative A (**Chapter 4.10.2.3**). The exact impacts would depend on the locations of activities, species affected, intensity of recreational fishing activity in the affected area, and substitutability of any lost fishing access.

4.10.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.10.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative E on recreational fisheries.

4.10.6.1 Impacts of Routine Activities

The reduction of deep-penetration, multi-client activities by 10 percent or 25 percent would reduce the extent, severity, and timing of active acoustic sound sources, vessel traffic, and stand-off distance compared with Alternative A. The analysis in Alternative A concluded that impacts from these IPFs would be **nominal**. The reduction in activity would not change the overall impacts for these IPFs; therefore, impacts would be **nominal** for recreational fisheries under Alternatives E1 and E2. Overall, impacts to recreational fisheries from routine activities under Alternative E are expected to be **nominal**.

4.10.6.1.1 Reduction of G&G Activity Levels

As discussed in **Chapter 4.10.2.1**, impacts of active acoustic sound sources are expected to be **nominal** for recreational fisheries under Alternative A. Under Alternatives E1 and E2, there would be a 10 percent or 25 percent reduction in activities, respectively, for deep-penetration, multi-client activities. A reduction in activities under Alternatives E1 and E2 could reduce the impacts of acoustic sound sources from certain seismic airgun surveys on recreational fisheries. However, seismic airgun surveys still will be conducted throughout the AOI, and recreational fish resources still will be impacted by airguns and electromechanical sounds sources. Localized short-term interruptions of recreational fishing activities may be expected, and slight decreases in recreational fisheries landings may occur. Therefore, a reduction in deep-penetration, multi-client activities will not change the overall impact level under Alternatives E1 and E2. Impacts of active acoustic sounds from seismic airguns and electromechanical sources will be **nominal** for recreational fisheries under Alternatives E1 and E2.

Under Alternatives E1 and E2, the majority of the activities will continue without restrictions; impacts to recreational fisheries are likely to be localized at several locations, intermittent in frequency of occurrence and temporary. Therefore, impacts to recreational fisheries landings arising from vessel traffic and stand-off distance are expected to remain **nominal** under Alternatives E1 and E2.

4.10.6.2 Impacts of an Accidental Fuel Spill

Under Alternatives E1 and E2, impacts of an accidental fuel spill on recreational fisheries would be very similar to those analyzed for Alternative C in **Chapter 4.10.4.2**. Alternatives E1 and E2 would reduce the number of surveys and vessels by 10 percent or 25 percent, respectively, but would not substantially change the risk of a small fuel spill because the majority of activities will continue to take place. A small diesel spill is expected to disperse and weather rapidly, with evaporation of volatile components. The impacts would depend on the size and location of the spill as well as the meteorological conditions. Impacts to recreational fisheries resources from an accidental fuel spill or small diesel fuel spill would remain **nominal** under Alternatives E1 and E2.

4.10.6.3 Cumulative Impacts

4.10.6.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.10.6.1 and 4.10.6.2** concluded that activities projected to occur under Alternative E would result in **nominal** impacts to recreational fisheries, depending on the IPF. When taken in the context of the cumulative scenario, the proposed action would have a nominal incremental impact to recreational fisheries.

4.10.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.10.2.3.2**) would remain the same under Alternative E.

4.10.6.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative E are described in **Chapter 2.7** and summarized in **Chapter 4.10.6.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3**). The reduction of deep-penetration, multi-client activities (in line miles) by 10 percent (Alternative E1) or 25 percent (Alternative E2) would reduce the extent, severity, and timing of active acoustic sound sources, vessel traffic, and stand-off distance; therefore, impacts for these IPFs would be incrementally decreased under Alternative E. Reductions in the line miles of deep-penetration, multi-client seismic airgun surveys would result in a net reduction of sound in the AOI. However, the changes under Alternative E do not change the impact level to the cumulative outcomes described in Alternative A (**Chapter 4.10.2.3**). The exact impacts would depend on the locations of activities, species affected, intensity of recreational fishing activity in the affected area, and substitutability of any lost fishing access.

4.10.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.10.2**). The following discussion outlines the effects of the additional mitigation measures included in Alternative F on recreational fisheries.

4.10.7.1 Impacts of Routine Activities

4.10.7.1.1 Area Closures

Alternative F would require area closures in the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area (**Figure 2.8-1**). The closures would reduce the impacts of active acoustic sound sources, vessel traffic, and stand-off distance on recreational fisheries occurring within or near the closure areas. The analysis in Alternative A concluded that impacts from active acoustic sound sources, vessel traffic, and stand-off distance would be **nominal**. A reduction in activities under Alternative F would not change the overall impact level. Therefore, impacts of active acoustic sound sources (e.g., airgun and electromechanical) are expected to be **nominal** for recreational fishing under Alternative F. Impacts of vessel traffic and stand-off distance are expected to be **nominal** for recreational fisheries under Alternative F.

4.10.7.1.2 Routine Activities Impact Conclusions

Assessment of the mitigation measures included in Alternative F concluded that some reduction in impacts may occur; however, consideration of the impact-level criteria, AOI, and 10-year timeframe results in no change in impact level of the overall impacts under Alternative F. Overall, impacts to recreational fisheries from routine activities under Alternative F are expected to be **nominal**.

4.10.7.2 Impacts of an Accidental Fuel Spill

A reduction in the geographical area covered by G&G activities would reduce the overall impact of an accidental fuel spill or small diesel fuel spills under Alternative F compared with Alternative A. The analysis in Alternative A concluded that impacts from an accidental fuel spill or small diesel fuel spill would be **nominal**. A reduction in activities under Alternative F would not change the overall impact level. Therefore, impacts to recreational fisheries from an accidental fuel spill or small diesel fuel spill would remain **nominal**.

4.10.7.3 Cumulative Impacts

4.10.7.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.10.7.1 and 4.10.7.2** concluded that activities projected to occur under Alternative F would result in **nominal** impacts to recreational fisheries.

When taken in the context of the cumulative scenario, the proposed action would have a nominal incremental impact to recreational fisheries.

4.10.7.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.10.2.3.2**) would remain the same under Alternative F.

4.10.7.3.3 Cumulative Impact Conclusions

Mitigation measures for the proposed action under Alternative F are described in **Chapter 2.8** and summarized in **Chapter 4.10.7.1**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3**). Mitigation measures under Alternative F are similar to Alternative C with the addition of four area closures: CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area. Most mitigation measures under Alternative F would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to recreational fisheries also would not change the **nominal** cumulative impacts described in Alternative A (**Chapter 4.10.2.3**). The exact impacts would depend on the locations of activities, species affected, intensity of recreational fishing activity in the affected area, and substitutability of any lost fishing access.

4.10.8 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.10.2**). Under Alternative G, no new permits/authorizations will be issued for G&G activities. Previously authorized activities still would occur under existing agreements or permits/authorizations but would drop off quickly. The VSP (2D only) and SWD surveys would continue at the level of activity in **Table 2.9-1**. The VSP surveys cover fewer line miles and shorter distances, use less sound energy, and usually are completed in a few days (**Appendix F, Section 1.1.5**). Thus, impacts from active acoustic sound sources, vessel traffic, and stand-off distances would not change immediately but would decrease over time. Impacts from other activities also would decrease over time. Therefore, impacts from activities on recreational fisheries would remain similar to Alternatives A and C (**nominal**); however, over time, impacts would reduce to **no impact** as activities were phased out. Overall, impacts to recreational fisheries from activities under Alternative G are expected to range from **nominal** to **no impact**.

Under Alternative G, a change in the spill volume for diesel fuel (1.2 to 7.1 bbl) is not expected. No new permits/authorizations will be issued for G&G activities. Previously authorized activities still would occur under existing agreements or permits/authorizations but would drop off quickly. However, VSP surveys will continue to be permitted. Thus, impacts of an accidental fuel spill on recreational fisheries would be very similar to those analyzed for Alternatives A and C in **Chapters 4.10.2.2 and 4.10.4.2**. Impacts to recreational fisheries from an accidental fuel spill or small diesel fuel spill would be **nominal**, declining to **no impact**.

Mitigation measures under Alternative G are described in **Chapter 2.9**. The cessation of activity for future G&G surveys requiring a permit/authorization from BOEM would substantially decrease cumulative impacts from all IPFs. However, VSP and SWD surveys are expected to continue under Alternative G. Therefore, following cessation of the majority of activities, there would be a **nominal** incremental increase in impacts to recreational fisheries from active acoustic sound sources, vessel traffic, stand-off distances, and accidental fuel spills under Alternative G. The exact impacts would depend on the locations of activities, species affected, intensity of recreational fishing activity in the affected area, and substitutability of any lost fishing access.

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.10.2.3.2**). Mitigation measures under Alternative G would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.10.2.3.2**) would remain the same under Alternative G.

4.10.9 Summary Conclusion

In summary, the IPFs that may impact recreational fisheries within the AOI include (1) active acoustic sound sources (e.g., airguns; non-airgun HRG sources such as high-resolution boomers, sparkers, and CHIRP subbottom profilers; SBESs and MBESs; and side-scan sonars), (2) vessel traffic, (3) stand-off distance, and (4) accidental fuel spill.

Impacts to recreational fisheries are assessed as **nominal** for all alternatives for all applicable IPFs due to the short-term and localized interactions between recreational fishing and G&G activities, with the exception of Alternative G. Impacts under Alternative G were assessed as **nominal** declining to **no impact**, except cumulative impacts which remain **nominal**.

4.11 ARCHAEOLOGICAL RESOURCES

4.11.1 Description of the Affected Environment

The following text summarizes the material presented in **Appendix E, Section 11** and supports the impact analysis presented below. The AOI contains unidentified submerged prehistoric and historic archaeological sites. Shipwrecks within the AOI date from the 16th century to the present. Several shipwreck databases and secondary sources were reviewed under this Programmatic EIS to estimate the number of potential archaeological sites that may be within the AOI. The results of the review indicate that there could be >12,000 historical archaeological sites – primarily shipwrecks – within the GOM. Due to the potential for unidentified archaeological resources on the Gulf of Mexico OCS, the National Park Service and MMS (BOEM's predecessor) sponsored three studies, beginning in 1977, to identify areas in the GOM where shipwrecks are most likely to occur (CEI, 1977; Garrison et al., 1989; Pearson et al., 2003). These studies examined a variety of factors that could influence the location of a shipwreck, including historic shipping routes, natural marine hazards, and atmospheric and oceanic conditions. Researchers identified OCS lease blocks with high probabilities of containing archaeological resources. New discoveries during recent HRG surveys have demonstrated that deepwater regions also have high potential for containing well-preserved archaeological sites. In response to these discoveries, BOEM has revised their guidelines, requiring archaeological surveys in all OCS lease blocks prior to any seafloor-disturbing impacts.

Research has shown the potential for the presence of prehistoric archaeological resources in the AOI. Archaeological evidence indicates that the GOM region was first occupied approximately 14,500 B.P. (Halligan et al., 2016). 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. 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. Although many specific areas in the GOM having the potential for prehistoric site preservation have been identified through archaeological surveys, industry generally has chosen to avoid these areas rather than conduct further investigations. The possibility of locating submerged prehistoric sites would be greatest in the nearshore zone (<60-m [197-ft] water depth) because portions of this area would have been exposed land during the period of human occupation.

4.11.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact archaeological resources within the AOI include (1) seafloor disturbance, (2) drilling discharges, (3) entanglement with bottom-founded cables, and (4) accidental fuel spills.

In considering the potential impacts to the associated archaeological resources, it is important to make the distinction between the AOI and planning areas. The AOI covers 689,166 km^2 (266,089 mi^2), including 45,630 km^2 (17,618 mi^2) of State waters outside of the planning area boundaries, so the total planning area in Federal waters considered for archaeological resources is 643,536 km^2 (248,471 mi^2). The potential direct impacts considered here include the planning areas only and do not include State waters that extend to 3 nmi (3.5 mi; 5.6 km) offshore Louisiana, Mississippi, and Alabama, and 9 nmi (10.4 mi; 16.7 km) offshore Texas and Florida, which are beyond OCS lease block area boundaries and where proposed BOEM-authorized G&G activities would not occur. In areas outside of the planning areas but within the AOI, only potential indirect impacts to archaeological resources propagating into the area from proposed activities are considered.

The analysis for Alternative A is organized by IPF and takes into account the potential effects of associated mitigation measures to influence the impact level. In contrast, the analysis of impacts associated with Alternatives B through G are organized by alternative-specific mitigation measures and how each of these measures may reduce impact levels.

Impact-Level Definitions

The NHPA (54 U.S.C. §§ 300101 *et seq*.) established a national program to preserve the Nation's historical and cultural resources. Section 106 of the NHPA requires Federal agencies to consider the effects of their actions on historic properties and to provide the President's Advisory Council on Historic Preservation an opportunity to comment on a proposed action before it is implemented. Regulations for implementing the Section 106 process are provided in 36 CFR part 800. State and Federal guidelines for cultural resources recognize that buildings, structures, objects, districts, archaeological sites, and cultural landscapes can be historically significant. Under Section 106 of the NHPA (36 CFR § 800.16), a historic property is "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places." Districts include the property types known as cultural landscapes (e.g., historic, rural, designed). To be eligible for the National Register of Historic Places, these property types must be >50 years old and/or meet at least one of the National Register of Historic Places significance evaluation criteria (36 CFR § 60.4), and the property must possess integrity. Specific aspects or types of integrity include location, design, setting, materials, workmanship, feeling, and association. To be eligible for listing in the National Register of Historic Places properties must meet one or more of the following evaluation criteria:

- Criterion A – the property is associated with events that have made a significant contribution to the broad patterns of our history;
- Criterion B – the property is associated with the lives of persons significant in our past;
- Criterion C – the property embodies the distinctive characteristics of a type, period, or method of construction; represents the work of a master; possesses high artistic values; or represents a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D – the property has yielded, or may be likely to yield, information important to prehistory or history.

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. In consideration of the National Register of Historic Places criteria and the sensitivity of submerged cultural resources to disturbance, the following impact-level criteria are used to evaluate the level of impact for each IPF.

- **Nominal** impacts to archaeological resources would be those that have neither adverse nor beneficial impacts.
- **Minor** impacts to archaeological resources would be disturbance of archaeological resources resulting in little, if any, loss of site integrity.
- **Moderate** impacts to archaeological resources would be site disturbance resulting 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 archaeological data recovery and in-place preservation.
- **Major** impacts to archaeological resources would be disturbances resulting 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 archaeological data recovery is the primary form of mitigation.

In addition to the impact-level criteria, negative and positive impacts as well as duration were considered. Beneficial impacts can occur when an archaeological site is stabilized in its current condition to maintain its existing level of integrity or when an archaeological site is preserved in accordance with the Secretary of the Interior's "Standards for the Treatment of Historic Properties." Short-term impacts last for the duration of construction-related activities, while long-term impacts last beyond the proposed construction activities or are permanent. All impacts to archaeological sites are considered long-term impacts.

4.11.2.1 Impacts of Routine Activities

4.11.2.1.1 Seafloor Disturbance and Entanglement

Placement of equipment (e.g., anchors, cables, nodes, receivers, bottom-founded monitoring buoys) on the seafloor could damage any significant archaeological resources present. Proposed activities under Alternative A include bottom sampling in all three Program Areas, including a maximum of 896 bottom samples in the Oil and Gas Program; 270 core samples, 270 grab samples, and 270 CPT samples in the Renewable Energy Program; and 90 grab samples, 50 jet probes, and 392 vibracores in the Marine Minerals Program (**Table 3.2-6**). The total of all bottom samplings from coring, grab samples, CPTs, and jet probes is 2,238 samplings in all three Program Areas. In total, 150,381 m^2 (1,618,688 ft^2) (**Table 3.2-7**) of seafloor would be disturbed under the proposed activities scenario.

Certain surveys in oil and gas exploration require placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor (**Chapter 3.3.1.8.2**). Locations and projected levels are not estimated for the proposed action; however, nodal surveys are relatively uncommon and typically are performed in shallow waters. **Appendix F, Section 1.1.3** provides complete descriptions of nodal surveys.

Drill test wells associated with oil and gas exploration activities are expected to impact ≥2 ha (5 ac) of the seafloor per well, primarily through physical coring of the sediment. Secondarily, deposition of drill muds and cuttings may bury artifacts, making future detection more difficult. Only two test wells are planned under the time period of this Programmatic EIS. The VSP surveys associated with oil and gas exploration also are expected to impact the seafloor through the placement of receivers in well boreholes. There are 397 to 561 VSP surveys planned over the 10-year period of this Programmatic EIS (**Table 3.2-7**).

Depth distribution of submerged cultural resources is an important consideration when evaluating potential impact. While historic shipwrecks may occur at any water depth within the AOI, prehistoric resources are depth limited, as outlined in **Chapter 4.11.1**. The highest probabilities for encountering submerged prehistoric sites vary within the AOI, primarily by depth, location, and local sedimentation rate. In general, areas deeper than 60 m (197 ft) can be expected to have no sensitivity for the presence of or potential for impact to prehistoric resources. Submerged prehistoric resources most likely would be found in the vicinity of paleochannels or similar geomorphic features that possess higher potential for preservation relative to other areas.

Because of the rich maritime history and potential for submerged archaeological resources in the AOI, all activities that disturb the seafloor could impact previously unidentified cultural resources. The potential impacts of survey operations generally are localized but occur over a widely dispersed area and may be caused by coring, bottom sampling, OBC and OBN surveys, vertical cable surveys, and anchor deployments associated with seafloor-disturbing activities. The placement of heavy objects (e.g., anchors, tethered nodes with sound dampeners) on the seafloor, in conjunction with OBC and OBN surveys, could have moderate to major impact an archaeological site should the objects come into direct contact with a historic resource. The OBCs 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 181 kg (400 lb). The “blind” method of laying down and peeling up the cable from the seafloor could result in the cable snagging on an archaeological site, causing **moderate** to **major** impacts. The OBNs are dropped from a surface vessel, with a localized impact over a large area, or they are placed by ROVs, thereby lessening potential impacts to any archaeological resources that may be present on the seafloor. The potential for impacts to archaeological resources resulting from G&G surveys could be reduced further through pre-disturbance survey plan reviews provided by BOEM.

Except in the case of OBC and OBN surveys, BOEM considers G&G surveys to have a **nominal** impact to the seafloor. If site-specific information regarding potential archaeological resources is provided to BOEM prior to approving G&G activities involving the seafloor, these activities likely would result in **nominal** impacts to archaeological resources. In the absence of a site-specific archaeological survey, or if ROVs are not utilized during deployment of nodes, BOEM cannot determine if an archaeological resource may have been impacted by OBC or OBN surveys. If impacts were to occur, they would be **moderate** to **major**, depending on the extent of the impact. BOEM requires that, if a cable becomes snagged upon retrieval operations, the operator must verify the cause of the snag, and if an archaeological resource was found to be impacted, note the extent of the impact. The operator is then required to immediately halt activities, and BOEM must be notified within 48 hours of the incident, which could possibly minimize further damage to archaeological resources.

For the Renewable Energy Program, BOEM has issued "Guidelines for Providing Archaeological and Historic Property Information" pursuant to 30 CFR part 585. The July 2015 revised guidelines specify that a site characterization survey must reliably cover any portion of the site that would be affected by seafloor-disturbing activities. The guidelines recommend avoidance as a primary mitigation strategy for objects of historical or archaeological significance.

4.11.2.1.2 Drilling Discharges

Archaeological resources likely would not be affected by drilling discharges in the AOI during the time period of this Programmatic EIS. The Oil and Gas Program predicts only two drilled test wells would occur during the 10-year period. Anticipated impacts to archaeological resources from drilling include discharge of drilling fluids and cuttings as well as localized accumulation of cement slurry. Based on the limited impacts of these activities to benthic communities, as discussed in **Chapter 4.5.2.1**, the impact to archaeological resources likely would be **nominal**. Avoidance of archaeological resources and the immediate reporting of unanticipated discoveries to BOEM are expected to prevent serious impact to archaeological resources. Given BOEM's requirement for site-specific information regarding archaeological resources for all drilling activities, impacts from drilling discharges in the AOI are expected to be **nominal**.

4.11.2.1.3 Routine Activities Impact Conclusions

This impact analysis considered the impact-level criteria, the AOI, and the 10-year timeframe. Mitigation measures associated with Alternative A are outlined in **Chapter 2.3** and detailed in **Appendix B**. Except in the case of OBC and OBN surveys, BOEM considers seafloor disturbance related to G&G surveys and drilling discharges to have a **nominal** impact to the seafloor. If site-specific information regarding potential archaeological resources is provided to BOEM prior to approving G&G activities involving the seafloor, seafloor-disturbing activities and the potential for entanglement likely would result in **nominal** impacts to archaeological resources. Archaeological review is not required in advance of OBN and OBC surveys; however, identified and potential archaeological resources are noted for avoidance. Deployment of OBCs and OBNs dropped from the surface and entanglement during recovery could have **moderate** to **major** impacts to unidentified archaeological resources. The OBNs placed by an ROV would have a **nominal** impact to archaeological resources, as the seafloor is visually inspected before placement and recovery. The requirement to visually verify any snags resulting from entanglement during recovery would identify potential damages to archaeological resources should they occur during an OBC or OBN survey. In summary, impacts to archaeological resources from project-related IPFs (including routine activities) are expected to range from **nominal** to **major**.

4.11.2.2 Impacts of an Accidental Fuel Spill

An accidental event could result in the release of fuel by a survey vessel. Based on USCG spill statistics, a spill scenario developed in **Chapter 3.3.2** assumed a diesel spill volume of 1.2 to 7.1 bbl. Fuel spills occurring at the ocean surface would disperse and weather; volatile components of the fuel would evaporate. Diesel and other fuel used for the operation of survey vessels is light and would float on the sea surface. A small proportion of the heavier fuel components could adhere to particulate matter in the upper portion of the water column and sink. Particulate matter contaminated with diesel fuel eventually would reach the seafloor, within or outside the AOI, depending on spill location, water depth, ambient currents, and sinking rate. However, given the relatively small size of the fuel spill and the loss of most spilled fuel through evaporation and dispersion, a small diesel fuel spill at the surface would have no effect on the seafloor and would not require seafloor cleanup activity. An accidental diesel fuel spill would be expected to result in **nominal** impacts to archaeological resources.

High-volume catastrophic fuel spills such as the *Deepwater Horizon* explosion, oil spill, and response are rare. The average size of a typical fuel spill is fairly small. Currently, there is very little published information available on the impacts of a high-volume fuel spill on archaeological resources.

4.11.2.3 Cumulative Impacts

4.11.2.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.11.2.1 and 4.11.2.2** determined that activities projected to occur under Alternative A would result in **nominal** to **major** impacts to archaeological, with the level of impact dependent upon the specific IPF being considered. The following analysis considers whether those incremental impacts, when added to or acting synergistically with other impact sources from the cumulative impacts scenario, may result in a significant impact.

4.11.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for archaeological resources are compared with the IPFs from each of the cumulative scenario components on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The following analysis evaluates the incremental increase by IPF from the proposed action and provides a conclusion of the cumulative incremental increase within the AOI. The IPFs for cumulative activities that could affect archaeological resources are (1) Federal and State oil and gas activity (2) vessel traffic; (3) seafloor disturbance and entanglement, (4) drilling discharges, (4) recreational activities; (5) research and monitoring; (6) artificial reef development; and (7) hurricanes. Impact analyses presented in **Chapters 4.11.2.1 and 4.11.2.2** concluded that activities projected to occur under Alternative A could result in **nominal** to **major** impacts to archaeological resources.

The G&G activities have been ongoing in the GOM for at least the past 30 years, and it is reasonable to assume they will continue into the future; however, for the purpose of this Programmatic EIS, the cumulative analysis assesses a 10-year timeframe to coincide with the proposed action timeframe of this Programmatic EIS.

Federal and State Oil and Gas Activity

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); 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 feasible before related activities take place. The impacts to archaeological sites from oil spills and associated activities **have not been quantified**.

In addition to G&G activities that occur as part of the proposed action, previously permitted G&G activities and ancillary activities (SWD and VSP surveys that occur on-lease), non-airgun HRG surveys for archaeological and benthic resources, and off-lease G&G activities for renewable energy will continue. For more information on impacts to benthic communities by oil and gas activities, refer to **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.13 of the 2017-2022 GOM Multisale EIS.

Vessel Traffic

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 survey is performed, no mitigation is imposed, a mitigation is not followed, or a site is unidentified prior to the activity.

Seafloor Disturbance and Entanglement

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 **nominal** to **major** if no survey is performed, no mitigation is imposed, a mitigation is not followed, or a site is unidentified prior to the activity.

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 (Atkinson, 2012). 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 **nominal** to **major**. There is no archaeological mitigation applied to commercial fishing.

Over the next 10 years, seafloor-disturbing activities under the OCS Program in the cumulative scenario will include the construction and installation of at most 8,233 exploration and production wells, 507 production structures (e.g., caissons, multi-leg platforms), and 17,437 km (10,835 mi) of pipelines (**Table 3.4-2**). Proposed action activities can disturb the seafloor by the placement of equipment, trenching, coring, and bottom sampling. These activities could damage archaeological resources, if present. Depending on size, production structures can impact the seafloor from as little as hundreds of square feet to up to tens of thousands of square feet. There are a limited number of renewable energy activities projected over the next 10 years. Seafloor disturbances from these activities would be localized and evaluated to minimize disturbances to nearby archaeological resources. Seafloor disturbances associated with marine minerals use would be in pre-determined OCS sand source areas (**Chapters 3.2.3 and 3.4.1.4**) for use in coastal restoration. As restoration activities would be limited to “beach-quality” sand sediments, seafloor disturbances would be localized.

Over the 10-year period, seafloor-disturbing activities associated with Alternative A would include a maximum of 3 wells, 2 bottom-founded monitoring buoys, and 2,238 bottom samplings (**Table 3.2-7**). One renewable energy development is being considered under the proposed action. For the activities under its purview, BOEM has existing regulations, guidelines, best management practices, and permit authorizations containing COAs regarding submerged cultural resources and their preservation. Because the locations of most submerged cultural resources are unknown and because of the high potential for information loss and damage, cumulative impacts to submerged archaeological resources could be significant. However, all activities under BOEM’s purview that could disturb the seafloor may be subject to guidance for submitting site-characterization surveys, which include the identification of potentially impacted cultural resources. Locations identified as having potential historic or prehistoric archaeological resources will be assigned an avoidance buffer for all activities. If a potential shipwreck or prehistoric site has been located during the course of

G&G activity, the operator must immediately halt operations and take the necessary steps to ensure the site is not disturbed further. BOEM must be notified within 48 hours of the discovery. If all existing protective measures and regulations are followed and potential archaeological resources are identified in advance, then a **nominal** incremental increase in impacts from seafloor-disturbing activities to archaeological resources under the OCS Program is expected. If an impact related to seafloor-disturbing activities or entanglements during recovery of OBCs and OBNs were to occur, the impact would be **moderate** to **major**, depending on the nature and extent of the impact.

Drilling Discharges

Cumulative scenario activities that would include discharges of drilling fluids, drill cuttings, and other effluents from drilling rigs would require BOEM's authorization as well as the submittal and agency review of site-specific information regarding archaeological resources prior to activity approval. BOEM's review is expected to help ensure that physical impacts to sensitive archaeological resources are avoided and that the resources are protected from impacts from cumulative scenario activities.

Drilling discharge activities from the proposed action are expected to result in a **nominal** impact to archaeological resources (**Chapter 4.11.2.1**). Considering the limited contribution of drilling discharges under the proposed action compared with existing drilling activities under the OCS Program and State waters oil and gas activities, a **nominal** incremental increase to impacts from the proposed action is expected.

Recreational Activities

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 ROV 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 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.

Artificial Reef Development

Artificial reef areas are designated by the USACE 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 USACE 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 **nominal** to **major** if no survey is performed, no mitigation is imposed, a mitigation is not followed, or a site is unidentified prior to the activity.

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 **nominal** to **major**. BOEM does not apply any archaeological mitigation in advance of potential hurricane activity.

4.11.2.3.3 Cumulative Impact Conclusions

Impact analyses presented in **Chapters 4.11.2.1 and 4.11.2.2** concluded that activities projected to occur under Alternative A would result in **nominal** to **major** impacts to archaeological resources if no survey is performed, no mitigation is imposed, a mitigation is not followed, or a site is unidentified prior to the activity.

For the activities under their purview, BOEM has existing regulations (NTLs), guidelines, best management practices, and permit authorizations containing COAs regarding submerged cultural resources and their preservation. Therefore, cumulative impacts to archaeological resources would result in a **nominal** to **major** incremental increase in impacts from seafloor disturbance and a **nominal** incremental increase in impacts from drilling discharges and accidental fuel spills.

4.11.3 Impacts – Alternatives B through F

The IPFs, impact-level criteria, and impact conclusions for Alternatives B through F are the same as for Alternative A (**Chapter 4.11.2**).

4.11.3.1 Impacts of Routine Activities

Additional mitigation measures implemented under Alternative B would not change the extent, severity, or timing of G&G activities related to impacts to archaeological resources. As discussed under Alternative A in **Chapter 4.11.2**, there are three applicable routine IPFs for archaeological resources: seafloor disturbance; drilling discharges; and entanglement. Except in the case of OBC and OBN surveys, BOEM considers seafloor disturbance related to G&G surveys and drilling discharges to have a **nominal** impact to the seafloor. If site-specific information regarding potential archaeological resources is provided to BOEM prior to approving G&G activities involving the seafloor, seafloor-disturbing activities and the potential for entanglement likely would result in **nominal** impacts to archaeological resources. Archaeological review is not required in advance of OBN and OBC surveys; however, identified and potential archaeological resources are noted for avoidance. Deployment of OBCs and OBNs dropped from the surface and entanglement during recovery could have **minor** to **major** impacts to unidentified archaeological resources. The OBNs placed by an ROV would have a **nominal** impact to archaeological resources as the seafloor is visually inspected before placement and recovery. The requirement to visually verify any snags resulting from entanglement during recovery would identify potential damages to archaeological resources should they occur during an OBC or OBN survey. In summary, impacts to archaeological resources from project-related IPFs (including routine activities) are expected to range from **nominal** to **major** (if no mitigation is imposed).

4.11.3.2 Impacts of an Accidental Fuel Spill

Under Alternative B, impacts of an accidental fuel spill on archaeological resources would be very similar to those analyzed for Alternative A in **Chapter 4.11.2.2**. Because a small proportion of the heavier fuel components could adhere to particulate matter in the upper portion of the water column and sink, particulate matter contaminated with diesel fuel could eventually reach the seafloor; an accidental diesel fuel spill would be expected to result in **nominal** impacts to archaeological resources.

4.11.3.3 Cumulative Impacts

4.11.3.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.11.3.1 and 4.11.3.2** concluded that activities projected to occur under Alternatives B through F would result in **nominal** to **major** impacts to archaeological resources if no survey is performed, no mitigation is imposed, a mitigation is not followed, or a site is unidentified prior to the activity.

4.11.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.11.2.3.2**). Mitigation measures under Alternatives B through G also would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.11.2.3.2**) would remain the same under Alternatives B through F.

4.11.3.3.3 Cumulative Impact Conclusions

A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.11.2.3**). Mitigation measures under Alternatives B through F would not change the extent, severity, or timing of activities in the proposed action; thus, the resultant impacts to archaeological resources also would not change because none of the mitigation measures would change the seafloor-disturbing activities or drilling discharges. As discussed in **Chapter 4.11.2.3**, a significant amount of vessel traffic is expected to occur under the cumulative scenario. All vessel movements are associated with a risk of collision and subsequent loss of fuel. The risk of accidental fuel spills arising from a vessel collision under the cumulative scenario is expected to be **nominal**. Changes to seismic airgun survey protocols would not substantially change the risk of a small fuel spill. Overall, the risk of a small fuel spill and the potential cumulative impacts to archaeological resources would be the same under Alternatives B through F as determined under Alternative A and would result in a **nominal** to **major** incremental increase in impacts from seafloor disturbance and a **nominal** incremental increase in impacts from drilling discharges and accidental fuel spills.

4.11.4 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.11.2**).

Under Alternative G, a limited number of VSP and SWD surveys would occur, and no seafloor-disturbing activities are projected (**Table 2.9-1**). If no new seafloor-disturbing activities occur under Alternative G, then **no impact** will occur to the archaeological resources from seafloor disturbance or drilling discharges; therefore, **no impacts** are expected under Alternative G. Overall, **no impacts** to archaeological resources are expected from activities under Alternative G.

Under Alternative G, impacts of an accidental fuel spill on archaeological resources would be very similar to those analyzed for Alternative A (**Chapter 4.11.2.2**). The analysis concluded that a small fuel spill at the sea surface would be unlikely to affect archaeological resources. Alternative G would cease future activity, but this would not substantially change the risk of a small fuel spill from ongoing activity. A small diesel spill is expected to disperse and weather rapidly, with evaporation of volatile components. An accidental diesel fuel spill would be expected to result in **nominal** impacts to archaeological resources.

Mitigation measures for the proposed action under Alternative G are described in **Chapter 2.9**. A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.11.2.3**). The cessation of activity for future G&G surveys requiring a permit/authorization from BOEM would not increase the cumulative impacts because VSP and SWD surveys are linked to current activity. Overall, the impacts to archaeological resources would remain **nominal** to **no impact** for Alternative G.

Though there would be no vessel involvement under Alternative G, all current vessel movements have a risk of collision and subsequent loss of fuel. The impacts of accidental fuel spills arising from a vessel collision under the cumulative scenario are expected to be **nominal**. Overall, the risk of a small fuel spill and the potential cumulative impacts to archaeological resources would be the same under Alternative G as determined under Alternative A and would result in a **nominal** incremental increase in impacts from seafloor disturbance, drilling discharges, and a collision-based fuel spill. Seafloor-disturbing activities associated with spill cleanup are not expected. Therefore, impacts to archaeological resources from spill response and cleanup activities associated with fuel spills from vessels under the cumulative activities scenario are expected to be **nominal** impacts.

The cessation of G&G activities would result in the loss of an important tool for exploration to identify the location and size of oil and gas prospects, development of renewable energy projects, and exploration for non-energy marine minerals such as sand and gravel (or other sediment) for beach nourishment, coastal restoration, and public works projects. Such a loss would result in increased environmental risk to industry and could potentially lead to increased exploratory drilling or a dramatic reduction in oil and gas activity in the GOM. The cessation of activity for future G&G

surveys requiring a permit/authorization from BOEM would not add a substantial increase to the cumulative impacts.

4.11.5 Summary Conclusion

In summary, the IPFs that may impact archaeological resources within the AOI include (1) seafloor disturbance, (2) drilling discharges, (3) entanglement with bottom-founded cables, and (4) accidental fuel spill.

Impacts to archaeological resources from seafloor disturbance and entanglement are assessed as **nominal** to **major**, depending on the type of survey and whether site-specific information regarding potential archaeological resources is available, for all alternatives except Alternative G. Under Alternative G, impacts would be reduced to **no impact**. Impacts from drilling discharges and an accidental fuel spill are assessed as **nominal** for all alternatives, except for Alternative G. Under Alternative G, impacts from drilling discharges would be reduced to **no impact**, and impacts from an accidental fuel spill would be **nominal**.

4.12 MULTIPLE-USE AREAS

4.12.1 Description of the Affected Environment

Areas of the OCS offer environmental, recreational, economic, historical, cultural, and/or social values in the same geographic area continuously; these area are called multiple-use areas. The G&G activity has the potential to interfere with these activities' potential use of the GOM and is described as a space-use conflict. The OCS Program's G&G-related operations that may cause space-use conflicts include the deployment of seismic vessels, bottom surveys, and the installation of subsurface anchors, nodes, and cables, and temporary exclusionary safety zones. In addition, seismic vessels may be supplied by service vessels and helicopters while conducting surveys. While these areas are in use by G&G operations, other activities and operations would be precluded from a very small area for several days, including the following:

- commercial and recreational fishing;
- shipping and marine traffic;
- military warning areas (MWAs);
- sand and gravel mining;
- renewable energy development;
- ocean dredged material disposal; and
- oil and gas exploration and production.

Space-use conflicts with commercial and recreational fishing are described in **Chapters 4.9 and 4.10**, respectively. Effects of G&G activity on human resources and economic impacts are described in **Chapter 4.13**. Potential impacts as a result of space-use conflicts are discussed here, and additional descriptions of other marine activities can be found in **Appendix E, Section 12**.

4.12.1.1 Shipping and Marine Transportation

Aspects of shipping and marine transportation that may be affected by space-use conflicts with G&G activity includes fairways usage and port capacity and usage by other industries, including freight, cruise ships, and tankering.

The USCG designates shipping fairways and establishes traffic separation schemes that control the movement of vessels as they approach ports (**Figure 4.12-1**) (33 CFR part 166).

Seven deepwater commercial ports that can handle fully laden Panamax ships (pre-Panama Canal expansion) are located in the AOI: Houston, Texas; Corpus Christi, Texas; Beaumont, Texas; Galveston, Texas; New Orleans, Louisiana; Mobile, Alabama; and Tampa, Florida. These deepwater ports are discussed further in **Chapter 4.12.1.6**. Military vessels operating in the AOI are associated with training and testing activities (**Chapter 4.12.1.2**). Commercial business craft include support vessels, fishing vessels (**Chapter 4.9**), and ferries. Commercial recreational craft include cruise ships and fishing charters (**Chapter 4.10**).

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, Texas; 139 cruise ship departures from New Orleans, Louisiana; and 199 cruise ship departures from Tampa, Florida (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 approximately 3 percent average increase of GOM port calls between 2003 and 2012, i.e., from 18,034 to 24,730 port calls (USDOT, MARAD, 2015a) (refer to Table 3-26 of the 2017-2022 GOM Multisale EIS).

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.

Tankering includes ships carrying crude or 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; however, by 2011, 97-100 percent of all tankers were double hulled.

4.12.1.2 Military Warning Areas and Other Military Uses

Aspects of military activity that may be affected by space-use conflicts with G&G activity includes training exercise areas, danger zones, and discontinued dump sites.

Twelve MWAs and six EWTAs (**Figure 4.12-2**) (NTL 2014-BOEM-G04) have been established in the AOI to allow military forces to conduct training and testing activities, including various air-to-air, air-to-surface, and surface-to-surface Naval fleet training, submarine and antisubmarine training, and Air Force exercises.

These areas are multi-use areas where military operations and oil and gas exploration and production have coexisted for many years. The MWAs and EWTAs cumulatively include 75 percent of the total acreage of the WPA, 31 percent of the total acreage of the CPA, and 91 percent of the total acreage of the EPA.

Portions of the AOI are further classified as danger zones, which can be closed or subject to limited public access during intermittent periods. Danger zones and restricted areas are defined and described by 33 CFR § 334.2, and encompass areas used for target practice, bombing, and rocket firing or are areas that provide security for Government property and/or protection to the public from the risks of property damage or injury from the Government's use of the area.

Additionally, the GOM has 26 sites distributed across all three planning areas that contain unexploded ordnances, submerged explosives, depth charges, torpedoes, or other obstructions; or sites that are identified as discontinued dump sites for explosives or other wastes (**Figure 4.12-2**).

4.12.1.3 Sand and Gravel Mining

Aspects of sand and gravel mining that may be affected by space-use conflicts with the Outer Continental Shelf G&G activity is limited to coastal areas. Compounding the scarcity of sand resources is that vast areas of these relatively small offshore sand resources are not extractable because of the presence of oil and gas infrastructure, archaeologically sensitive areas, and biologically sensitive areas or other sources of space-use conflicts. Offshore sand resource utilization in the AOI is limited to coastal areas where sand is needed for nourishment and restoration projects. 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. Mitigation 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. **Figure 4.12-3** shows the OCS lease blocks with significant sediment resources (USDOI, BOEM, 2015e). **Table 4.12-1** provides the recent projects in Florida and Louisiana, the cubic yards of sand, and the miles of restored shoreline (USDOI, BOEM, 2016b).

4.12.1.4 Renewable Energy Development – Wind Energy

Wind energy development may initially be restricted to coastal areas and may be affected by space-use conflicts with Outer Continental Shelf G&G activity. The EPAct, signed by President Bush in 2005, authorized USDOI to grant leases, easements, or rights-of-way on the OCS for the development of energy resources other than traditional hydrocarbons on the OCS. The *Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf: Final Environmental Impact Statement* was published by MMS (BOEM's predecessor) in 2007 (USDOI, MMS, 2007b), leading the way for BOEM to develop an alternative energy program, which was published as a final rule on April 29, 2009 in 30 CFR part 285.

There are no operational wind farms within the AOI and no Wind Energy Areas have been identified by USDOI or BOEM within the AOI. However, one licensed wind platform is currently the site of a meteorological monitoring tower used to track winds offshore of Galveston, Texas, in State waters (Coastal Point Energy, 2015), and a 150-MW wind farm is scheduled to be built on the site. Neither the company nor the State have any intentions at this time of proposing activities in Federal waters. Because of the lack of projected wind farms in the GOM, geophysical surveys are not expected to impact them.

4.12.1.5 Ocean Dredged Material Disposal Sites

The ocean dredged material disposal sites (ODMDSs) are typically located in coastal areas and may be affected by space-use conflicts with Outer Continental Shelf G&G activity. Regulated by

USEPA, ODMDSs are composed of materials from maintenance dredging and are available for potential beneficial uses to restore and create habitat, beach nourishment projects, and industrial and commercial development. There are 19 designated ODMDSs within the AOI (40 CFR § 228.15; USEPA, 2015) (**Figure 4.12-4**). The New Orleans District dredges an average annual 14.7 million yd^3 (11.3 million m^3). Materials from maintenance dredging are primarily disposed of offshore on existing dredged material disposal areas and in ODMDSs. Additional dredged material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by USACE and relevant State agencies prior to construction. 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 remaining 62 percent of the total material dredged yearly by USACE'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).

4.12.1.6 Oil and Gas Exploration, Development, and Production

The Gulf of Mexico OCS is divided into the WPA, CPA, and EPA, and as of June 2017, there were 2,968 active leases in the Gulf of Mexico OCS (USDOI, BOEM, 2017b). The majority of the active leases are located in the WPA and CPA, with only 37 active leases located in the EPA. Oil and gas operations and activities that may experience space-use conflicts with G&G activity include vessel traffic, leased areas (platforms and deepwater ports), and subsurface facilities and equipment. The Gulf of Mexico OCS Region oversees approximately 2,104 offshore oil and natural gas facilities, accounting for 16 percent of domestic oil production and 5 percent of domestic natural gas production (USDOI, BOEM, 2016).

The GOMESA was signed into law by President Bush on December 20, 2006. Among other provisions, the GOMESA banned oil and gas leases in the EPA within 125 mi (201 km) of the Florida coastline until at least 2022. The Act also banned new oil and gas leases from all areas in the EPA east of the Military Mission Line (86°41' W. longitude) and areas in the CPA within 161 km (100 mi) of the Florida coastline (**Figure 4.12-5**).

Offshore Deepwater Ports

According to MARAD, the LOOP is the only operational offshore deepwater port in the GOM with offshore marine terminal facilities. The LOOP carries 13 percent of all imported oil to the U.S. via subsea pipelines, transporting it onshore to Lafourche Parish where it is stored and piped via onshore pipelines to markets throughout the country.

Pipeline and Cable Infrastructure

There is an extensive network of pipelines in the AOI that carry produced oil and gas from the offshore field to refineries and terminals onshore (**Figure 4.12-6a-c**).

In 2008, BP began operation of a fiber optic communication system connecting seven of BP's platforms with the BP enterprise. In addition, there are several other submarine power cables and multiple umbilicals associated with oil and gas platforms and field development within the GOM (**Figure 4.12-7**).

4.12.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative)

As shown in **Table 4.1-2**, the IPFs that may impact multiple-use areas within the AOI include (1) vessel traffic, (2) aircraft traffic and noise, (3) stand-off distance, (4) seafloor disturbance, and (5) accidental fuel spill. For the purpose of this discussion, vessel traffic and stand-off distances will be addressed together because they are interrelated (seismic surveys conducted under all three Program Areas will result in these IPFs) and result in impacts of a similar nature. In considering the potential impacts with areas of disturbance (i.e., on the seafloor), it is important to make the distinction between the AOI and BOEM's planning areas. The total AOI area of 689,166 km^2 (266,089 mi^2) includes 45,630 km^2 (17,618 mi^2) of State waters outside of the planning area boundaries, so the total planning areas considered with the potential to be impacted by seafloor disturbance is 643,536 km^2 (248,471 mi^2).

Impact-Level Definitions

As described in **Chapter 4.1.2**, impact-level criteria 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). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For other marine uses, the following impact-level criteria have been used to evaluate the level of impact for each IPF.

- **Nominal** impacts to multiple-use areas would include those where little to no measurable impacts on other marine operations and activities are observed or expected.
- **Minor** impacts to multiple-use areas would include those that are detectable but not severe or extensive. Minor impacts to multiple-use areas would include limited, localized, and short-term disruptions of other marine operations and activities (from vessel traffic, stand-off distances, space-use conflicts, and seafloor disturbance).
- **Moderate** impacts to multiple-use areas would be detectable and extensive but not severe or they would be detectable, localized, and severe. Moderate impacts to multiple-use areas would include detectable disruptions of other marine operations and activities (from vessel traffic, stand-off distances, space-use conflicts, and seafloor disturbance).
- **Major** impacts to multiple-use areas would be detectable, extensive, and severe. Major impacts to multiple-use areas would include any G&G activity that results

in (1) a substantial increase in the volume of vessel traffic for an extended period over a large area resulting in an interruption of other marine operations and activities; (2) broad-scale, long-term stand-off distances resulting in long-term space-use conflicts with other marine operations and activities; or (3) severe and extensive disturbance to the seafloor.

4.12.2.1 Impacts of Routine Activities

4.12.2.1.1 Vessel Traffic and Stand-Off Distance

Vessel traffic generated by each type of G&G survey proposed within the AOI is shown in **Table 3.3-3**, and the types of surveys and activity level scenarios are described in **Chapter 3**. The level of vessel traffic related to G&G surveys would not represent a significant increase in total vessel traffic (**Table 3.4-2**) in offshore waters. When G&G survey vessels are actively performing data acquisition, they are slow-moving, which allows other vessels to easily move out of the way.

The proposed G&G activities include extensive 2D and 3D surveys involving towed streamer arrays (**Chapter 3.2.1.2**) that require a stand-off distance or an operational distance, where other vessels are required to stay away from the seismic gear (towed array), to avoid interference within the AOI. The stand-off distance is simply an area monitored by a seismic survey operator and has no formal status or designation by the USCG. However, a Local Notice to Mariners would be issued that would specify the survey dates and locations as well as the recommended avoidance requirements.

The extent of the stand-off distance varies depending on the array configuration and other factors (**Chapter 3.3.1.5**). Because survey vessels move at speeds of 4.5 kn (5.2 mph), the length of time that any particular point would be within the stand-off distance would be approximately 1 hour.

Survey vessels for non-seismic surveys (e.g., HRG, grab sampling, coring) would be relatively small and are expected to make daily round-trips to their shore base. Depending on the location of the survey area, vessels could mobilize from several different ports throughout the AOI. Activities related to renewable energy are not anticipated, and marine minerals surveys (e.g., HRG, grab sampling, vibracoring) would require relatively few round-trips per year (**Table 3.2-6**). Impacts of space-use by Outer Continental Shelf G&G-related vessel traffic and stand-off distance are expected to be **nominal**.

Shipping and Marine Transportation Vessel Traffic

Impacts from G&G activities on shipping and marine transportation would result from limited access to routes when stand-off distances are in place. Impacts would be relatively short, with the time and extent depending on the type of G&G activity; all impacts would be of short duration, on the order of days, for seismic surveys related to marine minerals (e.g., HRG surveys) and up to months with seismic surveys related to oil and gas exploration (e.g., 2D, 3D, 4D, WAZ, and HRG surveys).

Stand-off distances would move with the investigation equipment, so one specific location would not be impacted for an extended period of time. Lease areas to be surveyed would not be located within maintained navigation channels and would not disrupt primary commercial ship traffic routes.

Impacts of space-use by Outer Continental Shelf G&G-related activity to shipping and marine transportation are expected to be **nominal** because the number of G&G-related vessel trips involved and the duration of G&G surveys are small relative to existing vessel traffic throughout the AOI. There would not be a sufficient increase in vessel traffic to impact shipping and marine transportation.

Military Warning Areas and Other Military Uses

The MWAs and other military use areas, including restricted areas, danger zones, and unexploded ordnance sites, are discussed in **Chapter 4.12.1.2**. Much of the AOI is within MWAs (**Figure 4.12-2**), and G&G activities would be subject to restrictions imposed by military needs, rules, and regulations. Coordination with the appropriate military range complex or command headquarters is required by vessel operators or contractors performing G&G activities. Within the AOI, military and oil and gas exploration and production have coexisted for many years. Vessel traffic levels and stand-off distances associated with G&G activities are small and of limited duration but could be an obstruction to surface use by military units, depending on their location. Conflicts between G&G activities and scheduled military operations can be avoided through coordination, as stated in NTL 2014-BOEM-G04, and standard GOM lease stipulations (**Chapter 2**). Potential impacts of space use by Outer Continental Shelf G&G-related activities to military range complexes, MWAs, or areas of other military use would be **nominal** and avoidable when coordinated with the USDOD prior to commencement.

Sand and Gravel Mining

The OCS lease blocks within the AOI with significant sediment resources are discussed in **Chapter 4.12.2.3** and shown in **Figure 4.12-3**. The G&G surveys are conducted during and in support of sand and gravel mining operations.

The marine minerals scenario includes an estimated maximum activity level of approximately 3,533 line km (2,196 line mi) for HRG surveys, with additional grab sampling and vibracoring (approximately 1 week of survey time) for all geophysical survey activities (**Table 3.2-6**). A portion of the G&G activities analyzed in this Programmatic EIS are in support of sand and gravel mining, and therefore a positive impact to those mining activities. Impacts from the space use of Outer Continental Shelf G&G-related survey activities are expected to be **nominal** as there is little potential for use conflicts.

Renewable Energy Development

Renewable energy development within the AOI is discussed in **Chapter 4.12.1.4**. Currently, there are no operational wind farms in the GOM, and no wind energy areas have been identified by

BOEM. Because there are no existing renewable energy projects within the AOI, there will be **no impacts** to renewable energy development from space use of Outer Continental Shelf G&G-related vessel traffic and stand-off distances (resulting from seismic surveys utilizing towed arrays) within the AOI under Alternative A.

Ocean Dredged Material Disposal Sites

There are 16 designated ODMDSs within the AOI (**Chapter 4.12.1.5; Figure 4.12-4**). Impacts from vessel traffic and stand-off distances associated with the proposed action are expected to be **nominal** because the number of vessels involved and the duration of the surveys are small (**Table 3.3-3**).

Preclusion of vessels using the disposal sites would constitute a space-use conflict. Seismic vessels conducting G&G activities would be under a “restricted ability to maneuver” designation, which means other vessels in the path of the survey vessel must give way. Overall, impacts to ODMDSs from space use of Outer Continental Shelf G&G-related activities are expected to be **nominal**.

Oil and Gas Exploration, Development, and Production

Impacts to oil and gas exploration, development, and production from space use of Outer Continental Shelf G&G-related vessel traffic and stand-off distances (resulting from seismic surveys) would be **nominal**. Such impacts would be relatively short, on the order of days for small-scale seismic surveys, HRG surveys, grab sampling, and coring, and up to a few months for large-scale seismic surveys related to oil and gas exploration (**Table 3.3-3**). Stand-off distances would move with the investigation equipment, so one specific location would not be impacted for an extended duration. Multiple G&G survey types are conducted in support of oil and gas exploration, development, and production (**Tables 3.2-1 and 3.2-2**). All G&G surveys are subject to Form BOEM-0327 permit applications, which state, as a permit condition, that permitted activities do not “Interfere with or endanger operations under any lease or right-of-way or permit issued or maintained pursuant to the OCSLA.” The permit condition will limit or completely prevent conflicts between G&G activities and oil and gas exploration, development, and production resulting from vessel traffic and stand-off distances. Overall, impacts to oil and gas exploration, development, and production from space use of Outer Continental Shelf G&G-related activities are expected to be **nominal**.

Pipeline and Cable Infrastructure

An extensive network of pipelines in the GOM carries all gas production and >99 percent of OCS oil production from the offshore field to refineries and terminals onshore (**Figure 4.12-6a-c**). In 2007, BP was responsible for the installation of a fiber optic communication system in the GOM that extends into deep water to provide communications among assets. In addition, several submarine power cables and umbilicals are associated with oil and gas platforms and field development within the GOM (**Figure 4.12-7**). Because pipelines and submarine cables are bottom-founded equipment, vessel traffic and stand-off distances related to space use of Outer Continental Shelf G&G-related survey activities would have **no impact** to the existing infrastructure.

4.12.2.1.2 Aircraft Traffic

Aircraft traffic would result from remote-sensing surveys (aeromagnetic surveys) and helicopter support during drilling of COST wells, shallow test wells (**Chapter 3.2.1**), and service and support during deep-penetration seismic airgun surveys (**Table 3.3-3**). BOEM anticipates that one aeromagnetic survey may be conducted in the AOI during the time period covered by this Programmatic EIS (**Chapter 3.3.1.4**). Helicopter flights will be used to conduct crew changes for larger seismic vessels, the number of anticipated transits is provided in **Table 3.3-3** and discussed in **Chapter 3.3.1.4**.

Space-use conflict related to Outer Continental Shelf G&G-related aircraft traffic activities would have **no impact** on most of the other marine uses, including shipping and marine transportation, sand and gravel mining, renewable energy development, oil and gas exploration, and dredged material disposal. Aircraft traffic has the potential to interfere with military aircraft operations to be conducted within and between existing military range complexes supporting exercises and testing. The G&G aircraft activities would be subject to restrictions imposed by military needs, rules, and regulations. Military range complexes, including those restricted area and danger zones discussed in **Chapter 4.12.1.2**, cover most of the AOI (**Figure 4.12-2**). Aircraft traffic levels and the duration of airborne surveys associated with G&G activities are very limited in terms of survey area and duration. Potential space-use conflict of G&G activities to military range complexes would be **nominal** and avoidable when coordinated with the USDOD prior to commencement.

4.12.2.1.3 Seafloor Disturbance

Activities with the potential for seafloor disturbance under Alternative A include sampling by vibracoring, geologic core, and grab; use of jet probes and CPTs; the laying of OBNs, OBC, and vertical cable; the drilling of shallow test and COST wells; and the placement and retrieval of bottom-founded monitoring buoys. A total of 150,381 m^2 (1,618,688 ft^2) (**Table 3.2-7**) of seafloor would be disturbed under the proposed activities scenario. Presently, no estimates are available for seafloor disturbance by placement of nodes, cables, and sensors that support ocean cable, nodal, vertical cable, VSP, CSEM, and MT surveys. Nodal surveys are relatively uncommon, and are typically used in shallow waters. Impacts of G&G-related space use caused by seafloor disturbances are expected to be **nominal**.

Shipping and Marine Transportation

Seven commercial deepwater ports are located along the coast adjacent to the AOI (**Chapter 4.12.1.6**), however, only one port currently has offshore marine terminal facilities, although a second has been licensed for construction. Vessels using these ports include large commercial vessels, military vessels, commercial business craft, commercial recreational craft, research vessels, and personal craft. Seafloor disturbance resulting from G&G activities would have **no impact** on space-use needs of shipping and marine transportation.

Military Warning Areas and Other Military Uses

Military range complexes, including restricted areas and danger zones, and unexploded ordnance sites are discussed in **Chapter 4.12.1.2**. Most of the AOI is within military range complexes and G&G activities would be subject to restrictions imposed by military needs, rules, and regulations. Given that the USDOD would require prior approval of any G&G activities involving seafloor-disturbing activities or temporary placement of bottom-founded equipment or structures (including requiring site-specific information), impacts of G&G-related space use caused by seafloor disturbances to military range complexes are expected to be **nominal** and avoidable with proper coordination.

Sand and Gravel Mining

There are currently 14 significant OCS sand and gravel borrow area locations within the AOI, spanning several OCS lease blocks (**Chapter 4.12.1.3; Figure 4.12-3**). Sampling activities for marine minerals would be conducted at specific borrow sites in water depths < 30 m (98 ft). The G&G activities that could cause seafloor disturbance are consistent with the ongoing use of sand and gravel mining areas and do not present a conflict of use; therefore, impacts to sand and gravel mining uses would be **nominal**. Conflicts between G&G activities causing seafloor disturbance that are not consistent with the ongoing uses of sand and gravel mining areas must be avoided as stipulated in NTL 2009-G04.

Renewable Energy Development

Renewable energy development within the AOI includes one licensed wind platform that is currently the site of a meteorological monitoring tower; there are no operational wind farms and no wind energy areas have been identified by the USDOI or BOEM (**Chapter 4.12.1.4**). Sampling for renewable energy projects would occur at specific sites (consisting of one or more OCS lease blocks) in water depths <40 m (131 ft) and along potential cable routes to shore. The G&G activities that could cause seafloor disturbance are consistent with the ongoing use of renewable energy development areas and do not present a conflict of use; therefore, impacts to renewable energy development areas would be **nominal**.

Ocean Dredged Material Disposal Sites

There are 16 ODMDSs in the AOI (**Chapter 4.12.1.5**). G&G activities that could cause seafloor disturbance are expected to avoid these disposal sites, given that temporary placement of bottom-founded equipment or bottom sampling could be compromised by subsequent or prior dredge spoil deposition, respectively. Activities associated with G&G-related bottom sampling or temporary placement of bottom-founded equipment would not interfere with ocean dredged material disposal operations nor adversely affect any ODMDSs. As a result, G&G activities that could cause seafloor disturbance would have **no impact** to space use of ODMDSs.

Oil and Gas Exploration, Development, and Production

The G&G activities that cause seafloor disturbance are consistent with the ongoing use of oil and gas exploration areas and do not present a conflict; therefore, space-use conflict related to Outer Continental Shelf G&G activities on any G&G on-lease/ancillary activity, off-lease activity, or survey activity related to marine minerals and renewable energy development, BOEM's regulations at 30 CFR 551 and any impacts on oil and gas exploration, development, and production areas would be **nominal**.

Pipeline and Cable Infrastructure

Placement of equipment (e.g., anchors, nodes, cables, sensors, bottom-founded monitoring buoys) on the seafloor has the potential to damage pipeline or cable infrastructure. **Chapter 4.12.1.6** describes the extensive network of oil and gas pipelines in the GOM that have been developed over decades in addition to the associated submarine fiber optic cables, power cables, and umbilicals that support the oil and gas industry offshore. G&G activities that could cause seafloor disturbance are expected to avoid pipelines, fiber optic and power cables, and umbilicals given that existing pipeline and cable locations from publicly available data are mapped in **Figures 4.12-6a-c and 4.12-7**, respectively. Therefore, space-use conflict impacts to pipeline and cable infrastructure would be **nominal**.

4.12.2.1.4 Routine Activities Impact Conclusions

Based on the vessel traffic and associated stand-off distances, aircraft traffic, and seafloor disturbance expected under G&G activities, space-use conflict impacts to shipping and marine transportation, military, sand and gravel, renewable energy, ODMDSs, oil and gas activities, and infrastructure are expected to range from **no impact** to **nominal**. The level of G&G-related activity involved and the duration of these surveys is small relative to the existing vessel traffic throughout the AOI. There would not be a sufficient increase in vessel or aircraft traffic or seafloor disturbances to impact the other marine operations and activities occurring in the AOI.

4.12.2.2 Impacts of an Accidental Fuel Spill

An accidental event could result in the release of diesel fuel by a survey vessel from a vessel collision or spillage during at-sea fuel transfer operations. Based on USCG spill statistics, a spill scenario was developed in **Chapter 3.3.2** that assumes a diesel spill volume of 1.2 to 7.1 bbl. Spills occurring at the ocean surface would disperse and weather, and the volatile components of the fuel would evaporate. Fuel and diesel used for the operation of survey vessels is light and would float on the water surface. Given the relatively small size of the spill and the loss of most spilled fuel through evaporation and dispersion, a small diesel fuel spill at the surface would have no effect on other marine operations and activities occurring in the AOI, other than perhaps temporary loss of access near the spill.

Due to the extensive existing network of commercial shipping lanes/fairways in the GOM, traffic coordination and regulation by the USCG, and the regulation of structures on the OCS under

OCSLA, vessel-to-vessel collisions and vessel-to-structure collisions have been minimal compared with the extent of existing vessel traffic and movement. Because of the low potential of a vessel collision occurring and the even lower potential for a resultant spill, the risk of accidental fuel spills is expected to be remote.

Impacts of an accidental spill event would depend on the size and location of the spill in addition to the meteorological conditions at the time. A small diesel spill would have **nominal** impacts on other marine operations and activities because it would only prohibit full use of a small area by other marine users for a very limited amount of time.

4.12.2.3 Cumulative Impacts

4.12.2.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.4.2.1 and 4.4.2.2** determined that activities projected to occur under Alternative A would result in **no impact** to **nominal** impacts to other marine operations and activities, with the level of impact dependent upon the specific IPF being considered. The following analysis considers whether those incremental impacts, when added to or acting synergistically with other impact sources from the cumulative impacts scenario, may result in a significant impact.

Cumulative incremental impacts to other marine uses from the proposed action, when taking into consideration the potential impacts of the *Deepwater Horizon* explosion, oil spill, and response, non-OCS oil- and gas-related factors, the minimization of Outer Continental Shelf G&G-related impacts through stipulations and regulations, and the wide-ranging activities considered, would be expected to be **negligible** with no anticipated wide-spread impacts.

The G&G activities have been ongoing in the GOM for at least the past 30 years, and they likely will continue into the future; however, for the purpose of this Programmatic EIS, the cumulative analysis assesses a 10-year timeframe to coincide with the proposed action because it is not expected that G&G activities proposed within this Programmatic EIS will have lasting effects or extend beyond the 10-year period.

4.12.2.3.2 Activities Other Than OCS Program G&G Survey Activities

The cumulative scenario in **Chapter 3.4** describes other past, present, and reasonably foreseeable future actions. This cumulative impacts assessment considers the combined effects and assesses the incremental increase in impact from the proposed action when added to activities in the cumulative scenario. The IPFs identified for other marine operations and activities occurring in the AOI are compared with the IPFs from each of the cumulative scenario components on activities that coincide spatially and temporally with the proposed action (**Table 3.4-1**). The activities that have the potential to affect space use within multiple-use areas include (1) vessel traffic and stand-off distances, (2) aircraft traffic and noise, and (3) seafloor disturbance. The following analysis evaluates the incremental increase by IPF and provides a conclusion of the cumulative incremental increase within the AOI.

A detailed impact analysis of activities included in the cumulative scenario has been conducted as part of the commercial fishing (**Chapter 4.9**), recreational fishing (**Chapter 4.10**), and other marine uses (**Chapter 4.12**) chapters of this Programmatic EIS. Because several of the activities included in the cumulative scenario are included in the other marine uses category, the cumulative scenario will be addressed according to IPF rather than cumulative component.

Vessel Traffic and Stand-Off Distances

The potential impacts to other marine operations and activities from vessel traffic and stand-off distances stem from space-use conflicts. Space-use conflict from vessel traffic under the cumulative impacts scenario would originate from many of the cumulative scenario components, including Federal OCS Programs, oil and gas activities in State waters, deepwater ports, commercial and recreational fishing, shipping and marine transportation, dredged material disposal, military activities, scientific research, and maintenance dredging and Federal channels (**Table 3.4-1**). Overall, cumulative impacts to space use in multiple-use areas from combined vessel traffic is expected to be **nominal**. **Table 3.4-2** provides a summary of the oil and gas support vessel operations anticipated under the cumulative scenario within the OCS Program. Oil- and gas-related vessel traffic is a dominant component of total vessel traffic in the AOI. Vessel operations from G&G activity in all Federal OCS Program areas are expected to be less than 2 percent of the total vessel operations associated with the OCS Oil and Gas Program (**Tables 3.3-3 and 3.4-2**). Additional vessel traffic from G&G operations under the proposed action (**Chapter 3.3.1.3**) would not represent a significant increase to existing vessel traffic from cumulative scenario activities within the AOI and would not be sufficient to impact navigation on fairways, port capacity, or shipping and marine transportation. Therefore, the proposed action would produce a **nominal** incremental increase in space-use conflict from vessel traffic under the cumulative scenario.

Stand-off distances discussed in this analysis refer specifically to the area surrounding G&G seismic vessels to protect the towed streamer arrays. The implemented stand-off distance for seismic surveys would result in space-use conflict impacts if multiple G&G activities under the proposed action occur simultaneously within close proximity of each other. Stand-off distances established for multiple projects could result in a larger cumulative area excluded from short-term use by other vessels and may result in a longer time period where other marine uses are prohibited from certain areas. This type of cumulative impact could be most acute where stand-off distances and an increase in vessel traffic occur near commercial harbors. However, the level of increased vessel traffic would not increase significantly with the cumulative action scenario; therefore, only a **nominal** incremental increase in impacts to other marine operations and activities are expected from space-use conflict related to stand-off distances under the cumulative scenario.

Aircraft Traffic

Aircraft traffic under the cumulative impacts scenario would originate from the OCS Program, State waters oil and gas, military, scientific research, and maintenance dredging of Federal channels activities (**Table 3.4-1**). Helicopter traffic would result from oil and gas exploration activities, as they are used for transporting personnel to offshore oil drilling rigs and platforms. **Table 3.4-2** provides a summary of the oil and gas support vessel (helicopters) operations anticipated under the cumulative scenario within the OCS Program. Overall, cumulative impacts to space use in multiple-use areas from combined aircraft traffic is expected to be **nominal**.

Additional aircraft traffic from G&G operations under the proposed action (**Table 3.3-3**) would not represent a significant increase to existing aircraft traffic from cumulative operations within the AOI and would not be sufficient to interfere with normal commercial traffic or to add considerable pressure to the air traffic control system. Aircraft traffic levels and the duration of airborne surveys associated with G&G activities under the proposed action are very limited in terms of survey area and duration. Therefore, the proposed action would produce a **nominal** incremental increase in total space use related to aircraft activity and associated impacts expected under the cumulative scenario.

Seafloor Disturbances

Several activities under components of the cumulative scenario would involve seafloor disturbance, including oil and gas development, marine minerals use, commercial fishing, dredged material disposal, new cable infrastructure, military activities, scientific research, maintenance dredging, and coastal restoration programs. Seafloor-disturbing activities associated with the cumulative scenario over the next 10 years will include the construction and installation of at most 8,233 exploration and production wells, 507 production structures (e.g., caissons, multi-leg platforms), and 17,437 km (10,835 mi) of pipelines (**Table 3.4-2**). Because there are no renewable energy activities projected, related seafloor disturbances would be zero. Seafloor disturbances associated with marine mineral uses would be in pre-determined OCS sand resource areas (**Chapter 3.2.3**) for use in coastal restoration. Overall, cumulative impacts to space use in multiple-use areas from combined seafloor disturbances is expected to be **nominal**. Because of the effectiveness of mitigation measures imposed on all seafloor-disturbing activities resulting from the proposed action, incremental impacts from the proposed action are expected to be **nominal** (**Chapter 4.12.2.1**).

4.12.2.3.3 Cumulative Impact Conclusions

As discussed in **Chapter 4.12.2.1**, based on the vessel traffic and associated stand-off distances, aircraft traffic, and seafloor disturbance expected under G&G activities, impacts to space use in multiple-use areas are expected to be **nominal** because the level of G&G-related activity involved and the duration of these surveys is small in relation to the existing vessel traffic throughout the AOI. When assessing the contribution of the proposed G&G activities to the existing cumulative activities, there would be a **nominal** incremental increase in impacts to space use in multiple-use areas from vessel or aircraft traffic or seafloor disturbances to the other marine uses activities existing in the AOI.

4.12.3 Impacts – Alternative B (Settlement Agreement Alternative)

The IPFs and impact-level criteria applied for Alternative B are the same as for Alternative A (**Chapter 4.12.2**). For the sake of brevity, those detailed analyses are incorporated by reference for this analysis, and the following discussion outlines the effects of the additional mitigation measures included in Alternative B on other marine uses.

4.12.3.1 Impacts of Routine Activities

Additional mitigation measures under Alternative B would not change the extent, severity, or timing of aircraft traffic or seafloor disturbance impacts; therefore, impacts to other marine operations and activities would be unchanged under Alternative B and would range from **no impact** to **nominal** for space use in multiple-use areas. Most of the mitigation measures in Alternative B would not change the extent, timing, or severity of impacts; only mitigation measures that may change the level of effect to other marine uses are assessed here.

4.12.3.1.1 Coastal Waters Seasonal Restrictions (January 1 to April 30)

As discussed in **Chapter 4.12.2.1**, impacts of vessel traffic and stand-off distances on other marine operations and activities are expected to be **nominal** in all cases. The additional coastal seasonal restriction under Alternative B would change the timing of seismic airgun surveys in coastal waters and reduce vessel traffic and stand-off distances related to these surveys in coastal areas between January 1 and April 30. A change in survey timing in the additional closure area would result in a temporary reduction of space-use conflicts from vessel traffic and stand-off distances related to seismic airgun surveys, but it would not result in an overall reduction of survey activity within the AOI; therefore, the impacts to other marine operations and activities in multiple-use areas would remain **nominal** under Alternative B.

4.12.3.1.2 Minimum Separation Distances

Alternative B would establish a separation distance of 40 km (25 mi) between active sound sources in the Areas of Concern (**Chapter 2.4.2**) during simultaneous deep-penetration seismic airgun surveys. When outside the Areas of Concern, the separation distance will be 30 km (19 mi).

As discussed in **Chapter 4.12.2**, applicable routine IPFs for space use in multiple-use areas are vessel traffic and stand-off distances, aircraft traffic, and seafloor disturbance. Minimum separation distances for simultaneous seismic airgun surveys would not change the extent, severity, or timing of aircraft traffic or seafloor disturbance.

Minimum separation distances required during simultaneous deep-penetration seismic airgun surveys under Alternative B could result in reduced impacts from vessel traffic and stand-off distances by separating G&G activities (i.e., the use of different ports and a reduction of vessel traffic within a localized area) but not enough to result in a reduced space-use conflict level. As discussed in **Chapter 4.12.2.1**, impacts of vessel traffic and stand-off distances on other marine operations and activities in multiple-use areas are expected to be **nominal** in all cases.

4.12.3.1.3 Routine Activities Impact Conclusions

Based on vessel traffic and associated stand-off distances, aircraft traffic, and seafloor disturbance expected under G&G activities, impacts to space use in multiple-use areas by shipping and marine transportation, military, sand and gravel, renewable energy, ODMDSs, oil and gas activities, and infrastructure are expected to range from **no impact** to **nominal** because the level of G&G-related activity involved and the duration of these surveys are small relative to the existing vessel traffic throughout the AOI. There would not be a sufficient increase in space use by vessel or aircraft traffic or seafloor disturbances to impact the other marine operations and activities existing in the AOI.

4.12.3.2 Impacts of an Accidental Fuel Spill

Alternative B would change the timing of certain surveys because of additional coastal seasonal restrictions. Spills from seismic survey vessels could not occur in the closure areas during times of the closure period, although spills from other survey vessels could occur during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Overall, the risk of an accidental fuel spill and potential impacts on other marine operations and activities would be the same as under Alternative A (**nominal**).

4.12.3.3 Cumulative Impacts

4.12.3.3.1 OCS Program G&G Survey Activities

A detailed impact analysis of eight of the activities included in the cumulative scenario – (1) oil and gas exploration and development; (2) renewable energy development; (3) marine minerals use; (4) commercial and recreational fishing; (5) shipping and marine transportation; (6) dredged material disposal; (7) existing, planned, and new cable infrastructure; and (8) military activities – has been conducted as part of the commercial fishing (**Chapter 4.9**), recreational fishing (**Chapter 4.10**), and other marine uses (**Chapter 4.12**) chapters of this Programmatic EIS. Impact analyses presented in **Chapters 4.12.2.1 and 4.12.3.2** concluded that activities projected to occur under Alternative B would result in **nominal** space-use conflicts to other marine operations and activities.

4.12.3.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.12.2.3.2**). Mitigation measures under Alternative B would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.12.2.3.2**) would remain the same under Alternative B.

4.12.3.3.3 Cumulative Impact Conclusions

The cumulative impact analysis identified **nominal** incremental increases in space-use conflicts from all IPFs under Alternative A (**Chapter 4.12.2.3**). Minimum separation distances required during simultaneous deep-penetration seismic airgun surveys under Alternative B could result in reduced impacts from vessel traffic and space-use conflicts from the survey stand-off distances by separating G&G activities (i.e., the use of different ports and requiring transit corridors between survey vessels). Therefore, Alternative B would change the timing of seismic airgun surveys in certain areas, place limits on concurrent seismic airgun surveys, and exclude certain areas from seismic airgun surveys; however, the mitigation measures would not appreciably change the cumulative impacts noted under Alternative A.

4.12.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

The IPFs and impact-level criteria applied for Alternative C are the same as for Alternative A (**Chapter 4.12.2**). For the sake of brevity, those detailed analyses are incorporated by reference for this analysis, and the following discussion outlines the effects of the additional mitigation measures included in Alternative C on other marine operations and activities in multiple-use areas.

4.12.4.1 Impacts of Routine Activities

Additional mitigation measures under Alternative C would not change the extent, severity, or timing of aircraft traffic or seafloor disturbance impacts; therefore, impacts to other marine operations and activities would be unchanged under Alternative C and would range from **no impact** to **nominal** for other marine operations and activities. Most of the mitigation measures in Alternative C would not change the extent, timing, or severity of space-use conflicts; only mitigation measures that may change the level of effect to other marine uses are assessed here.

4.12.4.1.1 Coastal Waters Seasonal Restrictions (February 1 to May 31)

Alternative C would require seasonal restrictions for seismic airgun survey operations in Federal and State coastal waters of the GOM shoreward of the 20-m (66-ft) isobath between February 1 and May 31.

As discussed in **Chapter 4.12.2.1**, impacts of vessel traffic and stand-off distances on other marine operations and activities are expected to be **nominal**. A change in survey timing in the closure area would reduce the space-use conflicts of vessel traffic and stand-off distances from seismic airgun surveys on other marine uses during the 4-month closure period; however, the overall survey activity would not be reduced under this alternative, and a localized reduction of vessel traffic and stand-off distance is not enough to change the impact level; therefore, impacts to other marine operations and activities in multiple-use areas would remain **nominal**.

4.12.4.1.2 Routine Activities Impact Conclusions

Based on vessel traffic and associated stand-off distances, aircraft traffic, and seafloor disturbance expected under G&G activities, impacts to space use in multiple-use areas by shipping and marine transportation, military, sand and gravel, renewable energy, ODMDSs, oil and gas activities, and infrastructure are expected to range from **no impact** to **nominal** because the level of G&G-related activity involved and the duration of these surveys are small relative to the existing vessel traffic throughout the AOI. There would not be a sufficient increase in space use by vessel or aircraft traffic or seafloor disturbances to impact the other marine operations and activities existing in the AOI.

4.12.4.2 Impacts of an Accidental Fuel Spill

Under Alternative C, impacts of an accidental fuel spill on other marine operations and activities would be very similar to those analyzed for Alternative A in **Chapter 4.12.2.2**. Alternative C would change the timing of certain surveys because of expanded seasonal restrictions (coastal waters). However, spills from seismic survey vessels could occur in the closure areas during times outside the closure period. Also, spills from other survey vessels could occur during the closure period. A change in survey timing would not substantially change the risk of a small fuel spill. Overall, the risk of an accidental fuel spill and potential impacts on other marine operations and activities would be the same as under Alternative A (**nominal**).

4.12.4.3 Cumulative Impacts

4.12.4.3.1 OCS Program G&G Survey Activities

Impact analyses presented in **Chapters 4.12.4.1 and 4.12.4.2** concluded that activities projected to occur under Alternative C would result in **nominal** space-use conflicts to other marine operations and activities.

4.12.4.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.12.2.3.2**). Mitigation measures under Alternative C would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.12.2.3.2**) would remain the same under Alternative C.

4.12.4.3.3 Cumulative Impact Conclusions

Alternative C would change the timing of seismic airgun surveys in certain areas and decrease impacts to other marine operations and activities during the closure; however, a coastal seasonal restriction would not appreciably change the cumulative impacts noted under Alternative A and, therefore, overall **nominal** incremental increases in space-use conflicts are expected.

4.12.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

The IPFs and impact-level criteria applied for Alternative D are the same as for Alternative A (**Chapter 4.12.2**). For the sake of brevity, those detailed analyses are incorporated by reference for this analysis. The additional mitigation under Alternative D would not alter the space-use conflicts to other marine operations and activities from G&G-related vessel traffic, aircraft traffic, stand-off distances, or seafloor disturbance as described in Alternatives A and C (**Chapters 4.12.2.1 and 4.12.4.1**) and would have **no impacts** to **nominal** impacts. Under Alternative D, impacts of an accidental fuel spill on other marine resources would be as described in Alternatives A and C (**Chapters 4.12.2.2 and 4.12.4.2**) and would remain **nominal**.

4.12.5.1 Impacts of Routine Activities

The additional mitigation measure (a change in shutdown protocol to include all marine mammals except bow-riding dolphins) under Alternative D would not change the extent, severity, or timing of vessel traffic and exclusion zones, aircraft traffic, and seafloor disturbance impacts; therefore, space-use conflicts to other marine operations and activities would be unchanged under Alternative D and would range from **no impact** to **nominal**.

4.12.5.2 Impacts of an Accidental Fuel Spill

Alternative D would not add mitigation measures that would reduce the risk of an accidental fuel spill; however, potential impacts on other marine uses would be the same as under Alternative A (**nominal**).

4.12.5.3 Cumulative Impacts

4.12.5.3.1 OCS Program G&G Survey Activities

Mitigation measures for the proposed action under Alternative D would not change the extent, severity, or timing of activities in the proposed action; thus, the cumulative impact analysis would have **nominal** incremental increases in impacts from all IPFs under Alternative D.

4.12.5.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.12.2.3.2**). Mitigation measures under Alternative D would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.12.2.3.2**) would remain the same under Alternative D.

4.12.5.3.3 Cumulative Impact Conclusions

As discussed in **Chapter 4.12.2.1**, based on the vessel traffic and associated stand-off distances, aircraft traffic, and seafloor disturbance expected under G&G activities, impacts to space use in multiple-use areas are expected to be **nominal** because the level of G&G-related activity involved and the duration of these surveys is small in relation to the existing vessel traffic throughout the AOI. The mitigation measures under Alternative D would not appreciably change the cumulative impacts noted under Alternative A.

4.12.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

The IPFs and impact-level criteria applied for Alternative E are the same as for Alternative A (**Chapter 4.12.2**). For the sake of brevity, those detailed analyses are incorporated by reference for this analysis, and the following discussion outlines the effects of the additional mitigation measures included in Alternative E on other marine operations and activities.

4.12.6.1 Impacts of Routine Activities

The limitation of deep-penetration, multi-client activities under Alternative E would limit the extent, severity, and timing of space use by vessel and aircraft traffic; therefore, space-use conflicts for these IPFs would be limited under Alternative E.

The limitation of deep-penetration, multi-client activities under Alternatives E1 or E2 would not substantially change the extent, severity, or timing of space use by seafloor disturbance from G&G activities; therefore, space-use conflicts to other marine operations and activities from seafloor disturbance would remain unchanged from Alternative C and would range from **no impact** to **nominal**.

Seismic vessel traffic from deep-penetration, multi-client airgun surveys under Alternatives E1 or E2 would be limited, in line miles, by 10 percent or 25 percent, respectively, thereby limiting the potential for interference with other marine operations and activities such as shipping and marine transportation, military range complexes, sand and gravel mining, and ODMDSs. Service-vessel and helicopter traffic associated with crew changes are very limited in terms of area and duration; therefore, potential space-use conflicts would range from **no impact** to **nominal**.

4.12.6.2 Impacts of an Accidental Fuel Spill

Under Alternative E, impacts of an accidental fuel spill on other marine operations and activities would be very similar to those analyzed for Alternative C in **Chapter 4.12.2.2**, which indicated that a small spill at the sea surface would be unlikely to have any effect on other marine operations and activities.

Alternatives E1 and E2 may reduce the number of vessels relative to a 10 percent or 25 percent reduction in line miles of deep-penetration, multi-client activities, but this reduction would not substantially change the risk of a small fuel spill. If a small diesel spill were to occur, it would have **nominal** impacts to space use by other marine operations and activities because it would only prohibit full use of a small area by other marine users for a very limited amount of time.

4.12.6.3 Cumulative Impacts

4.12.6.3.1 OCS Program G&G Survey Activities

A detailed impacts assessment under the cumulative scenario is provided in Alternative A (**Chapter 4.12.2.3**). The limitation of deep-penetration, multi-client activities under Alternative E would limit the extent, severity, and timing of space use by vessel traffic, stand-off distances, aircraft traffic, seafloor disturbances, and accidental fuel spills; therefore, space-use conflicts would be **nominal** under Alternatives E1 and E2.

4.12.6.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.12.2.3.2**). Mitigation measures under Alternative E would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.12.2.3.2**) would remain the same under Alternative E.

4.12.6.3.3 Cumulative Impact Conclusions

Overall, the resultant cumulative impacts to other marine uses would result in **nominal** incremental increases under Alternative E.

4.12.7 Impacts – Alternative F (Alternative C Plus Area Closures)

The IPFs and impact-level criteria applied for Alternative F are the same as for Alternative A (**Chapter 4.12.2**). For the sake of brevity, those detailed analyses are incorporated by reference for this analysis, and the following discussion outlines the effects of the additional mitigation measures included in Alternative F on other marine uses.

4.12.7.1 Impacts of Routine Activities

Additional mitigation measures under Alternative F would not change the extent, severity, or timing of space use by aircraft traffic or seafloor disturbance impacts as described under Alternative C; therefore, impacts to other marine operations and activities would be unchanged under Alternative F and would range from **no impact** to **nominal** for other marine operations and activities.

Alternative F would require area closures in the CPA Closure Area, EPA Closure Area, Dry Tortugas Closure Area, and Flower Gardens Closure Area for seismic airgun survey operations. Area closures would eliminate space use of vessel traffic and stand-off distances from seismic airgun surveys on other marine operations and activities in those designated areas, as these surveys would not occur within the designated areas; however, space-use conflicts in non-closure areas could still occur and there would not be a reduction in the overall survey activity as part of the proposed action; therefore, the overall impacts to space use by other marine operations and activities would remain as **no impact** to **nominal**.

4.12.7.2 Impacts of an Accidental Fuel Spill

Under Alternative F, impacts of an accidental fuel spill on other marine uses would be very similar to those analyzed for Alternative C in **Chapter 4.12.4.2**. The analysis concluded that mitigation measures, including planning and implementing stand-off distances, vessel-to-vessel communication, issuance of warnings to mariners, and a coastal seasonal restriction area would limit the likelihood of a vessel collision or another vessel becoming entangled in towed G&G equipment and that a small spill at the sea surface would be unlikely to have any effect on space use by other marine operations and activities.

The risk of an accidental spill related to G&G activities would be lessened within the closure areas because G&G survey activities would be prohibited; however, vessels could use the area for transit, so the risk of an accidental spill would still exist. Additionally, the overall extent of survey activity within the GOM would not be reduced under Alternative F, and the overall risk, although low, of an accidental spill would remain despite certain areas being closed because spills from seismic survey vessels could occur in areas outside the closure areas. Also, spills from other vessels could occur within the closure areas. Therefore, area closures under Alternative F would not substantially change the risk of a small fuel spill. Overall, the risk of an accidental fuel spill and potential impacts to space use by other marine operations and activities would be the same as under Alternative C (**nominal**).

4.12.7.3 Cumulative Impacts

4.12.7.3.1 OCS Program G&G Survey Activities

The cumulative impact analysis identified **nominal** incremental increases in impacts from all IPFs under Alternative A. The cumulative scenario would remain unchanged for Alternative F, and the associated impacts would remain the same. Alternative F closure and restricted areas within the AOI would not appreciably change the cumulative impacts noted under Alternative A. While the area closures are effective in decreasing impacts, they will not decrease the overall activities and resultant impacts for the proposed action to the cumulative scenario.

4.12.7.3.2 Activities Other Than OCS Program G&G Survey Activities

A detailed impact assessment of other activities not associated with the OCS Program that contribute to the cumulative scenario is provided in Alternative A (**Chapter 4.12.2.3.2**). Mitigation measures under Alternative F would not change the extent, severity, or timing of other major factors not associated with the OCS Program. Therefore, the cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.12.2.3.2**) would remain the same under Alternative F.

4.12.7.3.3 Cumulative Impact Conclusions

As discussed in **Chapter 4.12.2.1**, based on the vessel traffic and associated stand-off distances, aircraft traffic, and seafloor disturbance expected under G&G activities, impacts to space use in multiple-use areas are expected to be **nominal** because the level of G&G-related activity involved and the duration of these surveys is small in relation to existing vessel traffic throughout the AOI. The mitigation measures under Alternative E would not appreciably change the cumulative impacts noted under Alternative A. Overall, the cumulative impacts to space use by other marine operations and activities would result in **nominal** incremental increases under Alternative F.

4.12.8 Impacts – Alternative G (No New Activity Alternative)

The IPFs and impact-level criteria applied for Alternative G are the same as for Alternative A (**Chapter 4.12.2**).

As evaluated in Alternative A (**Chapter 4.12.2.1**), impacts on other marine uses were concluded to range from **no impact** to **nominal**. If no new activity occurs under Alternative G, potential impacts to other marine operations and activities would remain **no impact** or **nominal**, as described in the **Chapter 4.12.2.3.2**. The cumulative impact analysis of other activities not associated with the OCS Program analyzed under Alternative A (**Chapter 4.12.2.3.2**) would remain the same under Alternative G.

Spills could occur within the AOI with current activity. If an accidental spill occurs, the spill size would likely be relatively small and the area of impact would be a small portion of the AOI. The type and severity of impacts to space use by other marine operations and activities would depend on the location of the event, but the impacts are expected to be **nominal** because an accidental fuel spill would only prohibit full use of a small area by other marine operations and activities for a very limited amount of time.

The cessation of activity for future G&G surveys requiring a permit/authorization from BOEM would limit the cumulative impacts because VSP and SWD surveys would still occur. Overall, the cumulative impacts to space use by other marine operations and activities would result in **nominal** incremental increases under Alternative G.

4.12.9 Summary Conclusion

In summary, the IPFs that may impact space use by other marine operations and activities within the AOI include (1) vessel traffic, (2) aircraft traffic, (3) stand-off distance, (4) seafloor disturbance, and (5) accidental fuel spills.

Impacts to space use by other marine operations and activities are assessed as **no impact** to **nominal** for all alternatives for all applicable IPFs because many of the components of space use by other marine operations and activities are expected to be conducted in support of, or in coordination with, G&G activities for all three Program Areas. In addition, G&G activities would be of relatively short duration, with the time and extent dependent on the type of G&G activity. Space-use conflicts would remain as **no impact** to **nominal** under Alternative G.

4.13 Human Resources, Land Use, and Economics

4.13.1 Description of the Affected Environment

The onshore portion of the AOI extends along the GOM coastline from the southwestern tip of the Florida Keys to the southern coast of Texas. The area encompasses 133 counties/parishes in 23 BOEM-designated Economic Impact Areas (EIA). The G&G activities offshore in the GOM have a corresponding impact on the human environment onshore, including land use and coastal infrastructure, environmental justice, demographics, and economic aspects of the communities along the Gulf Coast. Activities on the OCS are supported by onshore facilities, which can impact the human environment. Additional information on the affected environment can be found in **Appendix E, Section 13**.

4.13.1.1 Land Use and Coastal Infrastructure

The coastal areas of the GOM are not homogenous in terms of physical characteristics or socioeconomic attributes; they are divided into counties and parishes, each with unique histories and characteristics. Major cities near the study area include Houston, Texas; Baton Rouge and New Orleans, Louisiana; Pascagoula, Mississippi; Mobile, Alabama; and Tampa, Florida. Land uses in the study area range from urban areas in and around the cities previously mentioned to rural agricultural areas. Coastal land uses range from large areas of recreational beaches, wetlands, and barrier islands to deepwater ports and oil and gas production infrastructure. In addition, residential, commercial, farming/ranching, and other industrial uses are scattered along the coast.

The energy industry has a long history of operating in the GOM and, as a result, coastal infrastructure has been built to accommodate and service this sector. The G&G activities have been conducted for years in the GOM; therefore, companies that provide goods and services to support G&G activities are numerous and well established. For example, shipbuilding and repair service companies, ports, and equipment and material suppliers are all part of the coastal infrastructure (**Table 4.13-1**).

According to the *OCS-Related Infrastructure Fact Book* completed in 2011 (Dismukes, 2011), 28 major shipbuilding yards are located along the GOM, with the majority of these yards being topside repair yards. The yards mostly are clustered between New Orleans, Louisiana, and Mobile, Alabama.

Numerous ports and port facilities that could be used to support G&G activities on the OCS are located throughout the GOM region. Ports that support activities on the OCS typically fall into one of two categories: (1) smaller facilities that are privately owned and are designed and used to support energy development activities in the GOM; or (2) larger facilities that support a wide spectrum of maritime activities, including oil and gas exploration, as well as bulk container traffic and maritime transportation. The top 50 offshore support ports in the GOM identified in the *OCS-Related Infrastructure Fact Book* are primarily located around the New Orleans/Mobile area or in the Houston area (Dismukes, 2011).

The two primary ports that support G&G activities in the GOM are Port Fourchon in Lafourche Parish, Louisiana, and the Port of Galveston in Texas, according to G&G permit application forms submitted to BOEM. Port Fourchon is the largest port serving oil and gas production in the GOM. More than 250 companies utilize the port as a base of operation, and >90 percent of the GOM's deepwater oil production is serviced by Port Fourchon (Greater Lafourche Port Commission, n.d.). The Port of Galveston serves cruise ships, cargo ships, research vessels, barges, lay barges, and rigs. In 2013, a total of 912 ship calls occurred in the port, including 317 cargo ships, 85 research vessels, and 179 cruise ships. Pipe-laying vessels and drilling rigs accounted for 96 ship calls, while pipe-laying barges accounted for an additional 229 ship calls. Cargo barges accounted for six ship calls in 2013 (Port of Galveston, n.d.).

4.13.1.2 Environmental Justice

Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations") was signed by President Clinton on February 11, 1994. This Executive Order requires each Federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental impacts of its programs, policies, and activities on minority and low-income populations, including Native American populations. The USEPA and the CEQ emphasize the importance of incorporating environmental justice review in the analyses conducted by Federal agencies under NEPA and of developing protective measures that avoid disproportionate environmental impacts on minority and low-income populations.

President Clinton issued Executive Order 13045 ("Environmental Health Risks and Safety Risk to Children") on April 21, 1997. This Executive Order requires each Federal agency to "make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and shall ensure that its policies, programs, activities, and standards address disproportionate risks to children." The Executive Order was issued because a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health and safety risks.

The CEQ has issued the guidance below to Federal agencies on the terms used in Executive Order 12898.

- **Low-Income Population:** Low-income populations in an affected area should be identified using the annual statistical poverty thresholds from the U.S. Bureau of the Census.

- **Minority:** An individual who is a member of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.
- **Minority Population:** Minority populations should be identified where (1) the minority population of the affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.
- **Children:** Individuals under the age of 18.

Table 4.13-3 shows the percent of the population in geographic areas around Port Fourchon and the Port of Galveston that are considered minorities. Totals for the U.S. and for Louisiana and Texas are shown for comparison purposes. Port Fourchon is located within the Houma-Bayou Cane-Thibodaux metropolitan statistical area (MSA). The Port of Galveston is located in the Houston-Sugar Land-Baytown MSA. As shown in **Table 4.13-3**, the areas surrounding Port Fourchon have smaller percentages of minorities than Louisiana or the U.S. as a whole. In contrast, Galveston and the Houston-Sugar Land-Baytown MSA have greater percentages of racial minorities than Texas or the U.S. as a whole. Areas surrounding the Port of Galveston have smaller percentages of Hispanic or Latino populations than the statewide total but larger percentages than the national level (USDOC, Census Bureau, 2012). For environmental justice purposes, Galveston and the Houston-Sugar Land-Baytown MSA are considered to have meaningfully greater minority populations.

Table 4.13-4 shows the low-income populations in the same geographic areas. The Houma-Bayou Cane-Thibodaux MSA has a slightly greater percentage of residents defined as low income than the nationwide average and a smaller percentage than the total for Louisiana. In contrast, Lafourche Parish has a smaller percentage of residents defined as low income compared with State and national levels. Census data also showed that 24.7 percent of all residents in the City of Galveston were considered low income compared with 18.1 percent in Texas and 15.7 percent in the U.S., making this a difference that was meaningfully greater for environmental justice purposes. The Houston-Sugar Land-Baytown MSA around the Port of Galveston had a smaller percentage of low-income residents than the State and Nation (USDOC, Census Bureau, 2012).

4.13.1.3 Demographics

The population living in the coastal communities along the GOM has experienced a dramatic increase over the last 40 years. As of 2010, approximately 24.2 million people lived in communities influenced by activities in the GOM, more than double the number of individuals who lived in the same communities 40 years ago. In 2010, approximately 7.8 percent of the total population of the U.S. lived in communities along the GOM (USDOC,. Census Bureau, 2012; USDOC, NOAA, n.d.). However, this increase in population is not uniformly distributed throughout the region.

Because the GOM region is so diverse, some areas have experienced rapid growth while other areas have not kept up with national growth rates. As shown in **Table 4.13-2**, Florida has experienced the most rapid population growth in the region, with its total and Gulf Coast populations nearly doubling between 1970 and 1990. From 1990 to 2010, an additional 3.1 million people moved to the coastal areas of the GOM in Florida alone.

In contrast, population growth rates in the coastal areas of Alabama and Louisiana have not kept up with national growth rates. Between 1970 and 1990 and from 1990 to 2010, the U.S. experienced population growth rates of 22.4 and 24.1 percent, respectively (Hobbs and Stoops, 2002; USDOC, Census Bureau, 2012), whereas populations in the coastal areas of Louisiana increased by 18.0 and 7.9 percent, respectively, during the two time periods, and populations in the Alabama coastal areas increased by only 20.5 and 19.5 percent, respectively (**Table 4.13-2**).

Total population around Port Fourchon and the Port of Galveston is shown in **Table 4.13-3**. There were 208,178 residents living in the Houma-Bayou Cane-Thibodaux MSA and 96,318 residents living in Lafourche Parish in 2010. The area surrounding the Port of Galveston is much more populous. In 2010, there were >5.9 million people living in the Houston-Sugar Land-Baytown MSA. More than 47,000 residents lived in the City of Galveston (**Table 4.13-3**).

4.13.1.4 Regional Economic Factors

The communities along the GOM are diverse, ranging from large urban areas like Houston and New Orleans, which have well-integrated economies, to smaller rural areas that are more dependent on a few industries.

The GOM has a great economic impact on local and regional economies of coastal communities from Florida to Texas. In 2012, approximately 25,100 business enterprises generated nearly $161.2 billion in local gross domestic product and $33.9 billion in wages and salaries, supporting nearly 581,100 jobs as a result of activities associated with the GOM. Offshore mineral extraction was the largest sector in terms of gross domestic product and wages, accounting for 81.3 percent of the total economic activity and 57.5 percent of the total wages and salaries associated with the GOM. In contrast, the tourism and recreation sector accounted for >51.4 percent of all jobs associated with the GOM, but it generated only 16.7 percent of the total wages and salaries and only 7.4 percent of the local gross domestic product tied to activities in the GOM. Marine transportation and shipbuilding were large employment sectors as well. The marine construction sector and the living resources sector (e.g., commercial fishing) generated the smallest portion of GOM-related employment in 2010 (**Table 4.13-1**) (USDOC, NOAA, n.d.).

The energy industry has a long history in the Gulf Coast States, and it is mature and fully integrated into all aspects of local and regional communities. The offshore energy industry in the GOM extracts oil, natural gas, and natural gas liquids, which are processed and transported for use in various activities, including transportation, electricity generation, space heating, and chemical manufacturing. The extraction of oil, natural gas, and natural gas liquids entails capital and operating expenditures on various processes, including G&G surveying, drilling, platform fabrication, shipbuilding, and various support services. Spending on these equipment, facilities, and processes supports businesses further along supply chains as well as spending by workers. Quest Offshore Resources, Inc. (2011) provides an overview of the spending impacts of the offshore oil and gas industry in the GOM. The largest concentrations of the offshore energy industry are in coastal Texas and Louisiana. 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).

As described in greater detail in the 2017-2022 GOM Multisale EIS, the oil and gas industry in the GOM is an important economic engine for the economies of Texas, Louisiana, Mississippi, Alabama, and Florida, with 10 counties in the Gulf Coast region defined as mining-dependent (including oil and gas) by the U.S. Department of Agriculture's Economic Research Service. These counties include Zapata, Duval, Jim Wells, and Refugio Counties in Texas and Vermilion, Lafayette, Iberia, St. Mary, Terrebonne, and Plaquemines Parishes in Louisiana. The direct economic impact of the oil and gas industry in the GOM reaches into billions of dollars. In 2009 it was estimated that \$26.0 billion in capital and operating expenditures supported \$29.1 billion in gross domestic product. The importance of the oil and gas industry to the Gulf Coast economy is further multiplied when the indirect and induced economic impacts are considered. These impacts include the effects on the numerous Tier I and Tier II suppliers, as well as the effects associated with earnings paid to oil and gas workers. The 2017-2022 GOM Multisale EIS also provides information regarding the forecasted geographic distributions of economic impacts arising from future offshore oil and gas activities. Many of these impacts are forecasted to occur in the coastal areas of Texas and Louisiana.

Numerous companies offer G&G services in the GOM. According to an economic study on the oil services contract industry in the GOM region completed for BOEM in June 2011, the G&G services industry employs between 5,870 and 6,128 workers in the GOM region and contributes at least \$2.94 billion to the regional economy (Eastern Research Group, Inc., 2011).

A total of 79 companies were identified as providing G&G prospecting services in the GOM (Eastern Research Group, Inc., 2011). The firms ranged from large publicly owned multinational companies to small privately owned companies. Employment at the publicly owned companies ranged from 80,000 workers at Schlumberger to only 36 workers at GETECH, Inc. Some of these companies perform services in addition to G&G prospecting services; therefore, it cannot be assumed that all of the employees work in the G&G prospecting field. The majority of the privately held companies employed <25 workers. There were, however, a few notable exceptions, including Fairfield Industries that employed 400 workers, Paradigm that employed 950 workers, and Willis Group that employed 286 workers, which were large privately owned enterprises (Eastern Research Group, Inc., 2011). Along with the oil and gas industry, the G&G industry experienced a noticeable slowdown in activities in 2016 compared with prior years.

Much of the onshore portion of the G&G industry is located in Harris County, Texas, which encompasses much of greater Houston. Approximately 68 percent of all firms offering G&G services in the GOM are located in Harris County, 84 percent of the total employees working in the G&G industry are assigned to offices in Harris County, and 95 percent of the total revenues earned in the industry are attributed to companies in Harris County. Other areas with large concentrations of personnel engaged in G&G activities included Lafayette Parish in Louisiana and Fort Bend County in Texas (Eastern Research Group, Inc., 2011).

In addition to the oil and gas industry, G&G services and activities in the GOM are utilized by a wide variety of scientific, research, educational, governmental, and commercial enterprises. Studies into geomorphology, cartology, and climate change; cultural resource surveys; fisheries research; military and USCG activities; and BOEM's Marine Minerals Program all require G&G services. As a result, G&G services support these multimillion dollar industries that employ thousands of workers throughout the Gulf Coast.

4.13.2 Impacts – Alternative A (Pre-Settlement [June 2013] Alternative

For human resources, land use, and economics, the proposed action would involve 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 Gulf Coast States. This geographic area is broadly diverse in types of land use and distribution of coastal infrastructure related to OCS Program activities. Impacts to human resources, land use, and economics may be positive as well as negative. For example, increased economic demand for services provided by G&G activity 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 factors associated with G&G activities assessed in this chapter for their potential human resources, land use, and economic impacts are restricted to those aspects onshore. Offshore factors such as vessel exclusion zones and noise impacts on fish catchability could also potentially result in impacts to human resources (e.g., recreational resources and commercial fishing), but they are analyzed in other chapters of this Programmatic EIS. Assessment of potential impacts on minority and low-income populations includes all impacts to human resources, whether derived from onshore or offshore activities. Onshore routine events associated with G&G activities consist of the use of shore bases for deployment, support, and debarkation of vessels and the employment of personnel for work on each survey.

Impact-Level Definitions

As described in **Chapter 4.1.2**, the impact-level criteria 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 or long term); spatial extent (i.e., localized or extensive); and severity (i.e., severe or less than severe). Each impact-level criterion is developed on a resource-specific basis to determine the appropriate impact level for each IPF. For human resources, land use, and economics, the impact-level criteria below have been used to evaluate the level of impact for each IPF.

- **Beneficial** (positive) impacts to human resources, land use, and economics would include maintaining current employment levels, creating new employment, indirect and induced positive impacts through increased spending, and stimulating local and regional economies.
- **Nominal** (adverse) impacts to human resources, land use, and economics would include those where little to no measurable impacts are observed or expected, and there would be no disproportionately adverse human health and environmental effects on minority and low-income populations.
- **Minor** (adverse) impacts to human resources, land use, and economics would include those that are detectable but are neither severe nor extensive. Minor impacts would include limited, localized, and short-term disruption to onshore support facilities and the local community; a low level of disproportionate impact to minority or low-income populations present in shore base communities; or minimal adverse human health and environmental effects.
- **Moderate** (adverse) impacts to human resources, land use, and economics would be detectable and would be either extensive but not severe or localized and severe. Moderate impacts would include localized and severe (or extensive but not severe) disruption to onshore support facilities and the local community; a disproportionate impact to minority or low-income populations present in shore base communities; or visible adverse human health and environmental effects.
- **Major** (adverse) impacts to human resources, land use, and economics would be detectable and would be long-lasting, extensive, and severe. Major impacts would include extensive and severe disruption to onshore support facilities and the local community; a high level of disproportionate impact to minority or low-income populations present in shore base communities; or significant adverse human health and environmental effects.

4.13.2.1 Impacts of Routine Events

4.13.2.1.1 Land Use and Coastal Infrastructure

The G&G activities associated with Alternative A would maintain current uses of Gulf Coast ports, which are described in **Chapter 4.13.1.1**. Because vessels would be expected to be between 20 and 100 m (66 and 328 ft) in length, they would require modest berthing space. All major ports described previously can regularly accommodate much larger cargo vessels. The larger survey vessels used for oil and gas seismic exploration could spend up to a year at sea; during surveys, crew changes and replenishment of supplies would be conducted on a regular basis using smaller service vessels. Larger seismic vessels may visit a shore base periodically (e.g., for repairs and equipment replacement that cannot be done at sea). Smaller vessels used for renewable energy and marine mineral surveys and sampling would typically return to their shore bases daily, averaging less than 4 trips/day over the 10-year period and divided among the major ports. The G&G-related traffic volume along the channels connecting ports to sea will not noticeably adversely affect the current use of such channels by commercial vessels. To the extent that specific projects include greater use of onshore bases and port channels, they would be subject to site-specific environmental reviews.

Alternative A would also contribute to the impacts to land use and coastal infrastructure arising from the overall offshore oil and gas program. These impacts include impacts arising from changes in activity levels, expansions of existing infrastructure, new infrastructure facility construction, onshore waste disposal, navigation channel maintenance dredging, and accidental events. Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS provides more information regarding the impacts to land use and coastal infrastructure from overall offshore oil and gas activities. Overall, Alternative A would cause **beneficial** to **minor** impacts to land use and coastal infrastructure because current usage patterns would generally be maintained.

4.13.2.1.2 Environmental Justice

Chapter 4.13.1.2 identified potential environmental justice populations in the onshore area bordering the AOI. Alternative A would only minimally impact overall patterns of income, land use, and demographics along the Gulf Coast, including in areas with environmental justice relevant populations (such as Houston and Galveston). In addition, Alternative A would support the existing offshore oil and gas industry, which provides income to various Gulf Coast communities. The G&G activities would be subject to site-specific environmental reviews, which would further identify and minimize environmental justice issues. Additionally, as noted in Chapter 4.14.3.3 of the 2017-2022 GOM Multisale EIS, the 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. Refer to Chapter 4.14.3.3 of the 2017-2022 GOM Multisale EIS for more information. Finally, the offshore oil and gas industry developed, as a result of G&G activity effects, broad areas (and various groups within those areas) so there is no reason to suspect that specific environmental justice populations will be particularly impacted. Therefore, the impacts of Alternative A on environmental justice are expected to be **beneficial** to **nominal**.

4.13.2.1.3 Demographics

Alternative A would support existing patterns of G&G activities and subsequent offshore oil and gas activities. The demographic impacts of Alternative A will be correlated with the impacts to regional economic factors, which are discussed in **Chapter 4.13.2.1.4**. In addition, the actions associated with Alternative A are small relative to the myriad issues that will impact demographics over the timeframe of the proposed action. 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, economic activity, technological developments, and government policies. Chapter 4.14.2.1 of the 2017-2022 GOM Multisale EIS provides more information regarding current and likely future demographic patterns. Therefore, the impacts of Alternative A on demographics are expected to be **beneficial** to **nominal**.

4.13.2.1.4 Regional Economic Factors

Under Alternative A, BOEM would continue to permit/authorize G&G activities at current projected levels with the implementation of standard mitigation measures applied through exsisting NTLs, COAs, and best management practices.

BOEM conducted an analysis of the additional operational costs to industry that would arise from the alternatives. **Table 4.13-5** represents the incremental cost and percent cost change per survey for Alternatives B through F that would be incurred over the Alternative A, status quo, pre-Settlement Agreement mitigation measures identified in **Chapter 2.5.2** (“Mitigation Measures”) and detailed in **Appendix B, Section 1**. Alternative A was used as the baseline for the cost analysis to more fully understand the percent cost increase to industry for Alternatives B through F (i.e., the percent cost increase that would be incurred beyond past requirements, prior to the Amended Settlement Agreement). **Table 4.13-6** represents the total annual survey incremental cost for Alternatives A through F that would be incurred based on the forecasted annual numbers of surveys (**Table 3.2-1**) and survey incremental cost (**Table 4.13-5**). The industry cost analysis for this Programmatic EIS focused only on additional expenditures for operating costs from the proposed mitigations for Alternatives A through F; therefore, this cost analysis represents only one part of the whole economic analysis. For example, changes to activity levels, supply chain impacts, and impacts on energy markets are discussed qualitatively. In addition, a “Regulatory Impact Analysis” will be conducted as part of the requirements for the MMPA rulemaking, which will further analyze economic impacts.

Additionally, some procedures, such as PAM, that have been routinely self-implemented but not required through regulation were not considered as part of the baseline cost of Alternative A. In order to ramp-up and re-initate a survey in low visibility, surveyors are required to have PAM on board. Because surveyors are not required to operate during low visibility, PAM is only considered strongly encouraged under Alternative A but not required unless surveyors want to start up during low visibility conditions. Therefore, while PAM costs are not considered as part of the costs under Alternative A, most surveyors are accustomed to supplying their vessels with PAM for operation in low visibility, which can cost from $62,000 to $9.3 million depending on the survey type. Therefore, an adjusted baseline for Alternative A with those regularly using PAM would decrease the relative cost of other alternatives to Alternative A by 18 to 26 percent for the smaller HRG and VSP surveys and by 3 to 6 percent for the larger surveys such as 2D, 3D, 3D WAZ, and OBS. Additionally, while third-party PSOs and PAMs are available for hire, many companies task and train their own crew with some PSO and PAM duties, which may reduce some additional costs. To be conservative, we have calculated PSO and PAM daily wage rates according to third-party wages (i.e., $300 to $600 daily wages per person).

Table 4.13-7 provides the percent reduced efficiency per survey that could result for Alternatives A through F. The percent reduced efficiency is based on survey delays due to proposed mitigations. BOEM analyzed the number of days it took, including delays as a result of shutdown and reshoot times, due to the proposed mitigation over the number of days it would have taken without those additional shutdown and reshoot times. Alternative A was used as the baseline for the loss of efficiency analysis to more fully understand the reduced efficiency for Alternatives B through F due to standard operation delays and time adjustments prior to the Amended Settlement Agreement. A 10 percent loss of operational efficiency was assumed to be included for Alternative A as part of the pre-Settlement Agreement conditions.

Alternative A includes no newly proposed mitigation measures since the Settlement Agreement and would result in no increased cost or loss in operational efficiency (**Tables 4.13-5 through 4.13-7**). However, Alternative A would support the overall offshore oil and gas industry, which has numerous **beneficial** impacts. The offshore oil and gas industry supports the Gulf Coast economy through industry spending, government revenues, corporate profits, providing oil and gas to end markets, supporting coastal infrastructure, and supporting supply chains and income patterns. Alternative A would also indirectly contribute to some **minor** negative economic impacts of routine offshore oil and gas activities. For example, the OCS Program supports vessel traffic and offshore structures that can conflict with industries such as shipping, fishing, and tourism. Detailed information regarding the impacts of the OCS Program can be found in the 2017-2022 GOM Multisale EIS.

Overall, **beneficial** to **minor** impacts to economic factors are expected to arise from routine activities under Alternative A.

4.13.2.2 Impacts of an Accidental Spill

An accidental event could result in the release of fuel or diesel by a survey vessel. Based on USCG spill statistics, a spill scenario that assumes a diesel spill volume of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. In addition, any damage and harm done would be small relative to the size of local economies and populations. The diesel spill would be addressed via the use of vessels and local spill-response capabilities. Detailed information regarding the economic and social impacts of accidental events arising from the offshore oil and gas industry can be found in the 2017-2022 GOM Multisale EIS.

4.13.2.3 Cumulative Impacts

4.13.2.3.1 OCS Program G&G Survey Activities

The G&G survey activities considered in this Programmatic EIS will occur in the context of previously permitted G&G activities or other activities that would not be impacted by the considered mitigations. In addition, the G&G survey activities would contribute to the impacts of the overall OCS Oil and Gas Program. Detailed information regarding the impacts of the OCS Program can be found in the 2017-2022 GOM Multisale EIS. The overall OCS Program supports the Gulf Coast economy through industry spending, government revenues, corporate profits, and the provision of oil and gas to end markets. The industry’s spending impacts are particularly prevalent in coastal Louisiana and Texas. The overall OCS Program also supports coastal infrastructure such as ports and manufacturing facilities. The G&G survey activities could also contribute to some of the negative economic and social consequences of the OCS industry. For example, the OCS Program can result in accidental oil and chemical spills. The OCS Program also supports vessel traffic and offshore structures that can conflict with industries such as shipping, fishing, and tourism.

4.13.2.3.2 Activities Other Than OCS Program G&G Survey Activities

Other major factors not associated with the OCS Program's G&G activities encompass all human activities and natural processes that may affect land use and coastal infrastructure, environmental justice, demographics, and economic factors. A discussion of every conceivable human activity and natural process from a global or universal perspective would consume volumes and would not be a reasonable or realistic undertaking. Some of the key IPFs that have the potential to affect human resources, land use, and economics include (1) Federal and State oil and gas activity; (2) agricultural and aquaculture uses; (3) urbanization and demographic shifts (i.e., in-migration and out-migration); (4) evolution of State and Federal regulations; (5) global, national, and regional economic trends; (6) tourism; (7) coastal land loss; and (8) natural events and processes.

The impacts of the cumulative factors discussed in this chapter depend on the unique specifics of each situation, whether the impacts are measurable, how impacts are measured, how long the impacts would last, the size of the affected area, and most importantly, the viewpoints of the various people that may be involved. 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 does not assign individual labels (i.e., beneficial, negligible, minor, moderate, or major) to every category of cumulative impacts described.

Federal and State Oil and Gas Activity

Oil- and gas-related activities in Federal and State waters and onshore utilize many of the same coastal infrastructure facilities as G&G-related activities and would continue to contribute to the cumulative impacts on land use and coastal infrastructure. For all coastal infrastructure types, especially processing facilities, it has proven impossible to parse out what percentage of demand is generated by each activity. This difficulty is an inherent problem in analyzing most cumulative impacts to coastal land use and infrastructure.

Federal and State oil and gas activities 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. Revenues from oil programs in State waters have produced several beneficial 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 shore. In

2006, the Louisiana Legislature authorized Louisiana's Department 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). More detailed information on the effects of the Federal and State oil and gas programs to human resources, land use, and economics can be found in **Chapters 3.4.1 and 3.4.2** of this Programmatic EIS and Chapter 4.14 of the 2017-2022 GOM Multisale EIS.

Coastal and offshore oil spills may be associated with the 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 oil and gas activity is provided in Chapter 3.2 of the 2017-2022 GOM Multisale EIS. 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. 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 land use and coastal infrastructure categories. The impacts to land use and coastal infrastructure from coastal and offshore oil spills would depend on the size and location of the spill. For more information on the potential impacts of a low-probability catastrophic spill (which is not part of the proposed action and not reasonably foreseeable as a result of the proposed action), refer to BOEM's *Catastrophic Spill Event Analysis* (USDOI, BOEM, 2017c).

Agricultural and Aquaculture Uses

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).

When degradation of oyster reefs occurs, it may negatively impact people and communities, especially minority and low-income populations, 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.

Urbanization and Demographic Shifts

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, 2013).

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.

State and Federal Regulations

Within the geo-political realm, non-OCS G&G-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 by the Economic Research Service and predecessor agencies.

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, teacher-to-student ratios, standardized test scores, amount and extent of busing across cities and towns, and availability of special education services in the public schools (National Education Association, 2015; FSG Social Impact Consultants, 2011). Another very important non-OCS G&G-related IPF 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.

Global, National, and Regional Economic Trends

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 require cars and trucks to travel. However, the downturn has also led to increasing layoffs in the oil and gas industry (Larino, 2015; Stickney, 2015; Strauss, 2015; Thompson, 2016). Despite a rise in oil prices in early 2016, bankruptcies increased for oil companies (Eaton, 2016). By mid-2016, with the number of layoffs totaling over 350,000, oil companies were predicted to be facing a shortage of skilled workers when oil prices rebound (Cunningham, 2016). 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.

Woods & Poole Economics, Inc. (2016) provides forecasts of various economic and demographic variables, which help to quantify the contributions of other likely projects, actions, and trends to the cumulative case. Detailed information on the Woods and Poole data can be found in

Chapter 4.14.2.2.3 of the 2017-2022 GOM Multisale EIS. Table 4-37 of the 2017-2022 GOM Multisale EIS aggregates Woods & Poole's forecasts for 2050 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) will be TX-3 (which includes Houston and Galveston), FL-5 (which includes Tampa), TX-1, FL-6, LA-5 (which includes Baton Rouge), and LA-6 (which includes New Orleans). The smallest EIAs (presented in ascending order of gross regional product) will be MS-2, TX-6, LA-2, AL-2, and TX-4. From 2015 through 2050, the fastest employment growth is forecast in TX-1, TX-3, FL-4, and FL-6; the slowest employment growth is forecast in AL-2, LA-6, TX-5, and MS-1.

The G&G industry will 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 (International Energy Agency, 2016). Demand for energy products will 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, 2016a) and annual long-term (25-year) forecasts (USDOE, Energy Information Administration, 2016b).

Tourism

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. State renewable energy programs are non-OCS G&G-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 and who are negatively impacted by the disruption of the natural balance of the delicate ecosystem.

Coastal Land Loss

Coastal land loss resulting from erosion, subsidence, sea-level rise, 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, which is sinking faster than any place in the world (Marshall, 2013). As evident from the visual depictions in Louisiana's Coastal Master Plan (2012), coastal land loss is one of the greatest threats to the stability and future of coastal infrastructure, producing a **major** negative impact to those facilities located close to areas vulnerable to land loss. The severe threat to coastal infrastructure and communities becomes more evident each year, and the requests for action continue to increase (Traywick, 2016; Marshall, 2015).

Natural Events and Processes

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 (i.e., Ivan, Katrina, Rita, Gustav, and Ike), as well as minor hurricanes (i.e., 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 Metropolitan Area has been recovering gradually, but unevenly. Population before the 2005 storms was 1.386 million, which dropped to 1.040 million in 2006 and then 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 Petkova 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 GOM coastal region, including subsidence, severe erosion, changing water-use patterns, sea-level rise, storm surge, the 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 (Petkova et al., 2015).

4.13.2.3.3 Cumulative Impact Conclusions

The incremental cumulative impact of Alternative A is expected to be **beneficial** to **minor** since Alternative A reflects the continuation of current policies and because the impacts of Alternative A will be small relative to the cumulative trends discussed above.

4.13.3 Impacts – Alternative B (Settlement Agreement Alternative)

4.13.3.1 Impacts of Routine Events

4.13.3.1.1 Land Use and Coastal Infrastructure

The G&G activities associated with Alternative B would maintain current uses of Gulf Coast ports, which are described in **Chapter 4.13.1.1**. Because vessels would be expected to be between 20 and 100 m (66 and 328 ft) in length, they would require modest berthing space. All major ports described previously can regularly accommodate much larger cargo vessels. The larger survey vessels used for oil and gas seismic exploration could spend up to a year at sea; during surveys, crew changes and replenishment of supplies would be conducted on a regular basis using smaller service vessels. Larger seismic vessels may visit a shore base periodically (e.g., for repairs and equipment replacement that cannot be done at sea). Smaller vessels used for renewable energy and marine mineral surveys and sampling would typically return to their shore bases daily, averaging less than 4 trips/day over the 10-year period and divided among the major ports. The G&G-related traffic volume along the channels connecting ports to sea will not noticeably adversely affect the current use of such channels by commercial vessels. To the extent that specific projects include greater use of onshore bases and port channels, they would be subject to site-specific environmental reviews.

The mitigations associated with Alternative B would only minimally impact land use and coastal infrastructure because patterns of G&G survey activites would not be substantially impacted and because land use and coastal infrastructure is supported by other economic activities. **Chapter 4.13.3.1.4** ("Regional Economic Factors") describes the changes to economic activity that could arise from Alternative B. The impacts to land use and coastal infrastructure would be correlated to these economic changes if the changes were large enough to disrupt infrastructure usage and if it were difficult for facilities to find substitute sources of business. Alternative B would also contribute to the impacts to land use and coastal infrastructure arising from the overall offshore oil and gas program. These impacts include impacts arising from changes in activity levels, expansions of existing infrastructure, new infrastructure facility construction, onshore waste disposal, navigation channel maintenance dredging, and accidental events. Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS provides more information regarding the impacts to land use and coastal infrastructure from overall offshore oil and gas activities. Overall, Alternative B would cause **beneficial** to **minor** impacts to land use and coastal infrastructure.

4.13.3.1.2 Environmental Justice

Chapter 4.13.1.2 identified potential environmental justice populations in the onshore area bordering the AOI. The mitigations associated with Alternative B would not substantially impact the overall patterns of income, land use, and demographics along the Gulf Coast, including areas with environmental justice relevant populations (such as Houston and Galveston). In addition, Alternative B would support the existing offshore oil and gas industry, which provides income to various Gulf Coast communities. The G&G activities would be subject to site-specific environmental reviews, which would further identify and minimize environmental justice issues. Finally, the offshore oil and gas industry affects broad areas (and various groups within those areas), so there is no reason to suspect that specific environmental justice populations will be particularly impacted. Chapter 4.14.3.3 of the 2017-2022 GOM Multisale EIS provides further analysis of why BOEM's activities do not materially impact environmental justice. Therefore, the impacts of Alternative B on environmental justice are expected to be **beneficial** to **nominal**.

4.13.3.1.3 Demographics

Alternative B would support existing patterns of G&G activities and subsequent offshore oil and gas activities. The demographic impacts of Alternative B will be correlated with the impacts to regional economic factors, which are discussed in **Chapter 4.13.3.1.4**. The mitigations associated with Alternative B would only slightly change the economic variables, such as employoment, that drive demographic patterns. In addition, the actions associated with Alternative B are small relative to the myriad issues that will impact demographics over the timeframe of the proposed action; Chapter 4.14.2.1 of the 2017-2022 GOM Multisale EIS provides information regarding current and likely future demographic patterns. Therefore, the impacts of Alternative B on demographics are expected to be **beneficial** to **minor**.

4.13.3.1.4 Regional Economic Factors

Under Alternative B, BOEM expects levels of G&G activity to occur within the ranges predicted in **Table 3.2-1** and would continue to authorize G&G activity through the Amended Settlement Agreement requirements, existing NTLs, COAs, and best management practices, including required mitigation, monitoring, and reporting. Each mitigation in Alternatve B has a unique associated incremental cost to industry even though the scenario of projected activity remains the same as in Alternative A.

Alternative B would enable G&G activities that support the overall offshore oil and gas industry, which has numerous **beneficial** impacts. The offshore oil and gas industry supports the Gulf Coast economy through industry spending, government revenues, corporate profits, the provision of oil and gas to end markets and by supporting coastal infrastructure and supply chains and income patterns.

However, mitigation components of Alternative B, such as the minimum separation distance between seismic airguns, could increase costs over pre-Settlement Agreement levels depending on the survey type (**Tables 4.13-5 and 4.13-6**). The cost of smaller airgun surveys such as HRGs and VSPs could have a 18 to 35 percent cost increase, whereas larger surveys such as 2D, 3D, 3D WAZ, and OBS surveys could have a 10 to 28 percent cost increase. The seismic surveying company or the exploration and production company would take on any increased costs, depending on the extent to which the increased costs result in increased prices for seismic services. Also, depending on the procedures that industry were accustomed to following prior to the Settlement Agreement, some increases in cost (including PAM installation) may not be a new cost burden, though they are conservatively considered here (refer to **Chapter 4.13.2.1.4** for further discussion). All else being equal, increased costs would lead to decreased profits for these companies; however, increased costs would serve as income to the providers of mitigation-related services. The minimum separation distance between surveys and the expanded PAM Program requirements could reduce operational efficiencies by up to 30 percent due to increased shutdowns in G&G data gathering (**Table 4.13-7**). These costs and inefficiencies could cause financial impacts to the G&G industry and the oil and gas industry as a whole through various means, e.g., by increasing the costs of G&G activities over pre-Settlement Agreement levels, by preventing a certain survey from occurring, by delaying G&G activity, or by causing G&G activities to glean less information than would have been obtained under pre-Settlement Agreement conditions. However, the expected increase in the cost of G&G surveys under Alternative B, however, is unlikely to noticeably impact the level of oil and gas development in the Gulf of Mexico, given that the costs of G&G activities are relatively minor compared with expenditures on drilling, engineering, the installation of platforms, and production operations. In Chapter 3.1 of the 2017-2022 GOM Multisale EIS, BOEM developed a reasonable, robust range of oil and gas activity. After developing the alternatives for this Programmatic EIS, BOEM determined that the scenario described in the 2017-2022 GOM Multisale EIS is broad enough to encompass any indirect effects to the oil and gas industry from the range of G&G activity described in Alternative B. Alternative B would also indirectly contribute to some **minor** negative economic impacts of routine offshore oil and gas activities. For example, the OCS Program supports vessel traffic and offshore structures that can conflict with industries, such as shipping, fishing, and tourism. In addition, Chapter 4.2.1.23 of the 2017-2022 GOM Multisale EIS provides a sense of the geographic patterns of economic impacts that arise due to offshore oil and gas activities.

Alternative B would also entail coastal seasonal restrictions. Because the seasonal restrictions associated with Alternative B are only in place 4 months out of the year, they are unlikely to permanently prevent the collection of G&G data in any of the affected lease blocks. However, the seasonal restrictions could delay surveys. However, most industry interest for exploration activities is expected to be outside the restriction areas. Alternative B would also entail activity restrictions in the Areas of Concern in the EPA. Most of the EPA will be under a leasing moratorium until 2022; therefore, the impacts of these restrictions will likely be limited. However, the impacts would become greater to the extent that there is industry interest in developing these areas and if there were indications that the moratorium would eventually be lifted.

The costs, inefficiencies, and area restrictions would cause economic impacts to the extent that they disrupt offshore oil and gas exploration, development, and production. These disruptions would lead to indirect impacts to the oil and gas industry, indirect impacts to the associated supply chains, and induced impacts arising from spending reductions by workers. The 2017-2022 GOM Multisale EIS provides ranges of economic impacts expected to arise from overall offshore oil and gas activities. Alternative B would not change and likely fall within the ranges of economic impacts presented in the 2017-2022 GOM Multisale EIS. The 2017-2022 GOM Multisale EIS also provides a sense of the geographic patterns of economic impacts that could arise from changes to offshore oil and gas activities. In particular, the majority of the associated socioeconomic impacts would occur in coastal Texas and Louisiana, although some impacts (such as lost profits or lost oil and gas production) could be felt elsewhere. These impacts would depend on the state of the oil and gas industry as well as the overall economy. In 2017, the overall U.S. economy is reasonably healthy, but the offshore oil and gas industry is struggling with low energy prices (which is having a disproportionate impact on the Texas and Louisiana economies). If future oil and gas production were curtailed, energy prices could slightly increase and energy usage could slightly decrease. If Alternative B were to disrupt exploration plans, more oil and gas drilling in the AOI would depend on existing geophysical data. In addition, oil and gas companies may choose to focus exploration and development activities in lower-risk areas without survey restrictions. These alternative areas might be elsewhere within the Gulf of Mexico though companies could also choose to expand production internationally. However, these various potential impacts are expected to be limited because Alternative B is not forecasted to substantially disrupt G&G data collection nor indirectly affect oil and gas exploration, development, and production.

Loss in HRG survey activities that include subbottom profilers, side-scan sonar, and/or echosounders would negatively impact renewable energy or marine minerals development. However, substantial renewable energy development in the GOM is not expected in the near future. The immediate effects of disruptions to marine minerals development would be significant because OCS sand resources are the only viable option for many coastal restoration projects, especially offshore Louisiana, Mississippi, and parts of Florida. Identification and exploitation of new sand sources in Federal waters is integral to multiple Gulf Coast restoration programs and projects. There is an initiative underway with BOEM, USGS, and the Gulf Coast States to develop a Gulfwide offshore sand inventory. During mineral extraction operations, bathymetric surveys are required to ensure that sensitive habitats are not impacted and that infrastructure setback buffers are not compromised, and to track the volume of mineral production. In addition, the vessels used for marine minerals will be less impacted than vessels used for oil and gas exploration.because marine minerals vessels typically are smaller and do not use seismic airgun techniques.

Overall, the economic impacts of Alternative B are expected to be **beneficial** to **moderate**. The beneficial impacts will arise because most G&G activities, and the resultant oil and gas activities, will continue. The extent of the negative impacts of Alternative B will depend on the extent of the increased costs, inefficiencies, and potential changes in oil and gas activities.

4.13.3.2 Impacts of an Accidental Spill

An accidental event could result in the release of fuel or diesel by a survey vessel. Based on USCG spill statistics, a spill scenario that assumes a diesel spill volume of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. In addition, any damage and harm done would be small relative to the size of local economies and populations. The diesel spill would be addressed via the use of vessels and local spill-response capabilities. Detailed information regarding the economic and social impacts of accidental events arising from the offshore oil and gas industry can be found in the 2017-2022 GOM Multisale EIS.

4.13.3.3 Cumulative Impacts

4.13.3.3.1 OCS Program G&G Survey Activities

The G&G survey activities considered in this Programmatic EIS will occur in the context of previously permitted G&G activities or other activities that would not be impacted by the considered mitigations. In addition, the G&G survey activities would contribute to the impacts of the overall OCS oil and gas leasing program. For example, the OCS Program supports economic activity and oil and gas infrastructure along the Gulf Coast. However, the OCS Program can also lead to adverse impacts arising from accidental events and completion for resources with other industries. A detailed impacts assessment of the cumulative scenario is provided in Alternative A (**Chapter 4.13.2.3**).

4.13.3.3.2 Activities Other Than OCS Program G&G Survey Activities

Other major factors not associated with the OCS Program encompass all human activities and natural processes that may affect land use and coastal infrastructure, environmental justice, demographics, and economic factors. Some of the key IPFs that have the potential to affect human resources, land use, and economics include (1) Federal and State oil and gas activity; (2) agricultural and aquaculture uses; (3) urbanization and demographic shifts (i.e., in-migration and out-migration); (4) evolution of State and Federal regulations; (5) global, national, and regional economic trends; (6) tourism; (7) coastal land loss; and (8) natural events and processes. A detailed assessment of these cumulative impacts is provided in Alternative A (**Chapter 4.13.2.3.2**).

4.13.3.3.3 Cumulative Impact Conclusions

The incremental cumulative impacts of Alternative B to human resources, land use, and economics are expected to be **beneficial** to **moderate**, depending on the extent of increased costs and inefficiencies.

4.13.4 Impacts – Alternative C (Proposed Action – Alternative A Plus Additional Mitigation Measures)

4.13.4.1 Impacts of Routine Activities

4.13.4.1.1 Land Use and Coastal Infrastructure

The G&G activities associated with Alternative C would maintain current uses of Gulf Coast ports, which are described in **Chapter 4.13.1.1**. Because vessels would be expected to be between 20 and 100 m (66 and 328 ft) in length, they would require modest berthing space. All major ports described previously can regularly accommodate much larger cargo vessels. The larger survey vessels used for oil and gas seismic exploration could spend up to a year at sea; during surveys, crew changes and replenishment of supplies would be conducted on a regular basis using smaller service vessels. Larger seismic vessels may visit a shore base periodically (e.g., for repairs and equipment replacement that cannot be done at sea). Smaller vessels used for renewable energy and marine mineral surveys and sampling would typically return to their shore bases daily, averaging less than 4 trips/day over the 10-year period and divided among the major ports. The G&G-related traffic volume along the channels connecting ports to sea will not noticeably adversely affect the current use of such channels by commercial vessels. To the extent that specific projects include greater use of onshore bases and port channels, they would be subject to site-specific environmental reviews.

The mitigations associated with Alternative C would only minimally impact land use and coastal infrastructure because patterns of G&G survey activites would not be substantially impacted and because land use and coastal infrastructure is supported by other economic activities. **Chapter 4.13.4.1.4**(“Regional Economic Factors”) describes the changes to economic activity that could arise from Alternative B. The impacts to land use and coastal infrastructure would be correlated to these economic changes if the changes were large enough to disrupt infrastructure usage and if it were difficult for facilities to find substitute sources of business. Alternative C would also contribute to the impacts to land use and coastal infrastructure arising from the overall offshore oil and gas program. This includes impacts arising from changes in activity levels, expansions of existing infrastructure, new infrastructure facility construction, onshore waste disposal, navigation channel maintenance dredging, and accidental events. Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS provides more information regarding the impacts to land use and coastal infrastructure from overall offshore oil and gas activities. Overall, Alternative C would cause **beneficial** to **minor** impacts to land use and coastal infrastructure.

4.13.4.1.2 Environmental Justice

Chapter 4.13.1.2identified potential environmental justice populations in the onshore area bordering the AOI. The mitigations associated with Alternative C would only minimally impact overall patterns of income, land use, and demographics along the Gulf Coast, including areas with environmental justice relevant populations (such as Houston and Galveston). In addition, Alternative C would support the existing offshore oil and gas industry, which provides income to various Gulf Coast communities. The G&G activities would be subject to site-specific environmental reviews, which would further identify and minimize environmental justice issues. Finally, the offshore oil and gas industry affects broad areas (and various groups within those areas) so there is no reason to suspect that specific environmental justice populations will be particularly impacted. Chapter 4.14.3.3 of the 2017-2022 GOM Multisale EIS provides further analysis of why BOEM's activities do not materially impact environmental justice. Therefore, the impacts of Alternative C on environmental justice are expected to be **beneficial** to **nominal**.

4.13.4.1.3 Demographics

Alternative C would support existing patterns of G&G activities and subsequent offshore oil and gas activities. The demographic impacts of Alternative C will be correlated with the impacts to regional economic factors, which are discussed in **Chapter 4.13.4.1.4**. The mitigations associated with Alternative C would only slightly change economic variables, such as employoment, that drive demographic patterns. In addition, the actions associated with Alternative C are small relative to the myriad issues that will impact demographics over the timeframe of the proposed action; Chapter 4.14.2.1 of the 2017-2022 GOM Multisale EIS provides information regarding current and likely future demographic patterns. Therefore, the impacts of Alternative C on demographics are expected to be **beneficial** to **minor**.

4.13.4.1.4 Regional Economic Factors

Under Alternative C, BOEM expects levels of G&G activity to occur within the ranges predicted in **Table 3.2-1** and would continue to authorize G&G activity through existing NTLs, COAs, and best management practices, including required mitigation, monitoring, and reporting. Each mitigation in Alternatve C has a unique associated incremental cost to industry even though the scenario of projected activity remains the same as in Alternative A.

Alternative C would enable G&G activities that support the overall offshore oil and gas industry, which has numerous beneficial impacts. The offshore oil and gas industry supports the Gulf Coast economy through industry spending, government revenues, corporate profits, the provision of oil and gas to end markets, and by supporting coastal infrastructure and supply chains and income patterns.

However, the mitigation measures for Alternative C could increase costs over pre-Settlement Agreement levels depending on the survey type (**Tables 4.13-5 and 4.13-6**). The cost of smaller airgun surveys such as HRGs and VSPs are more affected (9% to 30% cost increase) by the implementation of the extended PAM and extended PSO mitigation than larger surveys such as 2D, 3D, and 3D WAZ surveys (1% to 10% cost increase). In addition, the expanded PSO and PAM Program requirements and the seasonal restrictions could reduce operational efficiencies by up to 9 percent due to increased shutdowns in G&G data gathering (**Table 4.13-7**). However, most surveys could likely occur during other time periods, lessening the financial impacts on industry. Similar to Alternative B, Alternative C could cause financial impacts to the G&G industry and to the oil and gas industry as a whole through various means, e.g., by increasing the costs of G&G activities over pre-Settlement Agreement levels, by preventing a certain survey from occurring, by delaying G&G

activity, or by causing G&G activities to collect less information than would have been obtained under pre-Settlement Agreement conditions. However, these impacts are expected to be less under Alternative C than those expected under Alternative B. Also, depending on the procedures that industry were accustomed to following prior to the Settlement Agreement, some increases in cost (including PAM installation) may not be a new cost burden, though they are conservatively considered here (refer to **Chapter 4.13.2.1.4** for further discussion).

Alternative C would also entail coastal seasonal restrictions. Because the seasonal restrictions associated with Alternative C are only in place 4 months out of the year, they are unlikely to permanently prevent the collection of G&G data in any of the affected lease blocks. However, the seasonal restrictions could delay collection of G&G data and possibly exploration for oil and gas resources, and could serve as a disincentive for overall oil and gas development in these areas. However, most industry interest for exploration activities is expected to be outside the restriction areas. Alternative C would also entail the implementation of a non-airgun HRG survey protocol. This protocol would increase the costs of non-airgun HRG suveys up to 11 percent.

The costs, inefficiencies, and seasonal restrictions would cause economic impacts to the extent that they disrupt offshore oil and gas exploration, development, and production. These disruptions would lead to indirect impacts to the oil and gas industry, indirect impacts to the associated supply chains, and induced impacts arising from spending reductions by workers. The 2017-2022 GOM Multisale EIS provides ranges of economic impacts expected to arise from overall offshore oil and gas activities. Alternative C would not change and falls within the ranges of economic impacts presented in the 2017-2022 GOM Multisale EIS. The 2017-2022 GOM Multisale EIS also provides a sense of the geographic patterns of economic impacts that could arise from changes to offshore oil and gas activities. In particular, the majority of the associated socioeconomic impacts would occur in coastal Texas and Louisiana, although some impacts (such as lost profits or lost oil and gas production) could be felt elsewhere. These impacts would depend on the state of the oil and gas industry as well as the overall economy. In 2017, the overall U.S. economy is reasonably healthy, but the offshore oil and gas industry is struggling with low energy prices (which is having a disproportionate impact on the Texas and Louisiana economies). If future oil and gas production were curtailed, energy prices could slightly increase, and energy usage could slightly decrease. If Alternative C were to disrupt exploration plans, more oil and gas drilling in the AOI would depend on existing geophysical data. In addition, oil and gas companies may choose to focus exploration and development activities in lower-risk areas without survey restrictions. These alternative areas might be elsewhere within the Gulf of Mexico, though companies could also choose to expand production internationally. Alternative C would also indirectly contribute to some **minor** negative economic impacts of routine offshore oil and gas activities. For example, the OCS Program supports vessel traffic and offshore structures that can conflict with industries, such as shipping, fishing, and tourism. However, these various potential impacts are expected to be limited because Alternative C is not forecasted to substantially disrupt oil and gas exploration, development, and production. Detailed information regarding the economic impacts of the OCS Program can be found in 2017-2022 GOM Multisale EIS.

Loss in HRG survey activities that include subbottom profilers, side-scan sonar, and/or echosounders would negatively impact renewable energy or marine minerals development. However, substantial renewable energy development in the GOM is not expected in the near future. The immediate effects of disruptions to marine minerals development would be significant because OCS sand resources are the only viable option for many coastal restoration projects, especially offshore Louisiana, Mississippi, and parts of Florida. Identification and exploitation of new sand sources in Federal waters is integral to multiple Gulf Coast restoration programs and projects. There is an initiative underway with BOEM, USGS, and the Gulf Coast States to develop a Gulfwide offshore sand inventory. During mineral extraction operations, bathymetric surveys are required to ensure that sensitive habitats are not impacted and that infrastructure setback buffers are not compromised, and to track the volume of mineral production. In addition, the vessels used for marine minerals will be less impacted than vessels used for oil and gas exploration marine minerals vessels typically are smaller and do not use seismic airgun techniques. The non-airgun survey protocol could increase costs for marine minerals projects.

Overall, the economic impacts of Alternative C are expected to be **beneficial** to **minor**. The beneficial impacts will arise because most G&G activities, and the resultant oil and gas activities, will continue. The extent of the negative impacts of Alternative C will depend on the extent of the increased costs, inefficiencies, and effects to oil and gas activities.

4.13.4.2 Impacts of an Accidental Spill

An accidental event could result in the release of fuel or diesel by a survey vessel. Based on USCG spill statistics, a spill scenario that assumes a diesel spill volume of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. In addition, any damage and harm done would be small relative to the size of local economies and populations. The diesel spill would be addressed via the use of vessels and local spill-response capabilities. Detailed information regarding the economic and social impacts of accidental events arising from the offshore oil and gas industry can be found in the 2017-2022 GOM Multisale EIS.

4.13.4.3 Cumulative Impacts

4.13.4.3.1 OCS Program G&G Survey Activities

The G&G survey activities considered in this Programmatic EIS will occur in the context of previously permitted G&G activities or other activities that would not be impacted by the considered mitigations. In addition, the G&G survey activities would contribute to the impacts of the overall OCS Oil and Gas Program. For example, the OCS Program supports economic activity and oil and gas infrastructure along the Gulf Coast. However, the OCS Program can also lead to adverse impacts arising from accidental events and completion for resources with other industries. A detailed impacts assessment of the cumulative scenario is provided in Alternative A (**Chapter 4.13.2.3**).

4.13.4.3.2 Activities Other Than OCS Program G&G Survey Activities

Other major factors not associated with the OCS Program encompass all human activities and natural processes that may affect land use and coastal infrastructure, environmental justice, demographics, and economic factors. Some of the key IPFs that have the potential to affect human resources, land use, and economics include (1) Federal and State oil and gas activity; (2) agricultural and aquaculture uses; (3) urbanization and demographic shifts (i.e., in-migration and out-migration); (4) evolution of State and Federal regulations; (5) global, national, and regional economic trends; (6) tourism; (7) coastal land loss; and (8) natural events and processes. A detailed assessment of these cumulative impacts is provided in Alternative A (**Chapter 4.13.2.3.2**).

4.13.4.3.3 Cumulative Impact Conclusions

The incremental cumulative impacts of Alternative C to human resources, land use, and economics are expected to be **beneficial** to **minor** because the introduced costs and inefficiencies would be small relative to the impacts described in the cumulative scenario.

4.13.5 Impacts – Alternative D (Alternative C Plus Marine Mammal Shutdowns)

4.13.5.1 Impacts of Routine Events

4.13.5.1.1 Land Use and Coastal Infrastructure

The G&G activities associated with Alternative D would maintain current uses of Gulf Coast ports, which are described in **Chapter 4.13.1.1**. Because vessels would be expected to be between 20 and 100 m (66 and 328 ft) in length, they would require modest berthing space. All major ports described previously can regularly accommodate much larger cargo vessels. The larger survey vessels used for oil and gas seismic exploration could spend up to a year at sea; during surveys, crew changes and replenishment of supplies would be conducted on a regular basis using smaller service vessels. Larger seismic vessels may visit a shore base periodically (e.g., for repairs and equipment replacement that cannot be done at sea). Smaller vessels used for renewable energy and marine mineral surveys and sampling would typically return to their shore bases daily, averaging less than 4 trips/day over the 10-year period and divided among the major ports. The G&G-related traffic volume along the channels connecting ports to sea will not noticeably adversely affect the current use of such channels by commercial vessels. To the extent that specific projects include greater use of onshore bases and port channels, they would be subject to site-specific environmental reviews.

The mitigations associated with Alternative D would only minimally impact land use and coastal infrastructure because patterns of G&G survey activites would not be substantially impacted and because land use and coastal infrastructure is supported by other economic activities. **Chapter 4.13.5.1.4** ("Regional Economic Factors") describes the changes to economic activity that could arise from Alternative D. The impacts to land use and coastal infrastructure would be correlated to these economic changes if the changes were large enough to disrupt infrastructure usage and if it were difficult for facilities to find substitute sources of business. Alternative D would also contribute to the impacts to land use and coastal infrastructure arising from the overall offshore oil and gas program. These include impacts arising from changes in activity levels, expansions of existing infrastructure, new infrastructure facility construction, onshore waste disposal, navigation channel maintenance dredging, and accidental events. Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS provides more information regarding the impacts to land use and coastal infrastructure from overall offshore oil and gas activities. Overall, Alternative D would cause **beneficial** to **minor** impacts to land use and coastal infrastructure.

4.13.5.1.2 Environmental Justice

Chapter 4.13.1.2 identified potential environmental justice populations in the onshore area bordering the AOI. The mitigations associated with Alternative D would only minimally impact overall patterns of income, land use, and demographics along the Gulf Coast, including areas with environmental justice relevant populations (such as Houston and Galveston). In addition, Alternative D would support the existing offshore oil and gas industry, which provides income to various Gulf Coast communities. The G&G activities would be subject to site-specific environmental reviews, which would further identify and minimize environmental justice issues. Finally, the offshore oil and gas industry affects broad areas (and various groups within those areas) so there is no reason to suspect that specific environmental justice populations will be particularly impacted. Chapter 4.14.3.3 of the 2017-2022 GOM Multisale EIS provides further analysis of why BOEM's activities do not materially impact environmental justice. Therefore, the impacts of Alternative D on environmental justice are expected to be **beneficial** to **nominal**.

4.13.5.1.3 Demographics

Alternative D would support existing patterns of G&G activities and subsequent offshore oil and gas activities. The demographic impacts of Alternative D will be correlated with the impacts to regional economic factors, which are discussed in **Chapter 4.13.5.1.4**. The mitigations associated with Alternative D would only slightly change economic variables, such as employoment, that drive demographic patterns. In addition, the actions associated with Alternative D are small relative to the myriad issues that will impact demographics over the timeframe of the proposed action; Chapter 4.14.2.1 of the 2017-2022 GOM Multisale EIS provides information regarding current and likely future demographic patterns. Therefore, the impacts of Alternative D on demographics are expected to be **beneficial** to **minor**.

4.13.5.1.4 Regional Economic Factors

Under Alternative D, BOEM expects levels of G&G activity to occur within the ranges predicted in **Table 3.2-1** and would continue to authorize G&G activity through existing NTLs, COAs, and best management practices, including required mitigation, monitoring, and reporting. Each mitigation in Alternatve D has a unique associated incremental cost to industry even though the scenario of projected activity remains the same as in Alternative A.

Alternative D would enable G&G activities that support the overall offshore oil and gas industry, which has numerous **beneficial** impacts. The offshore oil and gas industry supports the Gulf Coast economy through industry spending, government revenues, corporate profits, the provision of oil and gas to end markets, and by supporting coastal infrastructure and supply chains and income patterns.

However, mitigation measures for Alternative D could increase costs over pre-Settlement Agreement levels (**Tables 4.13-5 and 4.13-6**). The cost of smaller airgun surveys such as HRGs and VSPs are more affected (9% to 31% cost increase) by the implementation of the extended PAM and extended PSO mitigation than larger surveys such as 2D, 3D, 3D WAZ, and OBS surveys (1% to 13% cost increase). Additional marine mammal monitoring under the expanded PAM Program likely would reduce operational efficiencies by up to 13 percent due to increased shutdowns in G&G data gathering (**Table 4.13-7**). Seasonal restrictions could also delay G&G data collection; however, most surveys could likely occur during other time periods, lessening the financial impacts on industry. Similar to Alternative C, Alternative D could cause financial impacts to the G&G industry and to the oil and gas industry as a whole through various means, e.g., by increasing the costs of G&G activities over pre-Settlement Agreement levels, by delaying G&G activity, by preventing a certain survey from occurring, or by causing G&G activities to collect less information than would have been obtained under pre-Settlement Agreement conditions. The impact of Alternative D will also depend on the ability of vessels to monitor and implement its provisions. Also, depending on the procedures that industry were accustomed to following prior to the Settlement Agreement, some increases in cost (including PAM installation) may not be a new cost burden, though they are conservatively considered here (refer to **Chapter 4.13.2.1.4** for further discussion).

Alternative D would also entail coastal seasonal restrictions. Because the seasonal restrictions associated with Alternative D are only in place 4 months out of the year, they are unlikely to permanently prevent the collection of G&G data in any of the affected lease blocks. However, the seasonal restrictions could delay exploration for oil and gas resources, and could serve as a disincentive for overall oil and gas development in these areas. However, most industry interest for exploration activities is expected to be outside the restriction areas. Alternative D would also entail the implementation of a non-airgun HRG survey protocol. This protocol would increase the costs of non-airgun HRG suveys up to 12 percent.

The costs, inefficiencies, and seasonal restrictions would cause economic impacts to the extent that they disrupt G&G operations and influence offshore oil and gas exploration, development, and production. These disruptions would lead to indirect impacts to the oil and gas industry, indirect impacts to the associated supply chains, and induced impacts arising from spending reductions by workers. The 2017-2022 GOM Multisale EIS provides ranges of economic impacts expected to arise from overall offshore oil and gas activities. Alternative D would not change and would fall within the ranges of economic impacts presented in the 2017-2022 GOM Multisale EIS. The 2017-2022 GOM Multisale EIS also provides a sense of the geographic patterns of economic impacts that could arise from changes to offshore oil and gas activities. In particular, the majority of the associated socioeconomic impacts would occur in coastal Texas and Louisiana, although some impacts (such as lost profits or lost oil and gas production) could be felt elsewhere. These impacts would depend on the state of the oil and gas industry as well as the overall economy. In 2017, the overall U.S. economy is reasonably healthy, but the offshore oil and gas industry is struggling with low energy prices (which is having a disproportionate impact on the Texas and Louisiana economies). If future oil and gas production were curtailed, energy prices could slightly increase and energy usage could slightly decrease. If Alternative D were to disrupt exploration plans, more oil and gas drilling in the AOI would depend on existing geophysical data. In addition, oil and gas companies may choose to focus exploration and development activities in lower-risk areas without survey restrictions. These alternative areas might be elsewhere within the Gulf of Mexico, though companies could also choose to expand production internationally. Alternative D would also indirectly contribute to some **minor** negative economic impacts of routine offshore oil and gas activities. For example, the OCS Program supports vessel traffic and offshore structures that can conflict with industries, such as shipping, fishing, and tourism. However, these various potential impacts are expected to be limited because Alternative D is not forecasted to substantially disrupt oil and gas exploration, development, and production. Detailed information regarding the economic impacts of the OCS Program can be found in Chapter 4.2.1.23 of the 2017-2022 GOM Multisale EIS.

Loss in HRG survey activities that include subbottom profilers, side-scan sonar, and/or echosounders would negatively impact renewable energy or marine minerals development. However, substantial renewable energy development in the GOM is not expected in the near future. The immediate effects of disruptions to marine minerals development would be significant because OCS sand resources are the only viable option for many coastal restoration projects, especially offshore Louisiana, Mississippi, and parts of Florida. Identification and exploitation of new sand sources in Federal waters is integral to multiple Gulf Coast restoration programs and projects. There is an initiative underway with BOEM, USGS, and Gulf Coast States to develop a Gulfwide offshore sand inventory. During mineral extraction operations, bathymetric surveys are required to ensure that sensitive habitats are not impacted and that infrastructure setback buffers are not compromised, and to track the volume of mineral production. In addition, the vessels used for marine minerals will be less impacted than vessels used for oil and gas exploration marine minerals vessels typically are smaller and do not use seismic airgun techniques. The non-airgun survey protocol could increase costs for marine minerals projects.

Overall, the economic impacts of Alternative D are expected to be **beneficial** to **moderate**. The beneficial impacts will arise because most G&G activities, and the resultant oil and gas activities, will continue. The extent of the negative impacts of Alternative D will depend on the extent of the increased costs, inefficiencies, and changes in oil and gas activities.

4.13.5.2 Impacts of an Accidental Spill

An accidental event could result in the release of fuel or diesel by a survey vessel. Based on USCG spill statistics, a spill scenario that assumes a diesel spill volume of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. In addition, any damage and harm done would be small relative to the size of local economies and populations. The diesel spill would be addressed via the use of vessels and local spill-response capabilities. Detailed information regarding the economic and social impacts of accidental events arising from the offshore oil and gas industry can be found in the 2017-2022 GOM Multisale EIS.

4.13.5.3 Cumulative Impacts

4.13.5.3.1 OCS Program G&G Survey Activities

The G&G survey activities considered in this Programmatic EIS will occur in the context of previously permitted G&G activities or other activities that would not be impacted by the considered mitigations. In addition, the G&G survey activities would contribute to the impacts of the overall OCS oil and gas leasing program. For example, the OCS Program supports economic activity and oil and gas infrastructure along the Gulf Coast. However, the OCS Program can also lead to adverse impacts arising from accidental events and completion for resources with other industries. A detailed impacts assessment of the cumulative scenario is provided in Alternative A (**Chapter 4.13.2.3**).

4.13.5.3.2 Activities Other Than OCS Program G&G Survey Activities

Other major factors not associated with the OCS Program encompass all human activities and natural processes that may affect land use and coastal infrastructure, environmental justice, demographics, and economic factors. Some of the key IPFs that have the potential to affect human resources, land use, and economics include (1) Federal and State oil and gas activity; (2) agricultural and aquaculture uses; (3) urbanization and demographic shifts (i.e., in-migration and out-migration); (4) evolution of State and Federal regulations; (5) global, national, and regional economic trends; (6) tourism; (7) coastal land loss; and (8) natural events and processes. A detailed assessment of these cumulative impacts is provided in Alternative A (**Chapter 4.13.2.3.2**).

4.13.5.3.3 Cumulative Impact Conclusions

The incremental cumulative impacts of Alternative D to human resources, land use, and economics are expected to be **beneficial** to **moderate**, depending upon the ultimate costs and inefficiencies of the mitigation measures.

4.13.6 Impacts – Alternative E (Alternative C at Reduced Activity Levels)

4.13.6.1 Impacts of Routine Events

4.13.6.1.1 Land Use and Coastal Infrastructure

The G&G activities associated with Alternative E would maintain current uses of Gulf Coast ports, which are described in **Chapter 4.13.1.1**. Because vessels would be expected to be between 20 and 100 m (66 and 328 ft) in length, they would require modest berthing space. All major ports described previously can regularly accommodate much larger cargo vessels. The larger survey vessels used for oil and gas seismic exploration could spend up to a year at sea; during surveys, crew changes and replenishment of supplies would be conducted on a regular basis using smaller service vessels. Larger seismic vessels may visit a shore base periodically (e.g., for repairs and equipment replacement that cannot be done at sea). Smaller vessels used for renewable energy and marine mineral surveys and sampling would typically return to their shore bases daily, averaging less than 4 trips/day over the 10-year period and divided among the major ports. The G&G-related traffic volume along the channels connecting ports to sea will not noticeably adversely affect the current use of such channels by commercial vessels. To the extent that specific projects include greater use of onshore bases and port channels, they would be subject to site-specific environmental reviews.

Alternative E could impact land use and coastal infrastructure because G&G activity levels and associated oil and gas activities could be curtailed. **Chapter 4.13.6.1.4** ("Regional Economic Factors") describes the changes to economic activity that could arise from Alternative E. The impacts to land use and coastal infrastructure would be correlated to these economic changes if the changes were large enough to disrupt infrastructure usage and if it were difficult for facilities to find substitute sources of business. Alternative E would also contribute to the impacts to land use and coastal infrastructure arising from the overall offshore oil and gas program. These impacts include impacts arising from changes in activity levels, expansions of existing infrastructure, new infrastructure facility construction, onshore waste disposal, navigation channel maintenance dredging, and accidental events. Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS provides more information regarding the impacts to land use and coastal infrastructure from overall offshore oil and gas activities. Since Alternative E would entail reductions of activities, both the positive and negative consequences of oil and gas development would be reduced. Overall, Alternative E would cause **beneficial** to **minor** impacts to land use and coastal infrastructure.

4.13.6.1.2 Environmental Justice

Chapter 4.13.1.2 identified potential environmental justice populations in the onshore area bordering the AOI. Alternative E could modestly impact patterns of land use, demographics, and economics that drive environmental justice considerations. However, G&G activities would be subject to site-specific environmental reviews, which would further identify and minimize environmental justice issues. In addition, the offshore oil and gas industry affects broad areas (and various groups within those areas) so there is no reason to suspect that specific environmental justice populations will be particularly impacted. Chapter 4.14.3.3 of the 2017-2022 GOM Multisale EIS provides further analysis of why BOEM's activities do not materially impact environmental justice. Therefore, the impacts of Alternative E on environmental justice are expected to be **beneficial** to **nominal**.

4.13.6.1.3 Demographics

The demographic impacts of Alternative E will be correlated with the impacts to regional economic factors, which are discussed in **Chapter 4.13.6.1.4**. The activity reductions could change economic variables, such as employoment, that drive demographic patterns. However, the actions associated with Alternative E are small relative to the myriad issues that will impact demographics over the timeframe of the proposed action; Chapter 4.14.2.1 of the 2017-2022 GOM Multisale EIS provides information regarding current and likely future demographic patterns. Therefore, the impacts of Alternative E on demographics are expected to be **minor**.

4.13.6.1.4 Regional Economic Factors

Under Alternative E, BOEM expects G&G activity to occur at the reduced levels predicted in **Tables 2.7-1 and 2.7-2**. Total reduction of deep-penetration, multi-client activities (in line miles) would decline by 10 percent (Alternative E1) or 25 percent (Alternative E2) from the estimated levels in a calendar year. Alternative E could increase costs over pre-Settlement Agreement levels (**Tables 4.13-5 and 4.13-6**). The cost of smaller airgun surveys such as HRGs and VSPs are more affected (9% to 30% cost increase) by the implementation of the extended PAM and extended PSO mitigation than larger surveys such as 2D, 3D, and 3D WAZ surveys (1% to 10% cost increase). Seasonal restrictions and additional marine mammal monitoring under the expanded PAM Program likely would reduce operational efficiencies by up to 9 percent due to increased shutdowns (**Table 4.13-7**).

The reduction of G&G survey line miles by 10 percent or 25 percent would lead to a corresponding reduction in the size of the G&G industry in the Gulf Coast region. The G&G industry in the GOM employs approximately 6,000 workers and generates approximately $2.94 billion in regional economic output (Eastern Research Group, Inc., 2011). Assuming employment and output are proportional to the amount of G&G activity occurring in the GOM, a decline in G&G survey line miles by 10 percent or 25 percent likely would result in the loss of approximately 600 to 1,500 jobs within the industry. In addition, economic output in the region would be expected to decline by approximately $294 million to $735 million a year (Eastern Research Group, Inc., 2011). Additional indirect and induced economic impacts would occur as a result of this action. As the size of the G&G industry contracts, workers in the industry would have less income to spend in the regional economy. At the same time, suppliers to the G&G industry would see demand for goods and services decrease. Revenues at local retail outlets and service providers would decline. As these local merchants respond to this decrease in demand, they may decrease employment at their operations and/or purchase fewer goods and services from their providers. These newly displaced workers and suppliers would also have less income to spend, thus “multiplying” the negative economic impacts of the reduction in G&G activity. The bulk of the negative socioeconomic impacts would likely occur in areas that currently have the largest concentration of G&G firms; therefore, Harris County, Texas, would experience most of the negative socioeconomic impacts. Fort Bend County, Texas, and Lafayette Parish, Louisiana, would also experience employment losses and economic impacts if G&G services in the GOM were curtailed by 10 percent or 25 percent.

Given the relative size of the communities where the majority of the G&G industry is located, any direct loss of employment associated with Alternative E is expected to have a limited impact on the regional economy. In 2014, average labor forces ranged in size from approximately 122,000 workers in Lafayette Parish to nearly 2.3 million workers in Harris County. In addition, these areas experienced low unemployment, with average unemployment rates of 4.9 percent or less

(U.S. Dept. of Labor, Bureau of Labor Statistics, 2015a, 2015b). Given the relative size of the regional labor market and the existing low unemployment rates, the majority of workers that are expected be displaced from the G&G industry under Alternative E would likely be able to find employment in other industries in the region.

Non-BOEM-regulated surveys for scientific research, BOEM activities not covered by this program (i.e., geophysical surveys for archaeological and/or benthic resources), and surveys that occur in State waters would not be affected by the proposed reduction in activity under Alternative E and would continue as normal. However, the proposed reduction in G&G survey activities under Alternative E could indirectly affect the oil and gas program. Potential bidders depend on new data acquisition for bid preparation prior to lease sales, and reduced G&G activity could prevent certain new bids or introduce an element of uncertainty in bid amounts, which could deter some drilling and decrease overall production in the GOM. Immediate effects would result from the inability of the oil and gas industry to collect as much G&G data as they could under the proposed action, an inability of BOEM to project accurate resource estimates, and additional costs could be incurred by oil and gas companies as more uncertainty would be introduced into the exploration process. As a result of the lack of G&G data, some areas in the GOM that have not undergone significant G&G surveys could become less desirable for oil and gas leasing purposes and may not be developed until the price of oil and gas increased to a level high enough to offset the risks associated with less data.

These disruptions would lead to indirect impacts to the oil and gas industry, indirect impacts to the associated supply chains, and induced impacts arising from spending reductions by workers. As discussed in Alternative C, the 2017-2022 GOM Multisale EIS provides ranges of economic impacts expected to arise from overall offshore oil and gas activities. While it is difficult to predict the exact magnitude of the decline in offshore oil and gas activities arising from Alternative E, the 2017-2022 GOM Multisale EIS estimates provide a sense of the patterns of economic impacts that would occur. In particular, the majority of the associated socioeconomic impacts would occur in coastal Texas and Louisiana, although some impacts (such as lost profits or lost oil and gas production) could be felt elsewhere. These impacts would depend on the state of the oil and gas industry as well as the overall economy. In 2017, the overall U.S. economy is reasonably healthy, but the offshore oil and gas industry is struggling with low energy prices (which is having a disproportionate impact on the Texas and Louisiana economies). If future oil and gas production were curtailed, energy prices could slightly increase, and energy usage could slightly decrease. In addition, oil and gas companies may choose to focus exploration and development activities in lower-risk areas without survey restrictions. These alternative areas might be elsewhere within the Gulf of Mexico, though companies could also choose to expand production internationally. In Chapter 3.1 of the 2017-2022 GOM Multisale EIS, BOEM developed a reasonable, robust range of oil and gas activity. After developing the alternatives for this Programmatic EIS, BOEM determined that the scenario described in the 2017-2022 GOM Multisale EIS is broad enough to encompass any indirect effects to the oil and gas industry from the range of G&G activity described in Alternative E. In addition, the 2017-2022 GOM Multisale EIS provides a sense of the geographic patterns of economic impacts that arise due to offshore oil and gas activities. Refer to Alternative C for a discussion of the economic impacts of these mitigations. Also refer to Alternative C for a discussion of the impacts of the G&G industry on overall oil and gas activities, which are expected to be **beneficial** to **minor**. Also, depending on the procedures that industry were accustomed to following prior to the Settlement Agreement, some increases in cost (including PAM installation) may not be a new cost burden, though they are conservatively considered here (refer to **Chapter 4.13.2.1.4** for further discussion). Alternative E would also entail the implementation of a non-airgun HRG survey protocol. This protocol would increase the costs of non-airgun HRG suveys up to 11 percent.

Loss in HRG survey activities that include subbottom profilers, side-scan sonar, and/or echosounders would negatively impact renewable energy or marine minerals development. However, substantial renewable energy development in the GOM is not expected in the near future. The immediate effects of disruptions to marine minerals development would be significant because OCS sand resources are the only viable option for many coastal restoration projects, especially offshore Louisiana, Mississippi, and parts of Florida. Identification and exploitation of new sand sources in Federal waters is integral to multiple Gulf Coast restoration programs and projects. There is an initiative underway with BOEM, USGS, and the Gulf Coast States to develop a Gulfwide offshore sand inventory. During mineral extraction operations, bathymetric surveys are required to ensure that sensitive habitats are not impacted and that infrastructure setback buffers are not compromised, and to track the volume of mineral production. In addition, the vessels used for marine minerals will be less impacted than vessels used for oil and gas exploration marine minerals vessels typically are smaller and do not use seismic airgun techniques. The non-airgun survey protocol could increase costs for marine minerals projects.

Overall, Alternative E would have **minor** to **moderate** economic impacts. The impacts would depend on the ultimate reductions in G&G activities, as well as the corresponding impacts on offshore oil and gas development and production.

4.13.6.2 Impacts of an Accidental Spill

An accidental event could result in the release of fuel or diesel by a survey vessel. Based on USCG spill statistics, a spill scenario that assumes a diesel spill volume of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. In addition, any damage and harm done would be small relative to the size of local economies and populations. The diesel spill would be addressed via the use of vessels and local spill-response capabilities. Detailed information regarding the economic and social impacts of accidental events arising from the offshore oil and gas industry can be found in the 2017-2022 GOM Multisale EIS.

4.13.6.3 Cumulative Impacts

4.13.6.3.1 OCS Program G&G Survey Activities

The G&G survey activities considered in this Programmatic EIS will occur in the context of previously permitted G&G activities or other activities that would not be impacted by the considered mitigations. In addition, the G&G survey activities would contribute to the impacts of the overall OCS oil and gas leasing program. For example, the OCS Program supports economic activity and oil and gas infrastructure along the Gulf Coast. However, the OCS Program can also lead to adverse impacts arising from accidental events and completion for resources with other industries. A detailed impacts assessment of the cumulative scenario is provided in Alternative A (**Chapter 4.13.2.3**).

4.13.6.3.2 Activities Other Than OCS Program G&G Survey Activities

Other major factors not associated with the OCS Program encompass all human activities and natural processes that may affect land use and coastal infrastructure, environmental justice, demographics, and economic factors. Some of the key IPFs that have the potential to affect human resources, land use, and economics include (1) Federal and State oil and gas activity; (2) agricultural and aquaculture uses; (3) urbanization and demographic shifts (i.e., in-migration and out-migration); (4) evolution of State and Federal regulations; (5) global, national, and regional economic trends; (6) tourism; (7) coastal land loss; and (8) natural events and processes. A detailed assessment of these cumulative impacts is provided in Alternative A (**Chapter 4.13.2.3.2**).

4.13.6.3.3 Cumulative Impact Conclusions

The incremental cumulative impacts of Alternative E to human resources, land use, and economics are expected to be **beneficial** to **moderate**. The impacts would depend on the causes of the declines in G&G activities, as well as the resultant supply chain impacts.

4.13.7 Impacts – Alternative F (Alternative C Plus Area Closures)

4.13.7.1 Impacts of Routine Events

4.13.7.1.1 Land Use and Coastal Infrastructure

The G&G activities associated with Alternative F would maintain current uses of Gulf Coast ports, which are described in **Chapter 4.13.1.1**. Because vessels would be expected to be between 20 and 100 m (66 and 328 ft) in length, they would require modest berthing space. All major ports described previously can regularly accommodate much larger cargo vessels. The larger survey vessels used for oil and gas seismic exploration could spend up to a year at sea; during surveys, crew changes and replenishment of supplies would be conducted on a regular basis using smaller service vessels. Larger seismic vessels may visit a shore base periodically (e.g., for repairs and equipment replacement that cannot be done at sea). Smaller vessels used for renewable energy and marine mineral surveys and sampling would typically return to their shore bases daily, averaging less than 4 trips/day over the 10-year period and divided among the major ports. The G&G-related traffic volume along the channels connecting ports to sea will not noticeably adversely affect the current use of such channels by commercial vessels. To the extent that specific projects include greater use of onshore bases and port channels, they would be subject to site-specific environmental reviews.

Chapter 4.13.3.1.4 (“Regional Economic Factors”) describes the changes to economic activity that could arise from Alternative F. Alternative F, particularly the CPA Closure Area, could have important impacts to economic activity. The impacts to land use and coastal infrastructure would be correlated to these economic changes if the changes were large enough to disrupt infrastructure usage and if it were difficult for facilities to find substitute sources of business. Alternative F would also contribute to the impacts to land use and coastal infrastructure arising from the overall offshore oil and gas program. These include impacts arising from changes in activity levels, expansions of existing infrastructure, new infrastructure facility construction, onshore waste disposal, navigation channel maintenance dredging, and accidental events. Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS provides more information regarding the impacts to land use and coastal infrastructure from overall offshore oil and gas activities. Since Alternative F would entail reductions of activities, both the positive and negative consequences of oil and gas development would be reduced. Overall, Alternative F would cause **beneficial** to **minor** impacts to land use and coastal infrastructure.

4.13.7.1.2 Environmental Justice

Chapter 4.13.1.2 identified potential environmental justice populations in the onshore area bordering the AOI. Alternative F could modestly impact patterns of land use, demographics, and economics that drive environmental justice considerations. However, G&G activities would be subject to site-specific environmental reviews, which would further identify and minimize environmental justice issues. In addition, the offshore oil and gas industry affects broad areas (and various groups within those areas) so there is no reason to suspect that specific environmental justice populations will be particularly impacted. Chapter 4.14.3.3 of the 2017-2022 GOM Multisale EIS provides further analysis of why BOEM's activities do not materially impact environmental justice. Therefore, the impacts of Alternative F on environmental justice are expected to be **beneficial** to **nominal**.

4.13.7.1.3 Demographics

The demographic impacts of Alternative F will be correlated with the impacts to regional economic factors, which are discussed in **Chapter 4.13.7.1.4**. Alternative F, particularly the CPA Closure Area, could change economic variables, such as employoment, that drive demographic patterns. However, the actions associated with Alternative F are small relative to the myriad issues that will impact demographics over the timeframe of the proposed action; Chapter 4.14.2.1 of the 2017-2022 GOM Multisale EIS provides information regarding current and likely future demographic patterns. Therefore, the impacts of Alternative F on demographics are expected to be **minor**.

4.13.7.1.4 Regional Economic Factors

Under Alternative F, BOEM would continue to permit G&G activities and require that operators comply with mitigation requirements carried forward from Alternatives A and C, with the addition of four area closures to provide additional protection for certain cetaceans and other resources. The mitigation measures would increase costs over pre-Settlement Agreement levels (**Tables 4.13-5 and 4.13-6**). The cost of smaller airgun surveys such as HRGs and VSPs are more affected (9% to 30% cost increase) by the implementation of the extended PAM and extended PSO mitigation than larger surveys such as 2D, 3D, and 3D WAZ surveys (1% to 10% cost increase). The seasonal restrictions and additional marine mammal monitoring under the expanded PAM Program would likely reduce operational efficiencies by up to 9 percent due to increased shut downs (**Table 4.13-7**).

Under Alternative F, all proposed oil and gas drilling in the four closure areas would depend on existing seismic data. The CPA Closure Area is a particularly prolific and important area for offshore oil and gas activities. Industrial Economics, Inc. (2016) estimates that the closure areas account for 22 percent of active leases, 27 percent of proposed platforms, 34 percent of oil production (from 2012 to 2016), and 22 percent of natural gas production (from 2012 to 2016). The 2017-2022 GOM Multisale EIS provides information regarding the existing amounts of seismic coverage in various areas in the GOM. There are some levels of seismic coverage for many parts of the CPA Closure Area. However, the closure areas would prevent conducting seismic surveys in these areas using more advanced methods, particularly as continually evolving technology expands the frontiers of oil and gas development. As a result, basins that have not undergone sufficient G&G surveys prior to area closures would become less desirable for oil and gas leasing purposes and may be developed at a slower pace as oil and gas companies focus on lower-risk areas without survey restrictions. Additional costs would be incurred by oil and gas companies as more uncertainty would be introduced into the exploration process, potentially increasing exploratory drilling. If the closure areas have not undergone sufficient G&G surveys prior to cessation, they would become less desirable for oil and gas leasing purposes and may not be developed. Any oil and gas development that is displaced from the closure areas would be replaced by the development of reserves that companies expect to be of lower quality or more difficult to extract. The design and placement of new oil rigs and platforms in closure areas would become less certain as site-specific G&G surveys would not be available to guide them, making interference of geohazards a greater possibility and construction of structures more risky. Additional engineering and construction costs likely would be incurred to compensate for the lack of geohazard information. Finally, Alternative F would restrict oil and gas development to a smaller geographic area, which could introduce space-use conflicts among G&G companies attempting to survey within the smaller area.

These disruptions would lead to indirect impacts to the oil and gas industry, indirect impacts to the associated supply chains, and induced impacts arising from spending reductions by workers. As discussed in Alternative C, the 2017-2022 GOM Multisale EIS provides ranges of economic impacts expected to arise from overall offshore oil and gas activities. While it is difficult to predict the exact magnitude of the decline in offshore oil and gas activities arising from Alternative F, the 2017-2022 GOM Multisale EIS estimates provide a sense of the patterns of economic impacts that would occur. In particular, the majority of the associated socioeconomic impacts would occur in coastal Texas and Louisiana, although some impacts (such as lost profits or lost oil and gas production) could be felt elsewhere. These impacts would depend on the state of the oil and gas industry as well as the overall economy. In 2017, the overall U.S. economy is reasonably healthy, but the offshore oil and gas industry is struggling with low energy prices (which is having a disproportionate impact on the Texas and Louisiana economies). If future oil and gas production were curtailed, energy prices could slightly increase and energy usage could slightly decrease. In addition, oil and gas companies may choose to focus exploration and development activities in lower-risk areas without survey restrictions. These alternative areas might be elsewhere within the Gulf of Mexico, though companies could also choose to expand production internationally. In Chapter 3.1 of the 2017-2022 GOM Multisale EIS, BOEM developed a reasonable, robust range of oil and gas activity. After developing the alternatives for this Programmatic EIS, BOEM determined that the scenario described in the 2017-2022 GOM Multisale EIS is broad enough to encompass any indirect effects to the oil and gas industry from the range of G&G activity described in Alternative F. In addition, the 2017-2022 GOM Multisale EIS provides a sense of the geographic patterns of economic impacts that arise due to offshore oil and gas activities. Refer to Alternative C for a discussion of the economic impacts of these mitigations. Also refer to Alternative C for a discussion of the impacts of the G&G industry on overall oil and gas activities, which are expected to be **beneficial** to **minor**. However, the area closures, particularly the CPA Closure Area, would cause more noticeable economic impacts in Alternative F than under Alternative C. Depending on the procedures that industry were accustomed to following prior to the Settlement Agreement, some increases in cost (including PAM installation) may not be a new cost burden, though they are conservatively considered here (refer to **Chapter 4.13.2.1.4** for further discussion). Alternative F would also entail the implementation of a non-airgun HRG survey protocol. This protocol would increase the costs of non-airgun HRG suveys up to 11 percent.

Loss in HRG survey activities that include subbottom profilers, side-scan sonar, and/or echosounders would negatively impact renewable energy or marine minerals development. However, substantial renewable energy development in the GOM is not expected in the near future. The immediate effects of disruptions to marine minerals development would be significant because OCS sand resources are the only viable option for many coastal restoration projects, especially offshore Louisiana, Mississippi, and parts of Florida. Identification and exploitation of new sand sources in Federal waters is integral to multiple Gulf Coast restoration programs and projects. There is an initiative underway with BOEM, USGS, and the Gulf Coast States to develop a Gulfwide offshore sand inventory. During mineral extraction operations, bathymetric surveys are required to ensure that sensitive habitats are not impacted and that infrastructure setback buffers are not compromised, and to track the volume of mineral production. In addition, the vessels used for marine minerals will be less impacted than vessels used for oil and gas exploration marine minerals vessels typically are smaller and do not use seismic airgun techniques. The non-airgun survey protocol could increase costs for marine minerals projects.

Considering these factors, the socioeconomic impacts of Alternative F are expected to be **minor** to **moderate**. The exact impacts will depend on the extent to which existing seismic data coverage can fulfill the oil and gas industry’s exploration and development plans in the closure areas.

4.13.7.2 Impacts of an Accidental Spill

An accidental event could result in the release of fuel or diesel by a survey vessel. Based on USCG spill statistics, a spill scenario that assumes a diesel spill volume of 1.2 to 7.1 bbl was developed in **Chapter 3.3.2**. In addition, any damage and harm done would be small relative to the size of local economies and populations. The diesel spill would be addressed via the use of vessels and local spill-response capabilities. Detailed information regarding the economic and social impacts of accidental events arising from the offshore oil and gas industry can be found in the 2017-2022 GOM Multisale EIS.

4.13.7.3 Cumulative Impacts

4.13.7.3.1 OCS Program G&G Survey Activities

The G&G survey activities considered in this Programmatic EIS will occur in the context of previously permitted G&G activities or other activities that would not be impacted by the considered mitigations. In addition, the G&G survey activities would contribute to the impacts of the overall OCS oil and gas leasing program. For example, the OCS Program supports economic activity and oil and gas infrastructure along the Gulf Coast. However, the OCS Program can also lead to adverse impacts arising from accidental events and completion for resources with other industries. A detailed impacts assessment of the cumulative scenario is provided in Alternative A (**Chapter 4.13.2.3**).

4.13.7.3.2 Activities Other Than OCS Program G&G Survey Activities

Other major factors not associated with the OCS Program encompass all human activities and natural processes that may affect land use and coastal infrastructure, environmental justice, demographics, and economic factors. Some of the key IPFs that have the potential to affect human resources, land use, and economics include (1) Federal and State oil and gas activity; (2) agricultural and aquaculture uses; (3) urbanization and demographic shifts (i.e., in-migration and out-migration); (4) evolution of State and Federal regulations; (5) global, national, and regional economic trends; (6) tourism; (7) coastal land loss; and (8) natural events and processes. A detailed assessment of these cumulative impacts is provided in Alternative A (**Chapter 4.13.2.3.2**).

4.13.7.3.3 Cumulative Impact Conclusions

The incremental cumulative impacts of Alternative F to human resources, land use, and economics are expected to be **beneficial** to **moderate**. The impacts would depend on the ability of the oil and gas industry to use existing seismic data and the industry's ability to substitute among lease locations.

4.13.8 Impacts – Alternative G (No New Activity Alternative)

4.13.8.1 Land Use and Coastal Infrastructure

Alternative G could substantially impact economic patterns in the Gulf of Mexico. These economic changes would be large enough to impact the usage of certain types of coastal infrastructure that are utilized by the offshore oil and gas industry. Chapter 4.14.1 of the 2017-2022 GOM Multisale EIS provides more information regarding the impacts to land use and coastal infrastructure from overall offshore oil and gas activities. These include impacts from changes in the levels of OCS exploration, development, and production activities; expansions of existing infrastructure; new infrastructure facility construction; onshore waste disposal; navigation channel maintenance dredging; and accidental events. Alternative G would entail reducing these impacts to land use and coastal infrastructure arising from offshore oil and gas activities. Alternative G could also lead to economic adjustments in the energy industry, such as increased production from existing Federal and State leases, increased oil imports, and decreased consumption. These adjustments would entail their own impacts to land use and coastal infrastructure. For example, an oil spill arising from increased energy imports would have negative impacts on land use and coastal infrastructure. In aggregate, Alternative G would cause **minor** to **moderate** impacts to land use and coastal infrastructure. The exact impacts will depend on the size and speed of the adjustments in the offshore oil and gas industry.

4.13.8.2 Environmental Justice

Chapter 4.13.1.2 identified potential environmental justice populations in the onshore area bordering the AOI. Alternative G would reduce environmental justice impacts arising from the overall offshore oil and gas industry. However, as discussed in Chapter 4.14.3.3 of the 2017-2022 GOM Multisale EIS, the environmental justice impacts of offshore oil and gas activities are limited. Alternative G would also lead to adjustments in the energy industry, which could lead to some modest impacts. For example, if oil and gas production from onshore areas were to increase, some communities could experience increased noise, air emmissions, and space-use conflicts. Alternative G would lessen the risk of an offshore oil spill, but it would increase the risk of a spill from oil imports. In aggregate, the impacts of Alternative G on environmental justice are expected to be **minor**. The exact impacts would depend on the nature of the economic adjustments that occur.

4.13.8.3 Demographics

The demographic impacts of Alternative G will be correlated with the impacts to regional economic factors, which are discussed in **Chapter 4.13.3.1.4**. Alternative G could substantially impact employment and income, which could disrupt existing demographic patterns. However, disruptions to the oil and gas industry would be widely dispursed, lessening the changes to overall demographic patterns. In addition, there are a myriad of other issues that will impact demographics over the timeframe of the proposed action; Chapter 4.14.2.1 of the 2017-2022 GOM Multisale EIS provides information regarding current and likely future demographic patterns. Therefore, the impacts of Alternative G on demographics are expected to be **minor** to **moderate**.

4.13.8.4 Regional Economic Factors

Under Alternative G, no new G&G activities associated with the development of oil and gas reserves, renewable energy, or marine minerals would be authorized to occur within the AOI during the 10-year period covered by this Programmatic EIS. Other G&G survey activities would be unaffected by this ban, including any that occur within State waters, those that are for scientific studies and regulated by other Federal agencies, and any BOEM non-regulated G&G activities (i.e., geophysical surveys for archaeological and benthic resources). In the short term, G&G activities already approved would be allowed to continue for the duration of their authorized permit/authorization; however, no additional permits/authorizations would be approved. In the long term, all BOEM-regulated G&G activities in the GOM would cease upon expiration of permits/authorizations.

Implementation of Alternative G would have a **major** negative economic impact on the G&G industry. According to estimates made by the Eastern Research Group, Inc. (2011), the G&G industry is a $2.94 billion industry that employs an estimated 5,870 to 6,128 workers in the Gulf Coast region. Restricting all G&G activities associated with the development of oil and gas reserves, renewable energy, and marine minerals as planned under Alternative G would result in widespread layoffs and business closures within the industry. While some economic activity and employment in the G&G industry would continue as work continued on survey activities not included in the proposed action and through the reprocessing of existing data, the total size of the G&G industry in the GOM would greatly contract. Additionally, a restriction of G&G activities would result in the loss of an important tool for exploration to identify the location and size of oil and gas prospects, particularly in deep water where exploration wells are expensive. Moreover, cessation of G&G activities would also result in the loss of an important tool for identifying areas for the development of renewable energy projects and exploration for non-energy marine minerals such as sand and gravel (or other sediment) for beach nourishment, coastal restoration, and public works projects.

As the size of the G&G industry contracts, workers in the industry would have less income to spend in the regional economy. At the same time, suppliers to the G&G industry would see demand for their goods and services decrease. Local merchants could respond to this decrease in demand by decreasing employment at their operations and/or purchasing fewer goods and services from their providers. The majority of the direct socioeconomic impacts associated with the cessation of all G&G activities under Alternative G would be concentrated in Harris and Fort Bend Counties in Texas and in Lafayette Parish in Louisiana.

The cessation of G&G activities under Alternative G would have a noticeable impact on the oil and gas industry throughout the Gulf Coast region. Immediate effects would result from the inability of the oil and gas industry to collect new G&G data once existing permits/leases expire. All proposed oil and gas drilling in the AOI would depend on existing geophysical data. Additional costs would be incurred by oil and gas companies as more uncertainty would be introduced into the exploration process, potentially increasing exploratory drilling. Areas in the GOM that have not undergone sufficient G&G surveys prior to cessation would become less desirable for oil and gas leasing purposes and may not be developed. The design and placement of new oil rigs and platforms would become less certain as site-specific G&G surveys would not be available to guide the placement of new rigs and platforms, making the interference of geohazards a greater possibility and the construction of structures more risky. Additional engineering and construction costs would likely be incurred to compensate for the lack of geohazard information. The cessation of G&G activities would eventually threaten all components of the offshore oil and gas industry. Employment and income related to oil and gas exploration, development, and production would decline. Oil and gas production would gradually decline, which would increase prices and the United States' reliance on onshore and foreign energy sources. The U.S. Government's revenues from rentals, royalties, and bonus bids would also decline. The 2017-2022 GOM Multisale EIS provides estimates of the economic activity supported by offshore oil and gas activities, and thus informs the level of negative impacts that could arise from Alternative G. However, these effects could eventually be partially offset by the development of new technologies that would not be subject to Alternative G.

Alternative G would hinder any development of potential renewable energy leases by eliminating any opportunity for geological safety and characterization surveys. This would slow job growth in alternative energy production and hinder the transition from fossil fuels to non-traditional power sources. Although there currently are no active renewable energy projects in the GOM, this could drastically slow potential GOM job growth for this industry and hinder production of renewable energy from Federal waters. This could increase the time needed to switch from fossil fuels to renewable energy and could increase domestic dependency on foreign sources of fossil fuels.

Under Alternative G, all G&G activities for marine minerals would cease for the 10-year duration of this Programmatic EIS; thus, locating and securing new significant quantities of sedimentary resources would become more difficult and costly. State and local governments would be limited to utilizing only known resources or would need to acquire marine mineral resources from other areas. The immediate effects of disruptions to marine minerals development would be significant because OCS sand resources are the only viable option for many coastal restoration projects, especially offshore Louisiana, Mississippi, and parts of Florida. Identification and exploitation of new sand sources in Federal waters is integral to multiple Gulf Coast restoration programs and projects. There is an initiative underway with BOEM, USGS, and the Gulf Coast States to develop a Gulfwide offshore sand inventory. During mineral extraction operations, bathymetric surveys are required to ensure that sensitive habitats are not impacted and that infrastructure setback buffers are not compromised, and to track the volume of mineral production. A cessation of G&G activity would result in a limited capacity to address coastal erosion issues. Restoration projects would have to become more prioritized due to the availability of mineral resources. This could potentially restrict the number of projects, which could have increased risks and economic burdens.

The economic impacts of Alternative G would be **moderate** to **major**, depending on the impacted sector and on the pace of economic adjustments.

4.13.8.5 Cumulative Impacts

4.13.8.5.1 OCS Program G&G Survey Activities

The G&G survey activities considered in this Programmatic EIS will occur in the context of previously permitted G&G activities or other activities that would not be impacted by the considered mitigations. In addition, the decline in G&G survey activities would impact the overall OCS oil and gas leasing program. For example, the OCS Program supports economic activity and oil and gas infrastructure along the Gulf Coast. However, the OCS Program can also lead to adverse impacts arising from accidental events and completion for resources with other industries. A detailed impacts assessment of the cumulative scenario is provided in Alternative A (**Chapter 4.13.2.3**).

4.13.8.5.2 Activities Other Than OCS Program G&G Survey Activities

Other major factors not associated with the OCS Program encompass all human activities and natural processes that may affect land use and coastal infrastructure, environmental justice, demographics, and economic factors. Some of the key IPFs that have the potential to affect human resources, land use, and economics include (1) Federal and State oil and gas activity; (2) agricultural and aquaculture uses; (3) urbanization and demographic shifts (i.e., in-migration and out-migration); (4) evolution of State and Federal regulations; (5) global, national, and regional economic trends; (6) tourism; (7) coastal land loss; and (8) natural events and processes. A detailed assessment of these cumulative impacts is provided in Alternative A (**Chapter 4.13.2.3.2**).

4.13.8.5.3 Cumulative Impact Conclusions

The incremental cumulative impacts of Alternative G to human resources, land use, and economics are expected to be **beneficial** to **major**. This is because Alternative G could have far-reaching effects on people and businesses that depend on the offshore oil and gas industry.

4.13.9 Summary Conclusion

In summary, G&G activities offshore in the GOM impact the human environment onshore, including land use and coastal infrastructure, environmental justice, demographics, and the regional economy along the Gulf Coast. Activities on the OCS are supported by onshore facilities, which can impact the human environment. The selection of Alternatives A through D or F would support current activity levels in industries that depend on G&G surveying, which would have substantial **positive** economic impacts. However, these alternatives would also entail some negative economic impacts arising from costs, inefficiencies, accidental events, and supply chain impacts. These negative impacts are expected to be **minor** for Alternatives A and C. The negative impacts could become **moderate** for Alternatives B and D through F, depending on the ultimate introduced costs and inefficiencies, as well on how the offshore oil and gas industry adjusts its practices. The negative impacts of Alternative G would be **moderate** to **major** since it would substantially disrupt existing industries, supply chains, and energy consumers.

CHAPTER 5

OTHER NEPA CONSIDERATIONS

5 OTHER NEPA CONSIDERATIONS

5.1 UNAVOIDABLE ADVERSE IMPACTS OF THE PROPOSED ACTION

The NEPA regulations require an EIS to disclose any adverse environmental effects that cannot be avoided should the proposed action be implemented (40 CFR § 1502.16). While numerous effects to physical; ecological; and social, cultural, and economic resources can be avoided and minimized by adherence to regulations, guidance, and conventions; utilization of best management practices and industry standards; and implementation of mitigation measures, some unavoidable adverse effects associated with the proposed action can be expected to remain regardless of avoidance, minimization, and mitigation.

The use of airguns during seismic surveys would result in unavoidable Level B harassment of marine mammals and may cause behavioral responses in sea turtles, fishes, and marine and coastal birds. Mortality to marine mammals and sea turtles is not expected, and physical injury to marine mammals and sea turtles is expected to be avoided to the maximum extent practicable through protective measures included in the proposed action, including an exclusion zone and operational mitigation measures as described in **Chapters 2 and 4 and Appendix B**. However, some marine mammals may be exposed to sound levels that constitute Level A harassment (short of mortality) and that may induce TTS or PTS.

The behavioral impacts to marine mammals anticipated as a result of the proposed action analyzed in this Programmatic EIS are short-term disruption of behavioral patterns, abandonment of activities, and/or temporary displacement from discrete areas. Due to the extensive mitigations in the proposed action, no serious injuries are anticipated.

During non-airgun HRG surveys, the use of other acoustic sources such as side-scan sonars; boomer, sparker, and CHIRP subbottom profilers; and MBESs may cause behavioral responses in marine mammals that would also constitute Level B harassment. Mortality to marine mammals and sea turtles is not expected, and physical injury to marine mammals and sea turtles is expected to be avoided through protective measures included in the proposed action, including exclusion zone closures and operational mitigation measures, as described in **Chapters 2 and 4**. It is highly unlikely that animals would be exposed to sound levels that constitute Level A harassment (in marine mammals) or that may induce TTS or PTS during non-airgun HRG surveys. Non-routine effects to marine mammals, sea turtles, marine and coastal birds, fishes, and EFH that would be unavoidable and adverse would include direct exposure to fuel spills as some individuals may not recover from exposure.

Some other unavoidable adverse effects on marine life would be expected to occur as a result of the proposed action. For example, seafloor-disturbing activities such as geological and geotechnical sampling and placement of bottom-founded equipment or structures would inevitably disturb soft bottom benthic habitat. Short-term disturbances could include resuspension of seafloor sediments with very limited burial and rapid recolonization; no long-term impacts would be anticipated. Impacts to sensitive benthic communities (i.e., coral, hard/live bottom, and chemosynthetic communities) are expected to be avoided because BOEM requires site-specific information prior to approving any G&G activities involving seafloor-disturbing activities or placement of bottom-founded equipment or structures in the AOI.

Unavoidable adverse effects from routine operations to archaeological resources would be avoided and minimized with existing regulations; however, there is always a risk of unavoidable adverse impacts to archaeological resources where surveys are not required, inadequate, or unavailable.

5.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Section 102(2)(c)(ii) of NEPA requires an EIS to identify irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented. Resources include renewable and non-renewable natural resources, such as marine organisms and their habitat. A commitment of a resource is considered irreversible when the primary or secondary impacts from its use limit future options for its use. The commitment of resources applies primarily to the effects of use of non-renewable resources, which are resources that cannot be replenished by natural means (e.g., oil, natural gas, iron ore, and cultural resources). An irretrievable commitment refers to the use or consumption of a resource that is neither renewable nor recoverable (e.g., the disturbance of a cultural site) for use by future generations.

The proposed action would provide for the continued implementation of the permitting/authorization process to allow industry to conduct surveys to investigate the geology and geophysics of the seafloor within the AOI. All G&G activities would require additional BOEM environmental reviews and approvals prior to the commencement of any “on water” activities that could impact the environment. At the time of these environmental reviews, BOEM has the opportunity to request or require additional mitigations, if warranted. In addition, the Secretary of the Interior retains the discretion under the OCSLA to, among others, cancel or suspend plans, activities, and permits at any time, so as to protect the environment (refer to 43 U.S.C. § 1334(a)). Finally, for G&G activities related to renewable energy, BOEM requires that post-lease G&G activities comply with mitigation measures included in the lease stipulations.

In terms of renewable resources, should the proposed action proceed and ultimately result in G&G activities, the activities would not result in the destruction of marine resources such that the range of potential uses of the marine environment would be limited. In general, the impact of routine operations would not constitute an irreversible and irretrievable commitment of biological resources. Displacement and habitat loss may result in the reduction of some local populations and become irretrievable if alterations to the environment were permanently maintained; however, the degree of displacement and habitat loss would represent a transitory and negligible effect on the overall populations of most species. No critical habitat associated with threatened or endangered species would be lost as a result of implementation of the proposed action and subsequent implementation of G&G activities, should they occur. Non-renewable resources consumed during the operation of survey vessels, should G&G activities proceed, include the consumption of ship and aircraft fuel.

Proposed surveys would also require a commitment of human labor and financial resources. Because the reuse of these resources may not be possible, they would be irreversibly and irretrievably committed as part of the proposed action. Nonetheless, the commitment of resources is not expected to be significant.

5.3 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The NEPA regulations require that an EIS include an analysis of the relationship between a project's short-term use of the environment and the potential that those impacts may have on the maintenance and enhancement of long-term productivity in the affected environment (40 CFR § 1502.16). Impacts that narrow the range of beneficial uses of the environment are of particular concern. The proposed G&G surveys would allow industry to investigate the geology and geophysics of the subsurface within the AOI. This action would require short-term and long-term commitments of human labor and financial resources.

The impact analysis presented in **Chapter 4** considers these factors. Individual G&G surveys tend to be of short duration (from a few months to less than a year), transient, and in a limited geographic location compared with the Gulf of Mexico generally. Non-renewable resources that would be consumed during the operation of seismic research vessels include fuel and oil, and likely would result in short-term air emissions, but the magnitude of emissions likely would not be noticeable over the long term. The planned monitoring and mitigation measures, which include avoiding sensitive habitats and seasonally important areas, visual monitoring, and an exclusion zone, would minimize the effects of the proposed surveys. These potential direct effects would be short term, in avoiding exposures or minimizing the thresholds at which there are exposures. Long-term effects would tend to be more indirect, with impacts to the health of the population that may be possible as well, but minimized through these mitigations. Although some space-use conflicts with species or resources may occur, they are unlikely to cause impacts to certain unique resources or at population- or fitness-level effects. They would also tend to be localized, transient, and short term. Therefore, implementation of the proposed action would not reasonably be expected to result in any environmental impacts that would significantly affect the maintenance and enhancement of long-term productivity of the marine environment (**Chapter 4**).

CHAPTER 6

PUBLIC INVOLVEMENT AND AGENCY CONSULTATION AND COORDINATION

6 PUBLIC INVOLVEMENT AND AGENCY CONSULTATION AND COORDINATION

6.1 DEVELOPMENT OF THE PROPOSED ACTION

BOEM prepared this Programmatic EIS to evaluate reasonably foreseeable impacts to the marine environment from G&G survey activities in Federal and State waters from the coastline out to the EEZ within the WPA, CPA, and EPA for the three program areas, i.e., oil and gas, renewable energy, and marine minerals. BOEM conducted early coordination with appropriate Federal and State agencies and other concerned parties to develop the proposed action in this Programmatic EIS. Key agencies and organizations were contacted, including FWS, NOAA, USACE, USDOD, and National Aeronautics and Space Administration. The BSEE and NOAA are acting as cooperating agencies. **Chapter 6.3.3** further discusses the cooperating agency process and the respective roles of cooperating agencies. Based on the information and analysis presented in **Chapter 4**, this Programmatic EIS presents the environmental impacts of the proposed action and the alternatives in comparative form, defining the issues and providing a clear basis for choice among alternatives by the decisionmaker.

6.2 NOTICE OF INTENT

The NMFS previously initiated the scoping process in 2004 for the purpose of soliciting comments from stakeholders on the scope of a Draft Programmatic EIS, identifying issues to be analyzed, and developing possible alternatives and mitigating measures. BOEM reinitiated the scoping process through an NOI with a public comment period and a series of public meetings in 2013. BOEM published an NOI on May 10, 2013, announcing its intent to prepare, cooperatively with NOAA, a Programmatic EIS to evaluate potential environmental effects of multiple G&G activities in OCS waters of the GOM, extending from the coastline to the seaward boundary of the EEZ (*Federal Register*, 2013a). The NOI included dates, times, and locations for scoping meetings (**Chapter 6.3.1**). The public comment period was initially set to close on June 24, 2013; however, BOEM issued a correction to the NOI on June 5, 2013 (*Federal Register*, 2013d), changing the date for closing the public comment period to July 9, 2013.

6.3 SCOPING AND DEVELOPMENT OF THE DRAFT PROGRAMMATIC EIS

BOEM, as the lead agency with BSEE and NOAA as cooperating agencies, prepared the Draft Programmatic EIS in accordance with CEQ's regulations implementing NEPA (40 CFR part 1502) and USDOI's implementing procedures for NEPA (43 CFR part 46).

Scoping is an early and open process for determining the scope of the proposed action and the significant issues the EIS must analyze in depth. During the scoping process, the public provides input to assist the agency preparing the EIS (i.e., BOEM) in defining and prioritizing issues through meaningful participation, including the submission of comments. The scoping period begins with the publication of an NOI and is intended to solicit input from Federal, State, local, and Tribal governments; commercial interests; environmental groups; and the general public.

6.3.1 Scoping Meetings

Public scoping meetings were held by NMFS at the following locations and dates (one meeting per location):

Friday, December 3, 2004
Pontchartrain Hotel
2031 St. Charles Avenue
New Orleans, Louisiana

Thursday, December 16, 2004
NOAA Science Center
1301 East-West Highway
Silver Spring, Maryland

Public scoping meetings were held by BOEM at the following locations and dates (one meeting per location):

Monday, June 10, 2013
Embassy Suites Westshore
Tampa Airport
Tampa, Florida

Tuesday, June 11, 2013
Ramada Plaza Beach Resort
1500 Miracle Strip Parkway, SE
Fort Walton Beach, Florida

Wednesday, June 12, 2013
Government Plaza
205 Government Street
Mobile, Alabama

Thursday, June 13, 2013
Courtyard by Marriott,
Gulfport Beachfront
1600 East Beach Boulevard
Gulfport, Mississippi

Monday, June 17, 2013
Galveston Hilton
5400 Seawall Boulevard
Galveston, Texas

Wednesday, June 19, 2013
Bureau of Ocean Energy Management
1201 Elmwood Park Boulevard
New Orleans, Louisiana

Thursday, June 20, 2013
National Oceanic and Atmospheric
Administration
1305 East-West Highway
Silver Spring, Maryland

6.3.2 Comments Received During Scoping

During the initial scoping period, November 18 to December 22, 2004, NMFS received a total of 11 comment letters from the following: 4 comment letters from nongovernmental organizations (NGOs); 1 comment letter from an industry group; 1 comment letter from a geophysical subcontractor; and 5 comment letters from members of the public.

During the second scoping period, May 10 to July 9, 2013, BOEM received a total of 66 comments through the Internet/email (65%), formal letters (3%), and public meeting testimony, including oral and written comments (32%). Comments were received from individuals and organizations from nine states, Washington, DC, and Canada. Most comments came from private citizens. Other sources included Federal and State agencies, NGOs, and members of various for profit industries.

Most comments expressed concerns about G&G activities associated with offshore drilling, while a few comments also discussed siting of renewable energy. No comments were received concerning marine minerals activities. Of the comments received, 56 percent were opposed to G&G activities, 27 percent supported them, and 17 percent were neutral. Primary topics of the scoping comments included the following:

- concerns regarding impacts (particularly from underwater noise) to marine wildlife, specific species, and habitats;
- impacts to fisheries, recreation, and tourism;
- economic growth and job creation from G&G activities;
- advocating the use of alternative technologies for data collection;
- implementing mitigating measures such as restricting activities within time-area closures, expanding shutdown requirements, banning survey activities in the EPA, banning all activities supporting oil and gas, expanding the use of PAM, reducing source levels of survey equipment, sound source verification, establishing activity caps to lower cumulative sound exposure; and
- obtaining additional data regarding effects from the *Deepwater Horizon* explosion, oil spill, and response; long-term monitoring effects of G&G activities on marine mammals; and evaluating the effectiveness of mitigation measures.

The scope and content of this Programmatic EIS have been formulated to ensure the issues and concerns expressed by stakeholders during the scoping process have been fully addressed. The scoping report can be reviewed at http://www.boem.gov/GOM-PEIS-Scoping-Report/.

6.3.3 Cooperating Agencies

BOEM is required, per 43 CFR § 46.225, to invite eligible government entities to participate as cooperating agencies during the development of an EIS. Per CEQ regulations (40 CFR § 1508.5), a cooperating agency may be any Federal agency that has jurisdiction by law or special expertise with respect to environmental impacts expected from a Federal action. The responsibilities of a cooperating agency are provided at 40 CFR § 1501.6(b). To ensure the responsibilities of the lead agency and the relationship between cooperating agencies are clear to all, a Memorandum of Agreement (MOA) is typically executed by the agencies. The MOAs delineate roles and responsibilities in accordance with CEQ's January 30, 2002, "Memorandum for the Heads of Federal Agencies: Cooperating Agencies in Implementing the Procedural Requirements of the National Environmental Policy Act."

The NOI that was published in the *Federal Register* on May 10, 2013, included an invitation from BOEM to other Federal agencies and State, Tribal, and local governments to consider becoming cooperating agencies in the preparation of this Programmatic EIS. During the scoping period, BOEM received no expressions of interest by any Federal, State, Tribal, or local government having jurisdiction or special expertise with respect to becoming a cooperating agency, aside from the previously existing agreements with BSEE and NOAA (**Appendix A**).

In addition, in September 2013, BOEM sent joint inquiries to Federal agencies to participate as cooperating agencies on this Programmatic EIS. Federal agencies that were sent inquires have either declined or provided no response (**Appendix A**). In February 2014, the Mississippi Development Authority indicated that they would be interested in participating in this Programmatic EIS. In response, BOEM transmitted an invitation for interest to Mississippi Development Authority on May 27, 2014. The Mississippi Development Authority provided no response to BOEM's inquiry.

6.3.3.1 Bureau of Safety and Environmental Enforcement

BOEM and BSEE were formally established on October 1, 2011, as part of a major reorganization of the USDOI's offshore regulatory structure. The BSEE is the lead Federal agency in regulatory oversight and enforcement of G&G activities. The BSEE has an interest in the regulation of G&G surveys due to its responsibilities in working with BOEM to ensure the orderly development of mineral and other resources on the Federal OCS. In particular, BSEE is responsible for issuing permits for test drilling activities related to G&G explorations of the OCS (USDOI, BOEM, n.d.).

The BSEE uses a full range of authorities, policies, and tools to compel safety, emergency preparedness, environmental responsibility, and appropriate development and conservation of offshore oil and natural gas resources. One of these authorities is the OCSLA (43 U.S.C. § 1348(c)), which requires BSEE to conduct on-site inspections of all oil and gas operations on the OCS to ensure compliance with lease terms, regulations, and approved plans, and to assure that safety and pollution-prevention requirements are met. Noncompliance with these requirements or procedures may be followed by prescribed enforcement actions consisting of written warnings or shut-ins (a temporary sealing) of platforms, zones (wells), equipment, or pipelines. No similar inspections are required for the Marine Minerals Program or OREP. Key functions of BSEE include the following:

- providing an offshore regulatory program that develops standards and regulations, and emphasizes a culture of safety in all offshore activities;
- oil-spill response preparation, including review of industry's Oil Spill Response Plans, to ensure compliance with regulatory requirements;
- environmental enforcement with a focus on compliance by operators with all applicable environmental regulations as well as ensuring that operators adhere to the stipulations of their approved leases, plans, and permits; and
- funding scientific research to enhance the information and technology needed to build and sustain the organizational, technical, and intellectual capacity within and across BSEE's key functions that keeps pace with industry technological improvements, innovates regulation and enforcement, and reduces risk through

systematic assessment and regulatory and enforcement actions in order to better carry out BSEE's mission.

BOEM and BSEE

As part of the reorganization of Title 30 of the CFR, which established the creation of BOEM and BSEE, several MOAs were developed between the Bureaus to delineate responsibilities and establish the working relationship between the two agencies to synchronize environmental review and environmental enforcement for authorizations required to conduct conventional energy and resource activities on the OCS. An Environmental and NEPA Memorandum of Agreement, dated October 3, 2011, was established to help both Bureaus minimize duplication of effort, promote consistency in procedures and regulations, and resolve disputes (**Appendix A**).

The stated purpose of the Environmental and NEPA Memorandum of Agreement is that BSEE will serve as a cooperating agency on appropriate Bureau of Ocean Energy Management NEPA documents, oversee any requisite environmental monitoring needs, and ensure post-activity environmental compliance needs are met and documented. There is an expectation that serving as a cooperating agency, where practicable, will be the standard protocol for any Bureau of Ocean Energy Management NEPA analysis that BSEE may adopt for its decisions and that is related to BSEE environmental monitoring and compliance activities. Consistent with this policy, BSEE is a cooperating agency on this document.

6.3.3.2 National Oceanic and Atmospheric Administration

The NOAA is serving as a cooperating agency because the scope of the proposed action and alternatives involve G&G activities that could impact marine resources, including living and nonliving marine resources within NOAA's National Marine Sanctuaries (NMS). The NMFS has a statutory responsibility to protect, conserve, and recover marine mammals and threatened and endangered species. This responsibility includes the authority to authorize incidental take of marine mammals, engage in consultations with other Federal agencies, which can allow for take of threatened and endangered listed species, and enforce against unauthorized takes under both statutes. The NMFS executes these authorities pursuant to the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. §§ 1361 *et seq*.) and the Endangered Species Act of 1973 (ESA; 16 U.S.C. §§ 1531 *et seq*.). The NMFS has additional responsibilities to conserve and manage fishery resources of the United States. This includes consultations with other Federal agencies pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and the implementing regulations at 50 CFR part 600 for actions that may adversely affect EFH. The NOAA's Office of National Marine Sanctuaries has a statutory responsibility to protect and conserve NMSs. Consultation pursuant to Section 304(d) of the National Marine Sanctuaries Act (NMSA) is required of all Federal agencies for actions internal or external to an NMS that are likely to destroy, cause the loss of, or injure sanctuary resources. In addition to consultation requirements, permits may be required pursuant to the NMSA (16 U.S.C. §§ 1431-1445c-1) and the regulations for implementing the NMSA (15 CFR part 922).

Since the issuance of an Incidental Take Authorization (ITA) would allow for the taking of marine mammals, consistent with the provisions under the MMPA and incidental to the G&G activities, NOAA considers this issuance to be a major Federal action subject to NEPA. Therefore, NOAA's National Marine Fisheries Service intends to adopt this Programmatic EIS as the NEPA documentation associated with authorizing incidental take of marine mammals. In addition, NMFS and the Office of National Marine Sanctuaries may rely on the analysis within this Programmatic EIS to support consultation efforts under the ESA, MSFCMA, and NMSA.

An MOA was previously executed between BOEM and NOAA on June 12, 2013 (**Appendix A**), to work as co-lead agencies in the preparation of this Programmatic EIS. After further evaluation during the development of this Programmatic EIS, the two agencies determined that, pursuant to 40 CFR §§ 1501.5 and 1501.6, BOEM should act as the lead agency and NOAA should assist BOEM as a cooperating agency. Therefore, on September 8, 2015, BOEM and NOAA executed a new MOA that describes the obligations of both agencies concerning the preparation of this Programmatic EIS (**Appendix A**) with NOAA as a cooperating agency instead of a co-lead. The new MOA does not affect other responsibilities of the two agencies, NOAA in its role under the MMPA, ESA, and NMSA or BOEM in its role under the OCSLA.

6.4 Distribution of the Draft Programmatic EIS for Review and Comment

BOEM sent copies of the Draft Programmatic EIS to the government, public, and private agencies and groups listed below. Local libraries along the Gulf Coast were provided copies of this Draft Programmatic EIS; a list of these libraries is available on BOEM's website at https://www.boem.gov/nepaprocess/.

Federal Agencies

Congress
- Congressional Budget Office
- House of Representatives
- House Resources Subcommittee on Energy and Mineral Resources
- Senate Committee on Energy and Natural Resources

Department of Commerce
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration

Department of Defense
- Department of the Air Force
- Department of the Army
- Corps of Engineers
- Department of the Navy
- Naval Mine and ASW Command

Department of Energy
- Strategic Petroleum Reserve PMD

Department of Homeland Security
- Coast Guard

Department of State
- Bureau of Oceans and International Environmental and Scientific Affairs

Department of the Interior
- Bureau of Ocean Energy Management
- Bureau of Safety and Environmental Enforcement
- Fish and Wildlife Service
- Geological Survey
- National Park Service
- Office of Environmental Policy and Compliance
- Office of the Solicitor

Department of Transportation
- Office of Pipeline Safety

Environmental Protection Agency
- Region 4
- Region 6

Marine Mammal Commission

National Aeronautics and Space Administration

State and Local Agencies

Alabama
- Governor's Office
- Alabama Highway Department
- Alabama Historical Commission and State Historic Preservation Officer
- Alabama Public Library Service
- Alabama Public Service Commission
- City of Mobile
- City of Montgomery
- Department of Conservation and Natural Resources
- Department of Environmental Management
- Geological Survey of Alabama
- South Alabama Regional Planning Commission
- State Legislature Natural Resources Committee
- Town of Dauphin Island

Florida
- Governor's Office
- Bay County
- Citrus County
- City of Destin
- City of Fort Walton Beach
- City of Gulf Breeze
- City of Panama City
- City of Pensacola
- Department of Agriculture and Consumer Services
- Department of Environmental Protection
- Department of State Archives, History and Records Management
- Escambia County
- Florida Emergency Response Commission
- Florida Fish and Wildlife Conservation Commission
- Franklin County
- Gulf County
- Hernando County
- Hillsborough City-County Planning Commission
- Lee County
- Monroe County
- North Central Florida Regional Planning Council
- Okaloosa County
- Pasco County
- Santa Rosa County
- Sarasota County
- Southwest Florida Regional Planning Council
- State Legislature Agriculture and Natural Resources Committee
- Tampa Bay Regional Planning Council
- Walton County
- West Florida Regional Planning Council
- Withlacoochee Regional Planning Council

Louisiana
- Governor's Office
- Calcasieu Parish
- Cameron Parish
- City of Lake Charles
- City of Morgan City
- City of New Orleans
- Department of Culture, Recreation, and Tourism
- Department of Economic Development
- Department of Environmental Quality
- Department of Natural Resources
- Department of Transportation and Development
- Department of Wildlife and Fisheries
- Jefferson Parish
- Lafourche Parish
- Louisiana Geological Survey
- South Lafourche Levee District
- St. Bernard Parish
- State House of Representatives, Natural Resources Committee
- State Legislature Natural Resources Committee
- State of Louisiana Library
- Terrebonne Parish
- Town of Grand Isle

Mississippi
- Governor's Office
- City of Bay St. Louis
- City of Gulfport
- City of Pascagoula
- Department of Archives and History
- Department of Environmental Quality
- Department of Marine Resources
- Department of Wildlife, Fisheries, and Parks
- Jackson-George Regional Library System
- Mississippi Development Authority
- State Legislature Oil, Gas, and Other Minerals Committee

Federally Recognized Indian Tribes

Alabama-Coushatta Tribe of Texas
Caddo Nation
Chitimacha Tribe of Louisiana
Choctaw Nation of Oklahoma
Coushatta Tribe of Louisiana
Jena Band of Choctaw Indians
Miccosukee Tribe of Indians of Florida
Mississippi Band of Choctaw Indians
Muscogee (Creek) Nation
Poarch Band of Creek Indians
Seminole Tribe of Florida
Seminole Nation of Oklahoma
Tunica-Biloxi Indian Tribe of Louisiana

Industry

Adams and Reese, LLP
Alabama Petroleum Council
American Petroleum Institute
Applied Technology Research Corporation
Associated Gas Distributors of Florida
Baker Energy
Bepco, Inc.
C.H. Fenstermaker & Associates, Inc.
Century Exploration N.O., Inc.
Chet Morrison Contractors
Chevron U.S.A. Inc.
C-K Associates, LLC
Coastal Environments, Inc.
Columbia Gulf Transmission
CSA International
De Leon & Associates
Ecological Associates, Inc.
Ecosystem Management, Inc.
Energy Partners, Ltd.
Florida Natural Gas Association
Florida Petroleum Council
Florida Power and Light
Florida Propane Gas Association
Freeport-McMoRan, Inc.
General Insulation, Inc.
Global Industries, Ltd.
Halliburton Corporation
Han & Associates, Inc.
Horizon Marine, Inc.
John Chance Land Surveys, Inc.
L&M Botruc Rental, Inc.
Lampl Herbert Consultants
Larose Intercoastal Lands, Inc.
Linder Oil Company
Louisiana Oil and Gas Association
Magnum Steel Services Corp.
Mid Continent Oil and Gas Association
Nature's Way Marine, LLC
Offshore Process Services, Inc.
Oil and Gas Property Management, Inc.
Phoenix International Holdings, Inc.
Project Consulting Services
R.B. Falcon Drilling
Raintree Resources, Inc.
Science Applications International Corporation
SEOT, Inc.
Shell Offshore, Inc.
Stone Energy Corporation
Strategic Management Services-USA
T. Baker Smith, Inc.
The SJI, LLC
The Times-Picayune
URS Corporation
Waring & Associates

Special Interest Groups

1000 Friends of Florida
Alabama Oil & Gas Board
Alabama Nature Conservancy
Alabama Wildlife Federation
Apalachee Regional Planning Council
Apalachicola Bay and Riverkeepers
Audubon Louisiana Nature Center
Audubon of Florida
Barataria-Terrebonne National Estuary Program
Bay County Chamber of Commerce
Bay Defense Alliance
Citizens Assoc. of Bonita Beach
Clean Gulf Associates
Coalition to Restore Coastal Louisiana
Concerned Shrimpers of America
Conservancy of Southwest Florida
Earthjustice
Florida Chamber of Commerce
Florida Natural Area Inventory
Florida Wildlife Federation
Gulf and South Atlantic Fisheries Foundation, Inc.
Gulf Coast Environmental Defense
Gulf Coast Fisherman's Coalition
Gulf Restoration Network
Houma-Terrebonne Chamber of Commerce
Izaak Walton League of America, Inc.
LA 1 Coalition, Inc.
League of Women Voters of the
Pensacola Bay Area

Louisiana Wildlife Federation
Manasota-88
Mobile Bay National Estuary Program
Offshore Operators Committee
Organized Fishermen of Florida
Panama City Beach Convention and Visitors Bureau
Pensacola Archaeological Society
Perdido Key Association
Perdido Key Chamber of Commerce
Perdido Watershed Alliance
Restore or Retreat
Roffers Ocean Fishing Forecast Service
Santa Rosa Sound Coalition
Save the Manatee Club
Sierra Club
South Central Industrial Association
Surfrider Foundation
The Ocean Conservancy
The Nature Conservancy

Ports/Docks

Alabama
Alabama State Port Authority
Port of Mobile

Florida
Manatee County Port Authority
Panama City Port Authority
Port of Pensacola
Port St. Joe Port Authority
Tampa Port Authority

Louisiana
Abbeville Harbor and Terminal District
Greater Baton Rouge Port Commission
Greater Lafourche Port Commission
Grand Isle Port Commission
Lake Charles Harbor and Terminal District
Port of Iberia District
Port of New Orleans
St. Bernard Port, Harbor and Terminal District
West Cameron Port Commission

Mississippi
Mississippi State Port Authority

Educational Institutions/Research Laboratories

Dauphin Island Sea Laboratory
Florida A&M University
Florida Institute of Oceanography
Florida Institute of Technology
Florida Sea Grant College
Florida State University
Foley Elementary School
Gulf Coast Research Laboratory
Gulf Coast State College
Harbor Branch Oceanography
Louisiana Sea Grant College Program
Louisiana State University
Louisiana Tech University
Louisiana Universities Marine Consortium
Loyola University
McNeese State University
Mississippi State University
Mississippi-Alabama Sea Grant Consortium
Mote Marine Laboratory
Nicholls State University
Pensacola Junior College
Tulane University
University of Alabama
University of Florida
University of Louisiana at Lafayette
University of Miami
University of Mississippi
University of New Orleans
University of South Alabama
University of South Florida
University of Southern Mississippi
University of West Florida

Additionally, to initiate the public review and comment period on the Draft Programmatic EIS, BOEM took the following actions:

(1) contemporaneously published a Notice of Availability (NOA) for the Draft Programmatic EIS in the *Federal Registe*r, announcing a 45-day comment period; all comments received during the comment period have been included as part of the Programmatic EIS administrative record;

(2) mailed public notices that reported availability of the Draft Programmatic EIS and how to comment to all of the groups and agencies identified above;

(3) emailed a group notification that announced availability of the Draft Programmatic EIS and how to comment to all people who had furnished BOEM with their email address during scoping or had requested to be on such a mailing list;

(4) placed multiple newspaper notices announcing the availability of the Draft Programmatic EIS, all public meeting locations and times, and how to comment on the Draft Programmatic EIS;

(5) posted the Draft Programmatic EIS on BOEM's websites at http://www.boem.gov/GOM-G-G-PEIS/ and http://www.boem.gov/nepaprocess/;

(6) mailed official letters to the Governor's Offices of all States along the Gulf Coast that may have an interest in providing input on the proposed G&G activities, in accordance with BOEM's policy of consultation and coordination with State and local governments; and

(7) mailed official letters to the federally recognized Indian Tribes along the five Gulf Coast States.

All comments received on the Draft Programmatic EIS were considered during preparation of this Final Programmatic EIS.

6.5 Public Meetings

BOEM, in accordance with 40 CFR § 1506.6, held public meetings to solicit comments on the Draft Programmatic EIS; the meetings were an additional avenue to submit comments during the review period. The meetings provided the Secretary of the Interior with information from interested parties to help in the evaluation of potential effects of the proposed action. An announcement of the dates, times, and specific locations of the public hearings was included in the NOA for the Draft Programmatic EIS. Public meetings were scheduled to be held in the cities below, and additional information can be found on the project's website at https://www.boem.gov/Gulf-of-Mexico-Geological-and-Geophysical-Activities-Programmatic-EIS/.

Wednesday, November 9, 2016
Wyndham Garden New Orleans Airport
6401 Veterans Memorial Blvd.
Metairie, Louisiana

Tuesday, November 15, 2016
The Admiral Hotel Mobile, Curio Collection by Hilton
251 Government St.
Mobile, Alabama

Thursday, November 10, 2016
Courtyard by Marriott,
Gulfport Beachfront MS Hotel
1600 East Beach Blvd.
Gulfport, Mississippi

Monday, November 14, 2016
Four Points by Sheraton
Destin-Fort Walton Beach
1325 Miracle Strip Parkway SE
Fort Walton Beach, Florida

Thursday, November 17, 2016
Houston Marriott North
255 North Sam Houston Parkway East
Houston, Texas

6.6 Development of the Final Programmatic EIS

BOEM prepared this Final Programmatic EIS in accordance with CEQ regulations (40 CFR §§ 1502.9 and 1503) and sought comments in accordance with CEQ regulations. A 60-day comment period was specified for public review of the Draft Programmatic EIS (*Federal Register*, 2016f). BOEM then revised the Draft Programmatic EIS, as necessary, in response to the comments received.

6.6.1 Major Differences Between the Draft and Final Programmatic EISs

BOEM has revised this Programmatic EIS based on comments received during the public comment period for the Draft Programmatic EIS. These revisions include factual corrections, additions to existing information, and improvements or modifications to the analyses presented in the Draft Programmatic EIS. A summary of public comments received can be found in **Chapter 6.7**, and BOEM's responses to these comments can be found in **Appendix M**. Revisions to this Final Programmatic EIS included changes to all chapters and appendices of this Programmatic EIS.

6.6.2 Record of Decision

The environmental review process ends following a 30-day period after release of this Final Programmatic EIS with issuance of a ROD. The ROD will state the agency's decision; identify the alternatives considered, including the environmentally preferable alternatives; identify and discuss the factors involved in the decision; and state whether all practical means to avoid or minimize environmental harm have been adopted, and if not, why not.

6.7 Comments Received on the Draft Programmatic EIS

A summary of the number and types of comments received on the Draft Programmatic EIS is provided here. For more information, refer to **Appendix M**. All comments received during the public comment period were considered by BOEM. Comments were received from State and local officials; Federal, State, and local agencies; environmental organizations and NGOs; the oil and gas energy sector; and individuals.

BOEM received approximately 4,700 unique comment submissions on the Draft Programmatic EIS and more than 56,000 duplicate form letters. The vast majority of comments included statements of either support or opposition to the proposed action with no substantive information related to the Programmatic EIS. Comments or letters were received from Federal, State, and local governments and agencies, NGOs, and industry associations; however, the majority of comments were from private citizens. From the comment submittals, BOEM identified 450 substantive comments. Although the comments covered a wide range of topics, most of the comments centered on the NEPA process and analysis, range of alternatives, mitigating measures, marine mammals, and sociocultural systems. Refer to **Appendix M** for the responses to comments.

6.8 REGULATORY FRAMEWORK

Federal laws mandate the OCS leasing program (i.e., OCSLA) and certain environmental review processes (e.g., NEPA). The OCSLA establishes guidelines for the exploration of minerals (which, as defined by the OCSLA, is the process of searching for minerals, including geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or imply the presence of such minerals) on the OCS. Section 388 of the EPAct of 2005, Public Law 109-58, expanded the USDOI's authority to issue leases, easements, and rights-of-way on the OCS for activities that produce energy from sources other than oil and gas (e.g., alternative energy projects). All of these actions are subject to the environmental review process under NEPA.

Several Federal regulations (e.g., CZMA, ESA, and MSFCMA) establish specific consultation and coordination processes with Federal, State, and local agencies. In addition, activities and operations related to the OCS leasing process and G&G authorizations must comply with other Federal, State, and local laws and regulations, as appropriate. **Table 1.1-1** lists the major Federal laws and regulations and Executive Orders that apply to the three program areas: (1) oil and gas; (2) renewable energy; and (3) marine minerals. Summaries of selected applicable Federal laws and regulations are provided in **Appendix B**. Additional information regarding the regulatory framework for activities in the GOM is presented in Cameron and Matthews (2016).

6.8.1 Coastal Zone Management Act

The CZMA (16 U.S.C. §§ 1451 *et seq*.) was enacted by Congress to protect the coastal environment from increasing demands associated with commercial, industrial, recreational, and residential uses, including State and Federal offshore energy development. Provisions in the CZMA help the States develop coastal management programs (CMPs) to manage and balance competing uses of the coastal zone. All of the Gulf Coast States have approved CMPs (refer to **Appendix B** for more information). Requirements for the CZM consistency information are based on the approval of listed activities according to NOAA's Office for Coastal Management. If the activity is unlisted, the State must go through the process of the Office for Coastal Management for approving a State's unlisted activity request on a case-by-case basis (15 CFR § 930.54). Federal agencies must follow the Federal consistency provisions delineated in 15 CFR § 930.

There are several standards of "Federal consistency." Federal agency activities must be "consistent to the maximum extent practicable" with relevant enforceable policies of a State's federally approved CMP (15 CFR part 930 subpart C) (e.g., OCS lease sales, renewable energy competitive lease sales, and marine minerals negotiated competitive agreements). Private activities that require a Federal permit or license must be “fully consistent” with enforceable policies (15 CFR part 930 subpart D) (e.g., G&G permits, renewable energy non-competitive permitted activities, and negotiated non-competitive marine minerals agreements). The OCS plan activities must be “fully consistent” with enforceable policies (15 CFR part 930 subpart E) (e.g., exploration, development, and production activities, and renewable energy competitive plans). Many G&G ancillary seismic activities under 30 CFR part 550 require the preparation of an OCS plan that would be reviewed pursuant to 15 CFR part 930 subpart E. Refer to the “Frequently Asked Questions for Ancillary Activities” document (USDOI, BOEM, n.d.) for a list of activities that require the preparation of an OCS plan. If an activity will have reasonably foreseeable effects, including direct, indirect, or cumulative effects, the activity is subject to Federal consistency review.

For oil- and gas-related activities, a G&G permit must be obtained from BOEM prior to conducting off-lease geological or geophysical exploration or scientific research on unleased OCS lands or on lands under lease to a third party (30 CFR §§ 551.4(a) and (b)). Geological investigations include various seafloor sampling techniques to determine the geochemical, geotechnical, or engineering properties of the sediments. The G&G activities conducted by another Federal agency are not subject to BOEM authorization. Under the EPAct of 2005, BOEM does not have authority to regulate survey activities conducted off-lease, and there is no requirement for a G&G permit to be obtained from BOEM for conducting renewable energy survey activities.

Ancillary activities are defined in 30 CFR § 550.105 with regulations outlined in 30 CFR §§ 550.207-550.210. Ancillary activities are activities conducted on-lease and include G&G exploration and development G&G activities; geological and high-resolution geophysical, geotechnical, archaeological, biological, physical oceanographic, meteorological, socioeconomic, or other surveys; or various types of modeling studies. This Agency issued NTL 2009-G34, “Ancillary Activities,” to provide updated guidance and clarification on conducting ancillary activities in BOEM’s Gulf of Mexico OCS Region.

The CZMA places requirements on any applicant for an OCS plan that describes in detail Federal license or permit activities affecting any coastal use or resource, in or outside of a State’s coastal zone. The applicant must provide in the OCS plan submitted to BOEM a consistency certification and necessary data and information for the State to determine that the proposed activities comply with the enforceable policies of the State’s CMP, approved by NOAA, and that such activities will be fully consistent with those enforceable policies (16 U.S.C. § 1456(c)(3)(A) and 15 CFR § 930.76).

In accordance with the requirements of 15 CFR § 930.76, BOEM sends copies of an OCS plan, including the consistency certification and other necessary data and information, to the designated State CMP agency by receipted mail or other approved communication. If no State agency objection is submitted by the end of the consistency review period, BOEM shall presume consistency concurrence by the State (15 CFR § 930.78(b)). BOEM can require modification of a plan.

If BOEM receives a written consistency objection from the State, BOEM will not approve any activity described in the OCS plan unless (1) the operator amends the OCS plan to accommodate the objection and concurrence is subsequently received or conclusively presumed; (2) upon appeal, the Secretary of Commerce, in accordance with 15 CFR part 930 subpart H, finds that the OCS plan is consistent with the objectives or purposes of the CZMA or is necessary in the interest of national security; or (3) the original objection is declared invalid by the courts.

6.8.2 Endangered Species Act

The ESA establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. BOEM and BSEE are currently in consultation with NMFS regarding the OCS Program in the Gulf of Mexico, including G&G activities. BOEM is acting as the lead agency in the ongoing consultation, with BSEE's assistance and involvement. The programmatic consultation was expanded in scope after the reinitiation of consultation by BOEM following the *Deepwater Horizon* explosion, oil spill, and response, and it will include both existing and future OCS oil and gas leases in the Gulf of Mexico over a 10-year period. This consultation also considers any changes in baseline environmental conditions following the *Deepwater Horizon explosion*, oil spill, and response. The programmatic consultation will include post-lease activities associated with OCS oil- and gas-related activities in the Gulf of Mexico, as well as decommissioning activities.

With consultation ongoing, BOEM and BSEE will continue to comply with all reasonable and prudent measures and the terms and conditions under the existing consultations, along with implementing the current BOEM- and BSEE-required mitigation, monitoring, and reporting requirements. Based on the most recent and best available information at the time, BOEM and BSEE will also continue to closely evaluate and assess risks to listed species and designated critical habitat in upcoming environmental compliance documentation under NEPA and other statutes.

6.8.3 Magnuson-Stevens Fishery Conservation and Management Act

Pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act, Federal agencies are required to consult with NMFS on any action that may result in adverse effects to EFH. The NMFS published the final rule implementing the EFH provisions of the Magnuson-Stevens Fisheries Conservation and Management Act (50 CFR part 600) on January 17, 2002. Certain OCS oil- and gas-related activities authorized by BOEM may result in adverse effects to EFH and therefore require EFH consultation.

BOEM prepared a 2017-2022 EFH Assessment white paper, "Essential Fish Habitat Assessment for the Gulf of Mexico," on behalf of BOEM and BSEE that describes the Gulf of Mexico OCS Region's OCS proposed activities, analyzes the effects of the proposed activities on EFH, and identifies proposed mitigation measures (USDOI, BOEM, 2016c). This Assessment was sent to NMFS on June 8, 2016, with a letter requesting formal consultation. This regional programmatic EFH consultation will cover proposed GOM lease sales analyzed in the 2017-2022 Five-Year Program and the related activities (i.e., decommissioning and G&G). The EFH Assessment, the formalized conservation recommendations put forth by NMFS and accepted by BOEM/BSEE, or NMFS concurrence will complete the EFH consultation. However, all agencies will continue to communicate for the duration of the EFH consultation (i.e., 2017-2022).

6.8.4 National Historic Preservation Act

In accordance with the National Historic Preservation Act (54 U.S.C. §§ 300101 *et seq.*), Federal agencies are required to consider the effects of their undertakings on historic properties. The implementing regulations for Section 106 of the National Historic Preservation Act, issued by the Advisory Council on Historic Preservation (36 CFR part 800), specify the required review process. In accordance with 36 CFR § 800.8(c) and in lieu of 36 CFR §§ 800.3-800.6, BOEM intends to comply with Section 106 of the National Historic Preservation Act by using the NEPA substitution process and documentation for preparing this Programmatic EIS and Record of Decision, or any subsequent G&G project-specific environmental assessment. BOEM will initiate the Section 106 process if a proposed G&G work involves bottom-disturbing activity. As part of the Section 106 process, BOEM will involve consulting parties when necessary, which may include the Advisory Council on Historic Places, Tribal Historic Preservation Offices and other Tribal representatives, State Historic Preservation Offices, and the public. Through this process, BOEM will determine the area of potential effects and the level of archaeological survey that constitutes a reasonable and good faith effort to carry out appropriate identification of historic properties. BOEM, in consultation with the Advisory Council on Historic Places, State Historic Preservation Office, Tribal Historic Preservation Office or other Tribal representatives, and other consulting parties, has authority under Section 106 of the National Historic Preservation Act to develop and evaluate alternatives or modifications to the undertaking that could avoid, minimize, or mitigate adverse effects to these potential historic properties. Mitigations of adverse effects could include placing avoidance buffers around suspected resources or requests for an applicant to conduct further examinations of suspected resources.

Because of the broad scope of the possible activities discussed in this Programmatic EIS and the lack of a specific Federal undertaking at this time on which to consult, separate Section 106 consultations will be conducted by the regions and program offices managing specific undertakings as they arise. The activities discussed span BOEM's three Program Areas: Oil and Gas, Renewable Energy, and Marine Minerals. While certain of the analyzed activities are common for all three Program Areas, others are limited to a specific program area. Furthermore, while the Programmatic EIS discusses a range of proposed undertakings with a range of potential effects, BOEM will not know the exact nature of an undertaking until it is proposed and evaluated by BOEM. For these reasons, it is appropriate that specific Section 106 consultations will be initiated for proposed undertakings, when necessary, prior to BOEM approving any activities. However, in an effort to seek relevant information as early as possible, BOEM provided the Gulf Coast States, including State Historic Preservation Offices, the opportunity to review and comment on the preparation of this Programmatic EIS. Outreach letters were sent to the states in May 2013 for the NOI to prepare the Programmatic EIS and again with the NOA of the Draft Programmatic EIS in October 2016.

6.8.5 National Marine Sanctuaries Act

Section 304(d) of the NMSA requires that Federal agencies consult with NOAA'S Office of National Marine Sanctuaries for any Federal action internal or external to an NMS that is "likely to destroy, cause the loss of, or injure a sanctuary resource." If the proposed G&G work involves bottom-disturbing activity in proximity to an NMS, archaeological and shallow hazard surveys would be required to examine bottom conditions as part of the NEPA evaluation. Further, if a geophysical survey vessel(s) operates in proximity to an NMS, then BOEM will consult with the Office of National Marine Sanctuaries to determine whether any additional mitigation (i.e., setbacks from NMS boundaries) needs to be applied to further protect NMS resources. Coordination with the Office of National Marine Sanctuaries will occur on an individual permit/authorization basis. Specific mitigation measures and/or best management practices will be incorporated at the site-specific review and approval stages. BOEM will continue to coordinate with the Office of National Marine Sanctuaries when activities occur in the vicinity of an NMS.

6.8.6 Department of Defense

During the revision of the Draft Programmatic EIS, the U.S. Department of Defense (USDOD) notified BOEM that, within the boundaries of the AOI, there are ongoing USDOD operations and missions. The general guidance for military coordination has resulted in establishing a working group to ensure that G&G activities are coordinated with USDOD as site-specific G&G activities are proposed. The working group was formed to provide a structured process by which USDOD and BOEM can develop measures to minimize conflicts between the U.S. Department of the Interior's G&G surveys and USDOD operations. The USDOD/BOEM Interagency Working Group on Procedures Governing Coordination for Geologic and Geophysical Permit Activities on the Atlantic OCS and Eastern Gulf of Mexico Planning Area East of the Military Mission Line (ATL EGM-IWG) was created to address spatial conflicts of BOEM's proposed seismic and related G&G permitting activities with USDOD operations on the Atlantic OCS and EPA east of the military mission line. The current formalized procedures for coordination between USDOD's and the U.S. Department of the Interior's G&G activities over the rest of the Gulf of Mexico OCS will remain in place.

6.8.7 Government-to-Government Tribal Consultation

In accordance with Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," Federal agencies are required to establish regular and meaningful consultation and collaboration with Tribal officials in the development of Federal policies that have Tribal implications to strengthen the United States' government-to-government relationships with Indian Tribes and to reduce the imposition of unfunded mandates upon Indian Tribes. Furthermore, the U.S recognizes the right of Indian Tribes to self-government and supports Tribal sovereignty and self-determination. BOEM strives to meet the responsibilities that arise from the unique legal relationship between the Federal Government and Indian Tribal governments.

BOEM has begun outreach and coordination with potentially affected, GOM-affiliated federally recognized Indian Tribes, including the Alabama-Coushatta Tribe of Texas, Caddo Nation of Oklahoma, Chitimacha Tribe of Louisiana, Choctaw Nation of Oklahoma, Coushatta Tribe of Louisiana, Jena Band of Choctaw Indians, Miccosukee Tribe of Indians of Florida, Mississippi Band of Choctaw Indians, Muscogee (Creek) Nation, Poarch Band of Creek Indians, Seminole Tribe of Florida, Seminole Nation of Oklahoma, and Tunica-Biloxi Indian Tribe of Louisiana. In March 2015, BOEM sent to these Tribes an outreach letter describing the G&G activities and sought Tribal interest in consulting. A follow-up letter was sent in September 2016, along with a copy of the Draft Programmatic EIS, again seeking Tribal comments or interest in consulting. As of this writing, no comments have been received; however, where a Tribe expresses interest, BOEM intends to conduct formal government-to-government consultation.

CHAPTER 7

LITERATURE CITED

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CHAPTER 8

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8 PREPARERS AND REVIEWERS

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CHAPTER 9

GLOSSARY

9 GLOSSARY

Acoustics—The scientific study of sound, especially of its generation, transmission, and reception.

Acute—Sudden, short term, severe, critical, crucial, intense, but usually of short duration.

Active acoustics—The use of a sound transmitter and a receiver to both make a sound and listen for the echo.

Aeromagnetic survey—A type of geophysical survey carried out using a magnetometer aboard or towed behind an aircraft to measure and record the total intensity of the magnetic field.

Airgun—A pneumatic device used as an acoustic source to acquire marine seismic data. It is submerged below the water surface and towed behind a ship, usually as part of an array consisting of a number of airguns (i.e., airgun array).

Air quality—Assessment of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances. Air quality standards are the prescribed levels of substances in the outside air that cannot be exceeded during a specific time in a specified area.

Alternative—In the context of a NEPA document (i.e., an EA or EIS), a different method for accomplishing the Proposed Action. As examples, an alternative can consist of the same action in a different location, or the use of different mitigation measures.

Alternative energy—refer to "Renewable energy."

Ambient noise—The typical or persistent environmental background noise present in the ocean, with contributions from natural sources (wind, waves, rain, animal sounds, earthquakes, etc.) and, often, from distant and indistinguishable anthropogenic sources such as shipping. Sound from specific nearby anthropogenic activities is usually not considered to be part of the ambient noise.

Amplitude—The maximum absolute value of a periodic curve measured along its vertical axis. For sound waves, it is the maximum amount that the wave's pressure differs from ambient pressure in the medium through which the sound wave is propagating.

Anadromous—Species of fish that are born in fresh water, migrate as juveniles to the ocean and grow into adults, and then return to fresh water to spawn.

Anthropogenic—Coming from human sources, relating to the effect of humankind on nature.

Anthropogenic noise—Noise related to or produced by human activities.

Area of Interest (AOI)—The area in which the activities of the proposed action could take place and, therefore, the area of potential effect of this Programmatic EIS.

Array—The layout or arrangement of objects in a specific pattern, often in rows and columns.

Attenuation—Reduction; in this document, reduction of the level or intensity of sound.

Baleen whales—Whales with parallel rows of fibrous plates that hang from the upper jaw and are used for filter feeding. Also known as mysticetes (refer to “Mysticete”).

Barrel (bbl)—A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 L.

Bathymetry—The water depth at various places in a body of water; the information derived from measurements to determine water depth.

Bathypelagic—Pertaining to the subzone of the pelagic zone that generally includes waters deeper than 1,000 m. (3,300 ft). At this depth, there is little to no light, and photosynthesis is not possible. Consequently, there are no living plants, and most animals survive by consuming detritus falling from the pelagic zones above or by preying on other animals.

Behavioral effect—Defined in this Programmatic EIS as a change in an animal’s behavior or behavior patterns that results from exposure to some stimulus (e.g., an anthropogenic acoustic exposure) and exceeds some defined criterion (e.g., extends beyond the range of normal daily variation in behavior).

Benthic—Referring to the bottom-dwelling community of organisms that live on or in either the sea bottom.

Biological Opinion—An FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species, in response to formal consultation under Section 7 of the ESA.

Biological significance—An action or activity becomes biologically significant to an *individual* animal when it affects the ability of the animal to survive, grow, and reproduce. An action or activity becomes biologically significant to a *population* (i.e., may have population-level consequences) when it affects (reduces) the rate of increase of the population. Biologically significant actions or activities may include injurious and/or behavioral effects. Biologically significant behavioral effects include alterations in behaviors that are critical for the survival of an individual or population, such as foraging, reproduction, occupancy of preferred habitat(s), and migration.

Biota—The combined flora and fauna of a region.

Block—A geographical area portrayed on official BOEM protraction diagrams or leasing maps that contains approximately 2,331 ha (9 mi^2).

Blowout—Uncontrolled flow of fluids from a wellhead or wellbore.

Boomer—A low-energy towed device used as an acoustic source to acquire marine seismic data. The acoustic pulse is generated when an electrical signal discharges a capacitor bank causing two spring loaded, electrically charged plates in the boomer transducer to repel, creating a precisely repeatable pressure pulse primarily directed downward to the seafloor.

Bycatch—Nontarget organisms caught in fishing or other harvest operations and usually discarded.

Candidate species—Plants and animals for which FWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the ESA but for which development of a listing regulation is precluded by other higher priority listing activities.

Cape (spit)—A type of sand bar or beach that is built out from the shore by deposition of sediment (typically sand) carried in the longshore current; these landforms have a characteristic "hook" shape when viewed from above (e.g., Cape Cod).

Carbon monoxide (CO)—A colorless, odorless, and tasteless gas that is slightly less dense than air. Carbon monoxide is one of the six criteria air pollutants specified under Title I of the Clean Air Act.

Cavitation—The sudden formation and subsequent collapse of low-pressure bubbles of air in fluids that are moving as a result of applied mechanical forces. The phenomenon of cavitation is the single largest contributor to underwater sound from ship propellers.

Cetacea or cetacean—An order of aquatic mammals including baleen whales (refer to "Mysticetes") and toothed whales, dolphins, and porpoises (refer to "Odontocetes").

Chemosynthetic—Organisms that obtain their energy from the oxidation of various inorganic compounds rather than from light (photosynthetic).

CHIRP system—CHIRP (compressed high-intensity radiated pulse) refers to a variety of pulsed sonar systems capable of conducting high-resolution reflection profiling of the subbottom using low-energy acoustic sources with a nominal frequency range of a few kilohertz up to several tens or hundreds of kilohertz. Often, CHIRP data are collected by sweeping through a range of frequencies in a single pulse, but some systems referred to as CHIRP may be associated with only a single frequency.

Clastic—Sediments composed of pieces of pre-existing rock.

Clean Air Act (CAA)—An act that establishes NAAQS for six criteria pollutants—SO_x, NO_2, CO, O_3, PM_{10} and $PM_{2.5}$, and Pb. Collectively, the criteria pollutants are indicative of the quality of the ambient air. The Act requires facilities to comply with emission limits or reduction limits stipulated in State Implementation Plans. Under this Act, construction and operating permits, as well as reviews of new stationary sources and major modifications to existing sources, are required. The Act also prohibits the Federal Government from approving actions that do not conform to SIPs.

Clean Water Act (CWA)—An act that requires NPDES permits for discharges of effluents to surface waters, permits for stormwater discharges related to industrial activity, and notification of oil discharges to navigable waters of the U.S.

Coastal—An imprecise area of land and water located at the interface between the shore and the ocean, where physical, chemical, and biological processes occur as interactions between these two ecosystems or because of their proximity to each other.

Coastal state—A state bordering the Atlantic or Pacific Oceans or the Gulf of Mexico.

Coastal waters—Waters within the geographical areas defined by each State's Coastal Zone Management Program.

Coastal wetlands—Forested and nonforested habitats, mangroves, and marsh islands exposed to tidal activity. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for birds and other animals.

Coastal zone—The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches and extends seaward to the outer limit of the U.S. territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents.

Coastal Zone Management Act (CZMA)—16 U.S.C. §§ 1451 *et seq*. The CZMA regulates development in coastal areas to protect their unique resources.

Code of Federal Regulations (CFR)—A compilation of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the U.S. Each volume of the CFR is updated once each calendar year and is issued quarterly.

Continental margin—The ocean floor that lies between the shoreline and the abyssal ocean floor; includes the continental shelf, continental slope, and continental rise.

Continental Offshore Stratigraphic Test (COST) well—Wells that involve drilling penetration into the sea bottom of more than 152 m (500 ft) and are primarily drilled to gather geological information (defined in 30 CFR part 251).

Continental rise—A broad, gently dipping depositional plain that extends from the base of the continental slope from a depth of about 2,000 m (6,600 ft) to more than 5,000 m (16,400 ft).

Continental shelf—General term used by geologist to refer to the continental margin province that lies between the shoreline and the abrupt change in slope called the shelf edge, which generally occurs in the Gulf of Mexico at about 200 m (656 ft) water depth. The continental shelf is characterized by a gentle slope (about 0.1º). This is different from the judicial term used in Article 76 of the UNCLOS (refer to “Outer Continental Shelf”).

Continental slope—The continental margin province that lies between the continental shelf and continental rise, characterized by a steep slope (about 3º-6º).

Controlled Source Electromagentic (CSEM) survey—An offshore geophysical technique employed by the commercial offshore oil and gas industry that uses electromagnetic remote-sensing technology to estimate the presence and extent of subbottom hydrocarbon accumulations.

Council on Environmental Quality (CEQ)—The Federal council that coordinates Federal environmental efforts and works closely with Federal agencies and other White House offices to develop environmental policies and initiatives. Established by NEPA (refer to “National Environmental Policy Act”), the CEQ consists of three members appointed by the President. The CEQ regulations (40 CFR parts 1500-1508) describe the process for implementing NEPA, including preparation of EAs and EISs and the timing and extent of public participation.

Critical habitat—Defined in Section 3 of the ESA as (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the ESA, on which are found those physical or biological features (i) essential to the conservation of the species and (ii) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.

Crude oil—Petroleum in its natural state as it emerges from a well, or after it passes through a gas-oil separator but before refining or distillation; an oily, flammable, bituminous liquid that is essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

Cumulative impact—The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Decibel (dB)—A relative unit used to describe sound intensities. It is used to express the relative difference, usually between acoustic or electrical signals, equal to 10 or 20 times the common logarithm of the ratio of the two quantities. Since the dB scale is logarithmic and not linear, a 20-dB sound is 10 times louder than a 10-dB sound, and a 30-dB sound is 100 times louder than a 10-dB sound.

Demersal—Living at or near the bottom of a waterbody but having the capacity for active swimming. Term used particularly when describing various fish species.

Demersal fishes—Those fishes that spend at least the adult portion of their life cycle in association with the ocean bottom.

Deposition—The laying down of matter by a natural process (e.g., the settling of particulate matter out of air or water onto soil or sediment surfaces).

Depth sounder—An instrument that indirectly determines the ocean floor depth by transmitting acoustic pulses from the ocean surface and listening for their reflection (or echo) from the seafloor. A single beam depth sounder calculates the depth below the ship using the time it takes a sound pulse to travel to the seafloor, reflect, and then return back to the transducer. A multibeam depth sounder transmits a broad acoustic pulse from a specially designed transducer across the full swath across track then forms a receive beam that is much narrower (around 1°, depending on the system) to establish a two way travel time of the acoustic pulse. If the speed of sound in water is known for the full water column, the depth and position of the return signal can be determined from the receive angle and the two-way travel time.

Development—Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform, construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development Operations Coordination Documents (DOCDs)—A plan that describes development and production activities proposed by an operator for a lease or group of leases. The description includes the timing of these activities, information concerning drilling vessels, the location of each proposed well or production platform or other structure, and an analysis of both offshore and onshore impacts that may occur as a result of the plan's implementation.

Diapir—Intrusion of fluid rock (e.g., molten rock, salt, or mud) caused by the difference in buoyancy and pressure between it and the overlying rock.

Discharge—Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

Dispersion—A suspension of finely divided particles in a medium.

Distinct Population Segment (DPS)—A vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. The ESA provides for listing species, subspecies, or DPSs of vertebrate species.

Diurnal—Having a daily cycle or occurring every day.

Domestic—Produced in or indigenous to a particular country.

Drilling fluid (drilling mud)—A mixture of clay, water or refined oil, and chemical additives pumped continuously downhole through the drill pipe and drill bit, and back up the annulus between the pipe and the walls of the borehole to a surface pit or tank. The mud lubricates and cools the drill bit, lubricates the drill pipe as it turns in the wellbore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to downhole pressures; also called drilling fluid.

Easement—Authorization for the use, for a specified purpose, of land that is not owned by the user. For the OCS, a right of use and easement usually refer to the authorization by BOEM to an operator for the construction and maintenance of a structure or structures on OCS lands not subject to a lease granted to the operator.

Echolocation—The use of reflected sound waves by some animals to gather critical information such as the location of obstructions, predators, or food, or for purposes of reproduction.

Ecosystem—A group of organisms and their physical environment interacting as an ecological unit.

Effluent—The liquid waste of sewage and industrial processing.

Electromagnetic field—The field of energy resulting from the movement of alternating electric current along the path of a conductor, composed of both electrical and magnetic components and existing in the immediate vicinity of, and surrounding, the electric conductor. Electromagnetic fields exist both in high voltage electric transmission power lines and in low-voltage electric conductors in homes and appliances.

Embayment—A small bay or any small semi-enclosed coastal water body in which the opening to a larger body of water is restricted.

Endangered species—Under the ESA, any species that is in danger of extinction throughout all or a significant portion of its range (ESA §3[6]).

Endangered Species Act (ESA)—A U.S. Federal law whose purpose is to protect and recover imperiled species and the ecosystems upon which they depend. It is administered by FWS and NMFS. The FWS has primary responsibility for terrestrial and freshwater organisms, including manatees, polar bears, walruses, sea otters, and nesting sea turtles, while the responsibilities of NMFS are mainly marine wildlife including all cetaceans and sea turtles (in the marine stage), most pinnipeds, and anadromous fish such as salmon. Under the ESA, species may be listed as either endangered or threatened. The ESA also requires the designation of critical habitat for listed species (refer to "Critical habitat").

Energy—The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy) or heat.

Energy Policy Act of 2005 (EPAct)—A bill passed in August 2005 that included new authority (Section 388) for MMS (now BOEM) to regulate alternative energy resources on the OCS.

Environmental Impact Statement (EIS)—A document required of Federal agencies by NEPA for major proposals or legislation that would or could significantly affect the environment.

Environmental justice—The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Epifauna—Organisms living on the surface of the sediment/sea bed.

Epifaunal—A community of marine organisms that live attached to hard substrates or move around and live on hard substrates.

Epipelagic—Pertaining to a subzone of the pelagic zone where there is enough light for photosynthesis. Generally includes waters from the surface to approximately 200 m (660 ft) in depth.

Essential Fish Habitat (EFH)—As identified in the Magnuson-Stevens Fishery Conservation and Management Act, those waters and substrate that are defined within Fishery Management Plans for federally managed fish species as necessary to fish for spawning, breeding, feeding, or growth to maturity.

Estuary—Coastal semi-enclosed body of water that has a free connection with the open sea and where freshwater meets and mixes with seawater.

Exclusion Zone—The area at and below the sea surface within a radius of 500 m (1,640 ft) surrounding the center of an airgun array and the area within the immediate vicinity of the survey vessel.

Exclusive Economic Zone (EEZ)—The maritime region extending 200 nmi (230 mi; 370 km) from the baseline of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

Executive Order 12898—An Executive Order, signed in 1994, establishing environmental justice as a Federal Government priority and directing all Federal agencies to make environmental justice part of their mission. Environmental justice calls for fair distribution of environmental hazards.

Executive Order 13045—An Executive Order, signed in 1997 establisng the Protection of Children from Environmental Health Risks and Safety Risks.

Executive Order 13158—An Executive Order, signed in 2000 establishing the National Marine Protected Areas Initiative.

Executive Order 13554—An Exective Order, signed in 2010 establishing the Gulf Coast Ecosystem Restoration Task Force.

Exploration Plan (EP)—A plan that must be prepared by the operator and submitted to BOEM for approval before any exploration or delineation drilling is conducted on a lease.

Exploration well—A well drilled in unproven or semi-proven territory to determining whether economic quantities of oil or natural gas deposit are present; exploratory well.

Extralimital—Known on the basis of only a few records that probably resulted from unusual wanderings of animals into the region.

Fault—A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Federal Register—The official daily publication for actions taken by the U.S. Federal Government, such as Rules, Proposed Rules, and Notices of Federal agencies and organizations, as well as Executive Orders and other Presidential documents.

Fisheries exclusion zone—Refer to "Stand-off distance."

Flaring—The burning of natural gas that has been extracted with oil during drilling operations.

Frequency—In acoustics, a description of the rate of vibration, measured in cycles per second. One cycle per second is usually referred to as 1 Hz. Frequency is perceived by humans as pitch.

Frequency (pitch)—For sound waves, frequency is the rate at which the source-producing sound wave is vibrating or the rate at which the sound-producing body completes one vibration cycle. Frequency is expressed in units of Hertz (Hz), where 1 Hz is equal to one complete vibration cycle per second.

Gas hydrates—Gas molecules (e.g., methane) trapped in water-ice "cages" in subsea deposits.

Geology—The study of the materials, processes, environments, and history of the earth, including rocks and their formation and structure.

Geophysical survey—A method of exploration in which geophysical properties and relationships are measured remotely by one or more geophysical methods.

Geotechnical survey—A survey conducted to obtain information on the physical properties of the seafloor at and around a potential drill site.

Gulf Stream—The powerful, warm, and swift Atlantic Ocean current that is the western boundary current of the North Atlantic subtropical gyre (the clockwise circulation pattern produced by the earth's rotation). After passing Cape Hatteras, the Gulf Stream flows northeast toward Europe.

Habitat—A specific type of environment that is occupied by an organism, a population, or a community.

Harassment—Two definitions of harassment are used in this Programmatic EIS, depending on context. Under the ESA, harassment is an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Under the 1994 Amendments to the MMPA, harassment is any act of pursuit, torment, or annoyance which (a) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (b) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (Level B harassment).

High-frequency cetaceans—Species of cetaceans having a functional hearing range between 200 Hz and 180 kHz. Refer to Southall et al. (2007) for more information.

High-resolution geophysical (HRG) survey—A survey conducted to evaluate the suitability of a specific site for oil and gas exploration and development activities, renewable energy facilities, or marine mineral uses. The surveys are conducted to assess subseafloor conditions and to detect geohazards, archaeological resources, and certain types of benthic communities. The HRG surveys for oil and gas exploration may use an airgun in addition to electromechanical sources such as side scan sonar, boomer or chirp subbottom profiler, and single or multibeam depth sounder. The HRG surveys for renewable energy and marine minerals sites are not expected to use airguns.

Hydrocarbons—Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes—aromatic and aliphatics. They occur primarily in petroleum, natural gas, coal, and bitumens.

Hydrophone—Essentially an underwater microphone, a hydrophone is an underwater receiver used to detect the pressure change caused by sound waves propagating through the water. That pressure is converted to electrical energy which can be recorded or measured.

Incidental take—Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a Federal agency or applicant (refer to “Taking”).

Infauna—Animals living within the sediment.

Infrastructure—The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Intensity—For sound, intensity is the measure of the amount of energy that is transported over a given area per unit of time. Sound intensity is expressed in units of W/m^2.

Invertebrate—An organism lacking a backbone or spinal column. Any animal other than a fish, amphibian, reptile, bird, or mammal.

Lease—Authorization that is issued under Section 8 or maintained under Section 6 of the OCSLA and that authorizes exploration for, and development and production of, minerals.

Lease sale—The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals under specified conditions and periods of time.

Lessee—A party authorized by a lease, or an approved assignment thereof, to explore for and develop and produce the leased deposits in accordance with regulations at 30 CFR part 250.

Level A harassment—Under the MMPA, Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild.

Level B harassment—Level B harassment is any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where the patterns are abandoned or significantly altered. Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects have the potential to cause Level B harassment.

Localized—In close proximity to where work is being conducted.

Low-frequency cetaceans—Species of cetaceans having a functional hearing range between 7 Hz and 22 kHz. Refer to Southall et al. (2007) for more information.

Marine Mammal Protection Act (MMPA)—Enacted in October 1972, the MMPA provides protection for all marine mammals. The 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.

Marine Protected Area (MPA)—A marine area established under Executive Order 13158.

Masking—The obscuring of sounds of interest by interfering sounds, generally at the same or similar frequencies.

Memorandum of Agreement (MOA)—A written document describing a cooperative relationship between two parties wishing to work together on a project or to meet an agreed upon objective.

Meteorological tower—A tower containing equipment designed to measure wind speeds and to determine whether a site is suitable for a wind turbine.

Mid-frequency cetaceans—Species of cetaceans having a functional hearing range between 150 Hz and 160 kHz. Refer to Southall et al. (2007) for more information.

Minerals—As used in this document, minerals include oil, gas, sulphur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

Mitigation measure—A measure that will minimize, avoid, rectify, reduce, eliminate, or compensate for significant environmental effects.

Moratorium—Delay; a period during which certain proceedings or obligations are suspended.

M-weighting—Frequency weighting functions developed by Southall et al. (2007) for use in assessing the effects of underwater sounds on marine mammal. The weighting functions (designated "M" for marine mammals) are analogous to the C-weighting function for humans, which is commonly used in measuring high-amplitude sounds. Refer to Southall et al. (2007) for more information.

Mysticete—Any whale of the suborder Mysticeti having plates of whalebone (baleen plates) instead of teeth. Mysticetes are filter-feeding whales, also referred to as baleen whales, such as blue, fin, gray, and humpback whales.

National Ambient Air Quality Standards (NAAQS)—Air quality standards established by the CAA, as amended. The primary NAAQS specify maximum outdoor air concentrations of criteria pollutants to protect public health within an adequate margin of safety. The secondary NAAQS specify maximum concentrations that would protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Environmental Policy Act (NEPA)—A U.S. Federal law passed by Congress in 1969 (42 U.S.C. 4321 *et seq*.) establishing a national policy to provide a process for the consideration of environmental issues in Federal agency planning and decisionmaking. The potential environmental impacts of proposed Federal actions on the human and natural environment were to be considered prior to decision making. The NEPA procedures require that environmental information be made available to the public and the decision makers before decisions are made. Information contained in the NEPA documents must focus on the relevant issues in order to facilitate the decision-making process.

National Historic Preservation Act (NHPA)—The Federal statute that established a Federal program to further the efforts of private agencies and individuals in preserving the Nation's historic and cultural foundations.

National Marine Fisheries Services (NMFS)—The Federal agency that is a part of NOAA. The NMFS is responsible for the management, conservation, and protection of living marine resources within the U.S. EEZ. The NMFS is currently referred to as NOAA Fisheries.

National Marine Sanctuaries Act (NMSA) (16 U.S.C. §§ 1441 *et seq*.)—The NMSA authorizes the Secretary of Commerce to designate and protect areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or esthetic qualities as national marine sanctuaries.

National Oceanic and Atmospheric Administration (NOAA)—The Federal agency that manages commercial and recreational fisheries within Federal waters and designates EFH to help conserve Gulf fishery resources.

Nitrogen dioxide (NO_2)—A reddish-brown gas that is a strong oxidizing agent, produced by combustion (as of fossil fuels). The reactive oxides of nitrogen in the atmosphere are largely NO and NO_2, known together as NO_x. During the day, there exists a rapid interconversion of NO and NO_2 (refer to "Nitrogen oxides"). Nitrogen dioxide is one of the six criteria air pollutants specified under Title I of the CAA.

Nitrogen oxides (NO_x)—Nitrogen oxides include various nitrogen compounds, primarily nitric oxide (NO) and nitrogen dioxide (NO_2). They form when fossil fuels are burned at high temperatures and react with volatile organic compounds to form ozone, the main component of urban smog. They are also precursor pollutants that contribute to the formation of acid rain and to impairment of visibility.

Noise—Unwanted sound; a subjective term reflective of societal values regarding what constitutes unwanted or undesirable intrusions of sound.

Nonattainment area—An area that is shown by monitoring data or by air-quality modeling calculations to exceed primary or secondary ambient air quality standards established by USEPA.

Non-listed species—Species that are not listed as threatened or endangered by State or Federal agencies.

Notice of Intent (NOI)—A written notice published in the *Federal Register* that announces the intent to prepare an EIS under the NEPA. Also provides information about a proposed Federal action, alternatives, the scoping process, and points of contact within the lead Federal agency regarding the EIS.

Ocean current—Continuous forward movement of ocean water driven by wind and solar heating of the waters near the equator, although some ocean currents result instead from variations in water density and salinity.

Odontocete—Any toothed whale (i.e., cetacean without baleen plates) of the suborder Odontoceti (e.g., sperm whales, killer whales, beaked whales, dolphins, and porpoises).

Operator—An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Outer Continental Shelf (OCS)—All submerged lands that comprise the continental margin adjacent to the U.S. and seaward of State offshore lands.

Outer Continental Shelf (OCS) lands—Offshore lands located outside of State coastal waters. Generally, OCS lands begin approximately 3.3 statute mi (5.3 km) offshore with respect to coastal States, except in the cases of Texas and the west coast of Florida, where OCS lands begin approximately 10.2 statute mi (16.4 km) offshore.

Outer Continental Shelf Lands Act (OCSLA), as amended—The Act authorizing the U.S. Department of the Interior to regulate activities related to the development of mineral resources on the OCS.

Ozone (O_3)—A strong-smelling, reactive gas consisting of molecules composed of three oxygen atoms. It is formed in the atmosphere by chemical reactions involving nitrogen oxides and volatile organic compounds in sunlight. A major constituent of smog, it can impair the respiratory system and damage plants and ecosystems. Ozone is a criteria air pollutant under the CAA.

Particulate matter (PM)—A mixture of solid particles and liquid droplets found in the air.

Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small that they can only be detected using an electron microscope.

Pascal (Pa)—A unit of pressure equivalent to 1 newton of force applied evenly over 1 m2. The unit is named after Blaise Pascal, the eminent French mathematician, physicist, and philosopher.

Passive acoustics—The action of listening for sounds, often at specific frequencies or for purposes of specific analyses.

Passive acoustic monitoring (PAM)—A listening system that, in the marine environment, utilizes hydrophones, signal processing software, and (usually) some degree of human listening to detect and often to localize the vocalizations of marine mammals.

Pelagic—A broad term applied to species that inhabit the open, upper portion of marine waters rather than waters adjacent to land or near the seafloor.

Pelagic fishes—Fish that spend most of their lives swimming in the water column, as opposed to on or near the bottom.

Permanent threshold shift (PTS)—Exposure to high-intensity sound may result in auditory effects such as noise-induced threshold shift, or simply a threshold shift. If the threshold shift becomes a permanent condition, generally as a result of physical injury to the inner ear and hearing loss, it is known as PTS.

Physical oceanography—The scientific study of ocean physics, including ocean currents, waves, and tides.

Physiographic—Pertaining to the physical features of the land, in particular its slope and elevation.

Physiological effect—Defined in this Programmatic EIS as a variation in an animal's physiology that results from an anthropogenic acoustic exposure and exceeds the normal daily variation in physiological function.

Pinger—A pulse generator using underwater sound to transmit data, such as subject location.

Pinniped—Any member of a suborder (Pinnipedia) of aquatic carnivorous mammals (i.e., seals and sea lions) with all four limbs modified into flippers

Pitch—A property of sound; sound wave frequency as perceived by the receptor. In music, two tones whose frequencies make a 2:1 ratio are said to be separated by an octave interval; a frequency ratio of 5:4 defines a third; a frequency ratio of 4:3 defines a fourth; and a frequency ration of 3:2 defines a fifth.

Plankton—Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Planning area—A subdivision of an offshore area used as the initial basis for considering blocks to be offered for lease in the U.S. Department of Interior's areawide offshore oil and gas leasing program.

Platform—A steel or concrete structure from which offshore development wells are drilled.

PM_{10}—Particles with an aerodynamic diameter of less than or equal to 10 micrometers (0.0004 in.). These can be inhaled through the upper airways and deposited in the lower airways and gas-exchange tissues in the lung. PM_{10} is one of the six criteria air pollutants specified under Title I of the CAA.

$PM_{2.5}$—Particles with an aerodynamic diameter of less than or equal to 2.5 micrometers (0.0001 in). A greater fraction of particles in this size range can penetrate and be deposited deep in the lungs, and smaller portions of $PM_{2.5}$ (e.g., >0.1 micrometer) can enter the bloodstream. $PM_{2.5}$ is one of the six criteria air pollutants specified under Title I of the CAA.

Pneumatic—Operated by pressurizing air.

Population—A group of individuals of the same species occupying a defined locality during a given time that exhibit reproductive continuity from generation to generation.

Production—Activities that take place after the successful completion of any means for the extraction of resources, including bringing the resource to the surface, transferring the produced resource to shore, monitoring operations, and drilling additional wells or workovers.

Protected species observer (PSO)—A trained, dedicated, and experienced individual responsible for conducting visual watches for protected species, such as marine mammals and sea turtles, during marine seismic surveys; previously called Marine Mammal Observer or MMO.

Province—A spatial entity with common geologic attributes. A province may include a single dominant structural element such as a basin or a fold belt, or a number of contiguous related elements.

Pulse—A brief, broadband, atonal, transient sound; e.g., an explosion, gun shot, airgun pulse, or pile driving strike. Pulses are characterized by a rapid rise from ambient pressure to maximal pressure, and (at least near the source) by short duration.

Raptor—Bird of prey (e.g., an eagle, owl, or hawk).

Ramp up (or soft start)—Turning on airguns or other acoustic source at low power and gradually and systematically increasing the output until full power is achieved (usually over a period of minutes). The appropriate ramp up or soft-start method depends on factors such as the type of seismic survey equipment being used and vessel speed.

Received level—The level of sound that arrives at the receiver (e.g., a marine mammal) or listening device (hydrophone). The received level is the source level minus the transmission losses from the sound traveling through the water.

Record of Decision (ROD)—A concise summary of the decision made by the project proponent (e.g., BOEM) from the alternatives presented in a Final EIS. The ROD is published in the *Federal Register*.

Recreational beaches—Frequently visited, sandy areas along the shorefront that support multiple recreational activities at the land-water interface (e.g., National Seashores, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resorts).

Red tides—Blooms of single-cell algae that produce potent toxins harmful to marine organisms and humans and are a natural phenomenon in the Gulf of Mexico, occurring primarily off southwestern Florida and Mexico.

Region—In this Programmatic EIS, geographic areas on the OCS off the coast of the U.S.

where the BOEM has jurisdiction to regulate actions, including oil and gas development and development of mineral resources.

Relief—The difference in elevation between the high and low points of a surface.

Renewable energy—For the purposes of this Programmatic EIS, renewable energy is defined as energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydrological, geothermal, solar, wind, ocean, thermal, wave action, and tidal.

Reserves—Proved oil or gas resources.

Resonance—A phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration – the particular frequency at which the object vibrates most readily.

Rig—A structure used for drilling an oil or gas well.

Right-of-way—In property law, an easement to use another's land for passage. For the OCS, a right of way is most commonly used for pipelines that cross lands that the operator does not control entirely by lease.

Root mean square (rms) sound pressure—Average sound pressure over some specified time interval. For airgun pulses, the averaging time is commonly taken to be the approximate duration of one pulse, which in turn is commonly assumed to be the time interval within which 90 percent of the pulse energy arrives. The rms sound pressure level (in dB) is typically ~10 dB less than the peak level, and ~16 dB less than the peak-to-peak level.

Safety zone—Refer to "Stand-off distance."

Salinity—A measure of the salt content of water, usually expressed in parts per thousand (ppt).

Salt marshes—Intertidal wetlands that occur on the margins of estuaries, protected bays, and the landward side of barrier islands.

Scoping—An early and open process with Federal and State agencies and interested parties to identify possible alternatives and the significant issues to be addressed in an EIS.

Seagrass beds—More-or-less continuous mats of submerged, rooted, marine, flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish.

Sediment—Material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

Sedimentary basin—A geologically (but not necessarily topographically) depressed area with thick sediments (sedimentary rocks) in the interior and thinner sediments at the edges.

Seeps (hydrocarbon)—Gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes.

Separation distance—Refer to "Stand-off distance."

Seismic—Of, subject to, or caused by an earthquake or earth vibration.

Shallow test wells—Wells that involve drilling into the sea bottom to depths less than

152 m (500 ft) and are primarily drilled to gather geological information (30 CFR part 251).

Shoal—The sandy elevation of the bottom of a body of water, constituting a hazard to navigation; a sandbank or sandbar.

Short term—Lasting for a limited time (not permanent).

Significance criteria—Benchmark or standard used in an analysis to determine which environmental impacts are important.

Sound exposure level (SEL)—The total noise energy produced from a single noise event; the SEL is the integration of all the acoustic energy contained within the event. The SEL takes into account both the intensity and the duration of a noise event. The SEL is stated in dB re 1 μPa2 s for underwater sound.

Sound navigation and ranging (sonar)—Any anthropogenic (manmade) or animal (e.g., bats, dolphins) system that uses transmitted and/or received acoustic signals for navigation, communication, and determining position and bearing of a target. There are two broad types of anthropogenic sonar—active and passive. Active sonar involves the production of a signal that propagates through the environment and bounces off objects (such as a prey item). That reflected sound, or echo, travels back to the receiver, which interprets the echo. Therefore, active sonar involves two-way sound transmission. Passive sonar involves one-way sound transmission from an acoustic source (such as conspecific) to a receiver or listener.

Sound pressure level (SPL)—A measure of the rms, or "effective" sound pressure, converted to decibels. The SPL is expressed in dB re 1 μPa for underwater sound and dB re to 20 μPa for airborne sound.

Source level (SL)—The received sound pressure level measured or estimated at a nominal distance of 1 m from the source. It is often expressed as dB re: 1 μPa at 1 m or in bar m. For a distributed source, such as an airgun array, the nominal overall source level, as used in predicting received levels at long distances, exceeds the level measurable at any one point in the water near the sources.

Sparker—A low-energy acoustic source that generates a precisely timed electrical arc that momentarily vaporizes water between positive and negative leads. The collapsing bubbles produce a broad band omnidirectional pulse which can penetrate several hundred meters into the ocean bottom. Hydrophone arrays towed nearby receive the return signals.

Species of (special) concern—A species that may have a declining population, limited occurrence, or low numbers for any of a variety of reasons.

Stand-off distance—The area around a seismic survey vessel and its towed-streamer arrays to be kept clear of other vessel traffic and marine hazards that could result in a space-use conflict or interaction with other vessels for safety and security purposes.

Structure—Any OCS facility that extends from the seafloor to above the waterline; in petroleum geology, any arrangement of rocks that may hold an accumulation of oil or gas.

Sulfur oxides (SO_x)—A collective term for oxides of sulfur, of which the principal air pollutants are sulfur dioxide (SO_2), sulfur trioxide (SO_3), and sulfur mist generated by the combination of the sulfur oxides with water in the air. These gases are formed primarily by fossil fuel combustion. SO_x contributes to respiratory illness, particularly in children and the elderly, and aggravates existing heart and lung diseases. It also contributes to the formation of acid rain and to visibility impairments. SO_x is one of the six criteria air pollutants specified under Title I of the clean Air Act.

Supply vessel—A boat that ferries food, water, fuel, and drilling supplies and equipment to an offshore rig or platform and returns to land with refuse that cannot be disposed of at sea.

Surficial—Pertaining to or lying on the surface of the earth.

Taking—To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered or threatened species, or to attempt to engage in any such conduct (including actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts). Harassments are the most common form of taking associated with OCS Program activities.

Temporary—Lasting for a limited time (not permanent).

Temporary threshold shift (TTS)—Exposure to high-intensity sound may result in auditory effects such as noise-induced threshold shift, or simply a threshold shift. If the threshold shift recovers completely after a few minutes, hours, or days, it is known as TTS. A threshold shift represents an increase in the auditory threshold (i.e., a reduced ability to hear) at a particular frequency. By definition, TTS is recoverable and results from the temporary, non-injurious distortion of hearing-related tissues. In this Programmatic EIS, the smallest measurable amount of TTS (onset TTS) is taken as the best indicator for slight temporary sensory impairment. Because it is non-injurious, the acoustic exposure associated with onset TTS is used to define the outer limit of the portion of the Level B harassment zone attributable to physiological effects.

Terrace—A flat, wave-cut platform of various unconsolidated sedimentary deposits.

Terrigenous—Pertaining to sediments derived from land sources.

Threatened species—Under the ESA, any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (ESA § 3[20]).

Topography—The elevation or slope of the land surface.

Transmission loss—Pressure or energy losses that occur as the sound travels through the water. Losses occur because the wavefront spreads over an increasingly large volume as the sound propagates, and because of additional processes including scattering and the absorption of some of the energy by water.

Turbidity—Reduced water clarity due to the presence of suspended matter.

Turbine—A device in which a stream of water or gas turns a bladed wheel, converting the kinetic energy of the flow into mechanical energy available from the turbine shaft. Turbines are considered the most economical means of turning large electrical generators. They are typically driven by steam, fuel vapor, water, or wind.

Upwelling—The process by which warm, less-dense surface water is drawn away from a shoreline by offshore currents and replaced by cold, denser water brought up from the subsurface.

Velocity—For acoustics, the speed at which a sound wave (a longitudinal wave) travels through a medium. Velocity is measured in units of distance/time. The velocity or speed of a sound wave in any medium is dependent on both the inertial and elastic properties of the medium. In air, the speed of sound is dependent on the air's pressure (a measure of its inertial property of density) and its temperature (a measure of the air's elastic property of deformation in response to an applied force – in this case, the sound wave). At 1 atmosphere of pressure and a temperature of 20°C (68°F), the speed of sound is approximately 343 m/s (750 mph).

Vessel clearance zone—Refer to "Stand-off distance."

Vibratory—Operated by causing rapid, small movement in a back and forth manner.

Volatile organic compounds (VOCs)—Organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure.

Water quality—The condition of water with respect to the amount of impurities in it.

Watt—An International System unit of power equal to 1 joule per second.

Weathering (of oil)—The aging of oil due to its exposure to the atmosphere, resulting in marked alterations in its physical and chemical makeup.

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.