Office of National Marine Sanctuaries
National Oceanic and Atmospheric Administration

FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY

DRAFT ENVIRONMENTAL IMPACT STATEMENT: SANCTUARY EXPANSION

VOLUME I: CHAPTERS 1-6

June 2016

National Oceanic and
Atmospheric Administration (NOAA)

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Cover Photo:
Manta ray swimming over the reef in Flower Garden Banks National Marine Sanctuary.
Photo: G.P. Schmahl/FGBNMS

Flower Garden Banks National Marine Sanctuary Boundary Expansion: Draft Environmental Impact Statement

Abstract: In accordance with the National Environmental Policy Act (NEPA, 42 U.S.C. 4321 et seq.) and the National Marine Sanctuaries Act (NMSA, 16 U.S.C. 1434), the National Oceanic and Atmospheric Administration's (NOAA) Office of National Marine Sanctuaries (ONMS) has prepared a Draft Environmental Impact Statement (DEIS) that considers alternatives for the proposed expansion of boundaries at the Flower Garden Banks National Marine Sanctuary (FGBNMS). The proposed action serves NOAA's mission to conserve and manage coastal and marine ecosystems and resources, and furthers the FGBNMS mission to "identify, protect, conserve, and enhance the natural and cultural resources, values, and qualities of FGBNMS and its regional environment for this and future generations." ONMS has developed various boundary expansion alternatives, and the DEIS evaluates the environmental consequences of the alternatives under NEPA, applying criteria and evaluation standards under the regulations implementing NEPA (40 Code of Federal Regulations (CFR) § Parts 1500-1508) and the NOAA implementing procedures for NEPA (NOAA's Administrative Order 216-6). The DEIS also serves as a resource assessment under the NMSA, documenting (i) present and potential uses of the areas considered in the alternatives; (ii) commercial, governmental, or recreational resource uses in the areas that are subject to the primary jurisdiction of the Department of the Interior; and (iii) any past, present, or proposed future disposal or discharge of materials in the vicinity of the proposed sanctuary. NOAA's preferred alternative (Alternative 3) is the expansion of the existing boundaries from ~56 square miles to an area that encompasses ~383 square miles of waters in the northwestern Gulf of Mexico, including additional important and sensitive marine habitat areas outside the current sanctuary boundary. No significant adverse impacts to resources and the human environment are expected under any alternative. Long-term beneficial impacts are anticipated if the proposed action is implemented. Although an environmental assessment would have sufficed to analyze the impacts of the proposed action under NEPA, a DEIS has been prepared to satisfy the procedural requirements of the NMSA.

Lead Agency: National Oceanic and Atmospheric Administration

Cooperating Agencies: Bureau of Ocean Energy Management; Bureau of Safety and Environmental Enforcement

For Further Information Contact: Kelly Drinnen, Sanctuary Outreach Specialist, Flower Garden Banks National Marine Sanctuary, email: fgbexpansion@noaa.gov

Comments Due: We will consider public comments received on or before August 19, 2016.

Public Comments May Be Submitted:

Via the Web: www.regulations.gov (search for docket # NOAA-NOS-2016-0059) or http://flowergarden.noaa.gov/management/expansiondeis.html

Via U.S. Mail: Attn. George Schmahl, Superintendent, Flower Garden Banks National Marine Sanctuary, 4700 Ave. U, Bldg. 216, Galveston, TX 77551

About this Document

This Draft Environmental Impact Statement (DEIS) provides detailed information and analysis of a range of reasonable alternatives for the expansion of Flower Garden Banks National Marine Sanctuary, including location and regulation of various human uses in that area.

This DEIS has been prepared in accordance with the National Environmental Policy Act of 1969, as amended (NEPA), 42 United States Code (U.S.C.) §4321 et seq, its implementing regulations (40 CFR) § Parts 1500-1508), and the National Oceanic and Atmospheric Administration's (NOAA) implementing procedures for NEPA (NOAA's Administrative Order 216-6).

Accordingly, this document was preceded by a Notice of Intent to prepare a DEIS and carry out a public scoping process (80 FR 5699; February 3, 2015). The public scoping period commenced in February and ended on April 6, 2015, during which time public hearings were held and NOAA received both written and oral comments on the concept of expanding the boundaries of the sanctuary. NOAA received approximately 200 comments during that scoping period, generally supportive of the concept. NOAA is the lead agency for this action. NOAA's Office of National Marine Sanctuaries (ONMS) is the implementing office for this action. Cooperating agencies for the development of this DEIS include the Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE).

Recommended Citation:

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
Office of National Marine Sanctuaries
1305 East-West Highway
Silver Spring, Maryland 20910

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act of 1969 (NEPA), the National Oceanic and Atmospheric Administration (NOAA) encloses for your review the Draft Environmental Impact Statement (DEIS) for Flower Garden Banks National Marine Sanctuary (FGBNMS). The DEIS considers five alternatives for the proposed expansion of FGBNMS.

In 1992, NOAA designated East and West Flower Garden Banks as Flower Garden Banks National Marine Sanctuary. In 1996, Stetson Bank was added to the sanctuary through Congressional action. The three banks, encompassing 56 square miles, are part of a larger system of reefs and banks along the continental shelf in the north central Gulf of Mexico. Located 70 to 115 miles off the coasts of Texas and Louisiana, the three banks currently included within the sanctuary contain some of the most spectacular marine resources in the northern Gulf of Mexico, including some of the healthiest coral reef communities in the entire Caribbean and western Atlantic region.

The proposed action would serve NOAA's mission to conserve and manage coastal and marine ecosystems and resources, and furthers the FGBNMS mission to "identify, protect, conserve, and enhance the natural and cultural resources, values, and qualities of FGBNMS and its regional environment for this and future generations." FGBNMS has developed five sanctuary expansion alternatives, and the DEIS evaluates the environmental consequences of the alternatives under NEPA.

NOAA's preferred alternative (Alternative 3) would expand the existing sanctuary from 56 square miles to 383 square miles, to include additional important and sensitive marine habitat areas. No significant adverse impacts to resources and the human environment are expected under any alternative. Long-term beneficial impacts are anticipated if the proposed action is implemented. Although an environmental assessment would have sufficed to analyze the impacts of the proposed action under NEPA, a DEIS has been prepared to satisfy the procedural requirements of the National Marine Sanctuaries Act.

Public Meetings will be held as follows:

1) Galveston, Texas
Date: July 12, 2016
Location: Flower Garden Banks National Marine Sanctuary Office
Address: 4700 Avenue U, Building 216, Galveston, TX 77551
Time: 5:30-7:30 p.m.

2) Houston, Texas
Date: July 13, 2016
Location: Trini Mendenhall Community Center
Address: 1414 Wirt Rd., Houston, TX 77055
Time: 5:30-7:30 p.m.

3) New Orleans, Louisiana
Date: July 19, 2016
Location: Hilton New Orleans Airport, Segnette Room
Address: 901 Airline Drive, Kenner, LA 70062
Time: 5:30-7:30 p.m.

4) Mobile, Alabama
Date: July 20, 2016
Location: Five Rivers Delta Center
Address: 30945 Five Rivers Blvd., Spanish Fort, AL 36527
Time: 5:30-7:30 p.m.

5) Lafayette, Louisiana:
Date: July 21, 2016
Location: Estuarine Habitats and Coastal Fisheries Center
Address: 646 Cajundome Blvd., Lafayette, LA 70506
Time: 5:30-7:30 p.m.

Written comments will be accepted until August 19, 2016 and can be submitted online or through the mail to the sanctuary official identified below.

Responsible Official: John Armor
Acting Director, Office of National Marine Sanctuaries

Sanctuary Official: George Schmahl, Superintendent

Online:
Visit the federal eRulemaking portal at http://www.regulations.gov. In the search window, type NOAA-NOS-2016-0059, click the "Comment Now!" icon.

Mail:
Flower Garden Banks National Marine Sanctuary
4700 Ave. U, Bldg. 216,
Galveston, TX 77551

Sincerely,

John Armor
Acting Director

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List of Acronyms and Abbreviations

ACHP – Advisory Council on Historic Preservation
Advisory Council – Flower Garden Banks National Marine Sanctuary Advisory Council
ANSTF – Aquatic Nuisance Species Task Force
BEWG – Boundary Expansion Working Group
BOE – Barrels of Oil Equivalent
BOEM – Bureau of Ocean Energy Management (formerly MMS)
BSEE – Bureau of Safety and Environmental Enforcement (formerly MMS)
CEQ – Council on Environmental Quality
CFR – Code of Federal Regulations
CWA – Clean Water Act
DEIS – Draft Environmental Impact Statement
DWH – Deepwater Horizon
EFH – Essential Fish Habitat
EIS – Environmental Impact Statement
EPA – Environmental Protection Agency
ESA – Endangered Species Act
FGB – Flower Garden Banks
FGBNMS – Flower Garden Banks National Marine Sanctuary
FMP – Fishery Management Plan
FR – Federal Register
GHG – Greenhouse Gas
GIS – Geographic Information System
GOMESA – Gulf of Mexico Energy Security Act of 2006
GMFMC – Gulf of Mexico Fishery Management Council
HAPC – Habitat Area of Particular Concern
MMbbl – Million Barrels of Oil
MMPA – Marine Mammal Protection Act
MMS – Minerals Management Service (now BOEM and BSEE)
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NAAQS - National Ambient Air Quality Standards
NAO – NOAA Administrative Order
NAZ – No Activity Zone(s)
NEPA – National Environmental Policy Act
NHPA – National Historic Preservation Act
NMFS – National Marine Fisheries Service
NMSA – National Marine Sanctuaries Act
NOAA – National Oceanic and Atmospheric Administration
NOS – National Ocean Service
NPDES – National Pollution Discharge Elimination System
NRDA – Natural Resource Damage Assessment
NTL – Notice to Lessees
OCS – Outer Continental Shelf
OER – Office of Exploration and Research
ONMS – Office of National Marine Sanctuaries
PL – Public Law
PNAS – Proceedings of the National Academy of Sciences
PSBF – Potentially Sensitive Biological Feature
ROV – Remotely Operated Vehicle
TPWD – Texas Parks and Wildlife Department
USACE – U.S. Army Corps of Engineers

USFWS – U.S. Fish and Wildlife Service
USC – United States Code
VMS – Vessel Monitoring System

Executive Summary

Located in the northwestern Gulf of Mexico, 70 to 115 miles off the coasts of Texas and Louisiana, Flower Garden Banks National Marine Sanctuary (FGBNMS or sanctuary) currently includes three separate undersea features: East Flower Garden Bank, West Flower Garden Bank and Stetson Bank. The banks range in depth from 55 feet (17 meters) to nearly 500 feet (152 meters). Geologically they are underwater hills formed by ancient depositional salt layers pushed up through more dense overlying sedimentary layers due to structural uplift or weaknesses in the overlying beds. The banks provide a wide range of habitat conditions that support several distinct biological communities, including the northernmost coral reefs in the continental United States. These and similar formations throughout the northern Gulf of Mexico provide the foundation for essential habitat for a variety of species. The combination of location and geology makes FGBNMS extremely productive and diverse, and presents a unique set of challenges for managing and protecting its natural wonders.

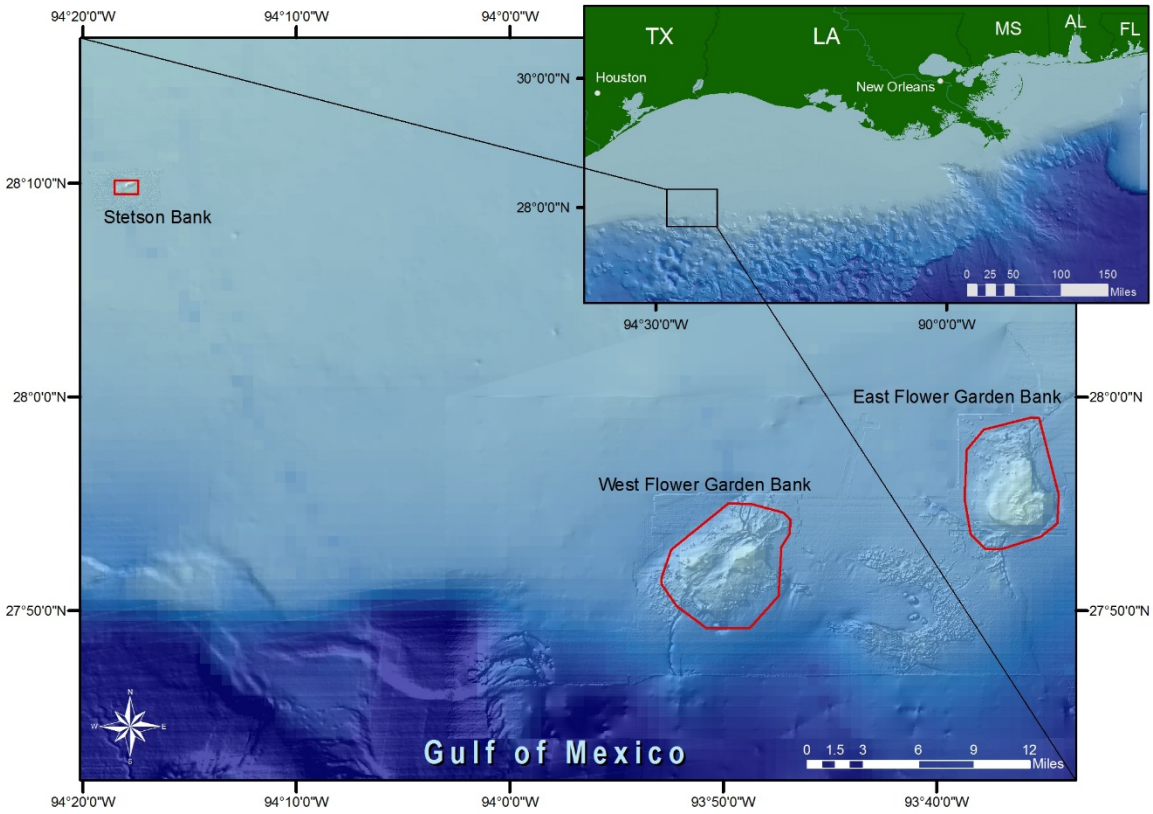

Figure ES.1. Flower Garden Banks National Marine Sanctuary

NOAA designated East and West Flower Garden Banks as a national marine sanctuary in 1992 for purposes of protecting and managing the conservation, ecological, recreational, research,

educational, historic and aesthetic resources and qualities of these areas. Congress added Stetson Bank to the sanctuary in 1996 (P.L. 104-283). The Flower Garden Banks Management Plan was originally developed in 1991 as part of the designation process (56 FR 63634). A more detailed description of the sanctuary and its resources can be found in Chapter 4 (Affected Environment).

The Office of National Marine Sanctuaries (ONMS) is required to periodically review sanctuary management plans to ensure that National Marine Sanctuary sites continue to best conserve, protect and enhance their nationally significant living and cultural resources. In 2012 the National Oceanographic and Atmospheric Administration (NOAA) updated and revised the 1991 Flower Garden Banks Management Plan to address recent scientific discoveries, advancements in managing marine resources, and new resource management issues (NOAA 2012b). The sanctuary mission—revised in that management plan review—is to:

- Identify, protect, conserve, and enhance the natural and cultural resources, values, and qualities of FGBNMS and its regional environment for this and future generations.

The 2012 Management Plan contains several action plans, including the Sanctuary Expansion Action Plan. In furtherance of that Action Plan, NOAA is proposing to expand the boundaries of the sanctuary and apply the existing management plan and regulations to the newly expanded area. Five expansion alternatives are evaluated in this DEIS, and the existing regulations that apply to the current sanctuary boundaries would be extended to the newly expanded area described under each alternative. The 2012 Management Plan explains the process undertaken by the Flower Garden Banks National Marine Sanctuary Advisory Council (Advisory Council) to arrive at its recommendation for expansion, including working group meetings and public workshops to explore the issue, deliberation of the working group's recommendation by the full Advisory Council, and adoption of the final recommendation by the full Advisory Council. The Advisory Council forwarded the recommendation to the sanctuary superintendent in December 2007. The primary reasons for recommending an expansion included identifying impacts to sensitive biological and geological resources, providing safe boater and diver access to the marine areas under consideration, restoring prior damage that occurred in the absence of sufficient regulatory protection, and protecting nationally significant biological and geological resources from further sustained damage in the absence of sufficient regulatory protection. The Advisory Council concluded that the comprehensive management approach offered by National Marine Sanctuary designation could provide the necessary protection to these nationally significant habitats and balances well established research, education, resource protection and law enforcement with compatible uses. Public scoping comments, both during the management plan review and following the Notice of Intent to prepare this Draft Environmental Impact Statement, also strongly supported expansion as a priority issue for the sanctuary. The Advisory Council recommendation is included in section 3.2 of the 2012 FGBNMS Management Plan, titled "Sanctuary Expansion Action Plan."

- Alternative 1, the no action alternative, maintains the existing FGBNMS boundaries, which encompass ~56 square miles (~42 square nautical miles) and include 3 distinct

geologic features and biological communities at East Flower Garden Bank, West Flower Garden Bank, and Stetson Bank.

- Alternative 2 is the sanctuary expansion recommendation made by the Advisory Council in 2007, encompassing a total of ~281 square miles (~212 square nautical miles). This alternative includes 12 nationally significant natural features within 9 discrete proposed boundary areas.

- Alternative 3 is the preferred alternative, and is a modified version of the Advisory Council recommendation. This alternative takes into account new information gained since the Advisory Council recommendation was made, simplifying the recommended boundaries for ease of enforcement and consistency with existing regulatory regimes, and encompassing ~383 square miles (~289 square nautical miles). This alternative includes a total of 18 nationally significant natural features within 11 discrete proposed boundary areas.

- Alternative 4 would add protection for high priority mesophotic and deep benthic resource areas across the north central Gulf of Mexico to the modified Advisory Council recommendation (Alternative 3), requiring additional operational capacity beyond what is currently available for the FGBNMS, and encompassing ~634 square miles (~479 square nautical miles). This alternative includes 43 nationally significant natural features (including 18 high priority mesophotic and deep benthic sites) within 29 discrete proposed boundary areas.

- Alternative 5 would provide for more comprehensive management and protection of important and vulnerable mesophotic and deep benthic habitats as well as important cultural and historic resource sites across the north central Gulf of Mexico, further expanding from the modified Advisory Council recommendation and encompassing ~935 square miles (~707 square nautical miles). This alternative includes 57 nationally significant natural features and 8 nationally significant cultural and historic resource sites within 45 discrete proposed boundary areas. Alternative 5 would also require additional operational capacity beyond what is currently available for the FGBNMS.

The proposed action evaluated in this DEIS is to expand, as appropriate, the network of protected areas within the sanctuary, and apply the existing sanctuary regulations and management actions to the expanded area. Based on the criteria developed by the Advisory Council's Boundary Expansion Working Group and the Advisory Council's 2007 recommendation, research and consultation with other federal and state agencies by sanctuary staff, and strong public support and comment during public meetings preceding this proposal, NOAA's preferred alternative (Alternative 3) is the expansion of the existing boundaries from ~56 square miles to an area that encompasses ~383 square miles of waters in the northwestern Gulf of Mexico, including additional important and sensitive marine habitat areas outside the current sanctuary boundary.

Expanding the FGBNMS boundaries under NOAA's preferred alternative would also modify the existing Stetson Bank boundary and would incorporate East and West Flower Garden Banks in a single new habitat complex area inclusive of Horseshoe Bank. The preferred alternative would also establish seven new discontiguous boundaries encompassing seven individual banks (McGrail, Geyer, Sonnier, Alderdice, MacNeil, Elvers, and Parker) and two additional habitat complexes inclusive of multiple reefs and banks (the Bright-Rankin-28 Fathom complex and the Bouma-Bryant-Rezak-Sidner complex). NOAA's preferred alternative would result in a ~383-square-mile sanctuary (including the existing sanctuary) encompassing 18 nationally significant reef and bank features (see Figure ES-2).

Table ES.1. Summary of expansion alternatives evaluated in this DEIS

	Resources Present	Subregions of the North Central Gulf of Mexico	Total Area (sq. mi.)
Alternative 1: No Action, retain current boundary	Coral reef/coral community; mesophotic coral habitats	NW banks	56.21
Alternative 2: 2007 Sanctuary Advisory Council recommendation	Coral reef/coral community; mesophotic coral habitats	NW banks, continental slope	281.15
Alternative 3: 2015 FGBNMS staff recommendation, NOAA's preferred alternative	Coral reef/coral community; mesophotic coral habitats	NW banks, continental slope	383.19
Alternative 4: NOAA's preferred alternative plus high priority mesophotic and deep coral sites	Coral reef/coral community; mesophotic coral habitats; deep coral ecosystems	NW banks; Pinnacles; continental slope	633.76
Alternative 5: Comprehensive protection for known high value north central Gulf of Mexico benthic habitats and cultural resources	Coral reef/coral community; mesophotic coral habitats; deep coral ecosystems; shipwrecks	NW banks; Pinnacles; continental slope	935.18

Chapter 1 provides background on the National Marine Sanctuary System and Flower Garden Banks National Marine Sanctuary, Chapter 2 states the Purpose of and Need for Action, and Chapter 4 describes the Affected Environment.

Chapter 3 (Description of Alternatives) provides a description of a range of alternatives. In addition to the "No Action" alternative and the FGBNMS Advisory Council recommendation, NOAA is evaluating alternatives that are larger in area, and designed to address key resources that lie beyond the existing sanctuary boundaries.

Chapter 5 (Analysis of Environmental Consequences) provides an analysis of the potential environmental impacts for each alternative. No significant adverse impacts to resources and the human environment are expected under any alternative. The boundaries proposed under each of the expansion alternatives encompass progressively greater numbers of nationally significant

biological and geological features and progressively greater areal extent. Environmental consequences are proportional to the number of features and areal extent encompassed under each alternative. As such, Alternative 5 represents the environmentally preferable alternative under this analysis. However, ONMS has identified Alternative 3 as the agency's preferred alternative (i.e., the alternative that the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors). Alternative 3 provides the greatest environmental benefit that can be managed with current FGBNMS operational capacity.

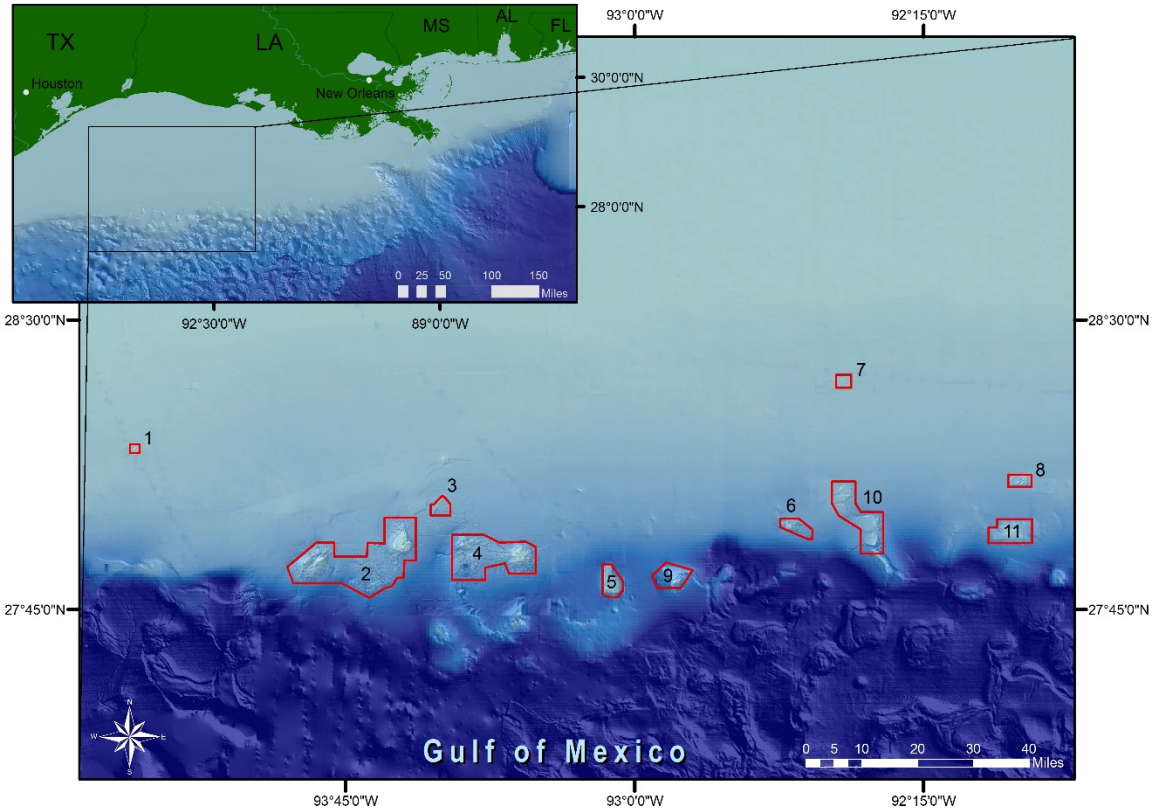

Figure ES.2. NOAA's preferred alternative (Alternative 3) for FGBNMS sanctuary expansion. The numbered banks in this map are as follows: 1. Stetson Bank, 2. West Flower Garden Bank, East Flower Garden Bank and Horseshoe Bank, 3. MacNeil Bank, 4. Rankin Bank, 28 Fathom Bank and Bright Bank, 5. Geyer Bank, 6. McGrail Bank, 7. Sonnier Bank, 8. Alderdice Bank, 9. Elvers Bank, 10. Bouma Bank, Bryant Bank, Rezak Bank and Sidner Bank, 11. Parker Bank.

Chapter 1

INTRODUCTION AND BACKGROUND

1.1 Historical Context for Boundary Expansion

The expansion proposed in this action is the logical outcome of decades of scientific research and growing public recognition of the need for additional protection of significant offshore marine places in the northern Gulf of Mexico. In the 1970s, scientists began to explore the outer continental shelf (OCS) in this region as interest in offshore oil and gas resources intensified. What they found was a surprising array of underwater features that are hotspots of marine biological diversity. These range from tropical coral reefs, like those found at the Flower Garden Banks, to mounds of deepwater branching corals (including species such as *Lophelia)* in the cold, dark depths where sunlight cannot penetrate. In between are numerous thriving biological communities associated with hard bottom bank features in depths were sunlight is diminished (known as "mid-light" or "mesophotic" zones). These ecosystems support fish and invertebrate populations of significant ecological and economic importance.

It was recognized early on that many of these areas are worthy of special protection. A stipulation to avoid and protect topographic features has been made part of appropriate OCS oil and gas leases since 1973. In 1974, the Flower Garden Banks were among the first to be designated by the Bureau of Land Management (predecessor agency of the Minerals Management Service (MMS) and subsequently the Bureau of Ocean Energy Management (BOEM)) as "No Activity Zones" (NAZs), where oil and gas exploration and production activities could not occur. A number of other reefs, banks and other features were also designated as NAZs in subsequent years. These included the reefs and banks of the northwestern Gulf of Mexico off Texas and Louisiana, and the Pinnacles area off Mississippi and Alabama. Stipulations to avoid and protect live bottom "Pinnacle Trend" features and "Low Relief" features have been made part of appropriate OCS oil and gas leases since 1974 and 1982, respectively. In 1984, the Flower Garden Banks were designated as "Habitat Areas of Particular Concern" (HAPCs) by the Gulf of Mexico Fishery Management Council (GMFMC), in recognition of their important ecological functions they serve as Essential Fish Habitat. The interest in the Flower Garden Banks culminated in their designation as a National Marine Sanctuary in 1992, and Stetson Bank was added to the sanctuary in 1996.

Meanwhile, scientific interest in the region continued to grow. Detailed mapping and characterization studies were conducted by MMS and the U.S. Geological Survey in the Pinnacles area beginning in the late 1990s. In the early 2000s, the "Sustainable Seas Expedition", led by Dr. Sylvia Earle and supported by the National Geographic Society, initiated new

exploration of the reefs and banks of the northwestern Gulf of Mexico, and brought added awareness of these areas to the American public. In addition, since 2003, MMS (now BOEM), and NOAA's Office of Ocean Exploration and Research have supported significant research on deepwater *Lophelia* and other coral communities, and have documented and characterized a number of historically important shipwrecks.

To protect these areas, a variety of management actions has been utilized to address specific potential impacts. As biologically sensitive areas were identified, additional protective measures were developed by the MMS (now BOEM) to minimize impacts from routine oil and gas activities by distancing activities from sensitive habitats. BOEM has protected deepwater benthic communities since 1998 through mitigations attached to OCS oil and gas-related permits, which distance bottom-disturbing activities from these sensitive habitats. In 2005, 12 additional reefs and banks of the northwestern Gulf of Mexico were designated as HAPCs by the GMFMC, and in 2014, a process was initiated by the Council to identify and designate additional HAPCs for areas containing significant mesophotic and deep coral communities. In 2007, revisions to the Magnuson-Stevens Fishery Conservation and Management Act required NOAA to identify known locations of deep sea corals and submit that information to the Fishery Management Councils, due to the recognition of the importance of these systems as fish habitat. In 2006, FGBNMS initiated a Management Plan Review process. Public input from that process identified a strong interest to expand the sanctuary boundary to include additional reefs and banks. The FGBNMS Advisory Council identified boundary expansion as one of the primary issues to be addressed in the revised management plan. The Advisory Council made a specific recommendation for expansion to FGBNMS management in 2007. In 2012, the FGBNMS published a revised management plan that included a "Sanctuary Expansion Action Plan" incorporating the Advisory Council expansion recommendation.

However, in 2010, one of the worst environmental disasters in American history occurred in the northern Gulf of Mexico. The Deepwater Horizon (DWH) drilling rig exploded, resulting in the deaths of 11 people and the release of over 3.2 million barrels (135 million gallons) of oil and dispersant into surrounding waters. The oil spill impacted a wide range of habitats and biological resources across an extensive geography in the Gulf of Mexico region. Monitoring and assessment of impacts was initiated throughout the Gulf of Mexico, including at selected reefs and banks in the northwestern Gulf, the Pinnacles area, the Florida Middle Grounds, the Florida Keys, and various locations from deepwater habitats to the coastal zone. Significant injury has been documented at deepwater coral areas in the vicinity of the wellhead, reefs of the Pinnacles area and other seafloor habitats.

The incorporation of places of national significance into the National Marine Sanctuary System supports national ocean resource management objectives articulated by many publicly vetted and expert-driven strategic planning efforts that reference the need for additional conservation protections for important habitat areas nationally and in the northern Gulf of Mexico. NOAA's 2010 "Strategic Plan for Deep-sea Coral and Sponge Ecosystems" identified a conservation and management strategy to "Enhance conservation of deep-sea coral and sponge ecosystems in

National Marine Sanctuaries and Marine National Monuments." Expansion of the sanctuary also supports specific recommendations contained within the Gulf Coast Ecosystem Restoration Task Force's Gulf of Mexico Regional Ecosystem Restoration Strategy (GCERTF 2011) to "Conserve and protect offshore environments", including the unique hard bottom structures like those in the vicinity of the Pinnacles and the Flower Garden Banks. Similar recommendations have been identified in a variety of other recent studies, such as the those generated by an expert working group and contained within the report entitled "A Once and Future Gulf of Mexico Ecosystem" (Peterson et al. 2011) to "establish deep-sea biological preserves to protect organisms such as coral that provide habitat structure" for fish and other valuable species. These areas have also been targeted by a variety of conservation groups for additional protection. For example, "Mission Blue", an ocean conservation group headed by Dr. Sylvia Earle, has identified the "Gulf of Mexico Deep Reefs" as one of 50 priority international "Hope Spots," special places that are critical to the health of the ocean (Mission Blue 2016).

Sanctuary expansion would extend the comprehensive conservation and management capacities authorized by the NMSA to new areas, providing a mechanism for implementation of specific restoration, monitoring and research activities for important marine resources. These types of activities could overlap with potential restoration strategies associated with the Deepwater Horizon (DWH) oil spill. For example, protecting and managing mesophotic and deep benthic coral communities through the use of offshore MPAs, including areas around the Flower Garden Banks and the Pinnacles area, has been identified as a restoration approach in the Final Programmatic Damage Assessment and Restoration Plan for the DWH Oil Spill (2016).

In general, the northern Gulf of Mexico is a heavily utilized and industrialized region, and there is a significant concern about impacts from bottom-disturbing activities (e.g. certain activities related to oil and gas exploration and production, fishing with bottom tending gear, vessel anchoring, salvage activities) on the sensitive biological resources and geological features associated with many reefs and banks in the area. At the same time, the opportunities for research, exploration, and education related to these significant ocean resources are critical for understanding changes occurring in the environment and fostering a stewardship ethic and an understanding of the ecosystem services these resources provide for communities throughout the Gulf of Mexico region. For these and other reasons, the comprehensive management approach offered by National Marine Sanctuary designation is needed, and the Flower Garden Banks National Marine Sanctuary is uniquely positioned to provide a coordinated conservation program to protect these vital areas.

1.2 Office of National Marine Sanctuaries

The Office of National Marine Sanctuaries (ONMS) is within NOAA's National Ocean Service and serves as the trustee for a system of marine protected areas, encompassing more than 170,000 square miles of ocean and Great Lakes waters from the state of Washington to the Florida Keys, and from Lake Huron to American Samoa (Figure 1.1).

Figure 1.1. Map of the National Marine Sanctuary System

ONMS manages the national marine sanctuaries under the authority of the National Marine Sanctuaries Act of 1972 (NMSA), 16 USC § 1431 *et seq*, (see Appendix E and www.sanctuaries.noaa.gov/about/legislation/). National Marine Sanctuary System regulations implement the NMSA and are codified at 15 CFR Part 922. In addition, the Papahānaumokuākea Marine National Monument is cooperatively managed by ONMS, the U.S. Fish and Wildlife Service, and the State of Hawaii under the authority of a Presidential Proclamation and the Antiquities Act. ONMS, the U.S. Fish and Wildlife Service, the Department of State, the Department of Defense, and the Government of American Samoa also cooperatively manage the Rose Atoll Marine National Monument. The joint regulations implementing the designation of the national monument are codified at 50 CFR Part 404.

These national marine sanctuaries and the marine national monuments include both nearshore and offshore marine areas. Their designation provides protection for sensitive marine ecosystems, such as coral reefs and kelp forests, deepwater habitats and geologic features such as canyons and seamounts, migration corridors and other habitats used by ecologically and economically important or protected marine species, and historically significant maritime archeological sites including shipwrecks and other artifacts. In addition, these areas serve as valuable educational, recreational, scientific and economic resources. National marine sanctuaries range in size from

just over three-quarters of a square mile in Monitor National Marine Sanctuary to 139,797 square miles at Papahānaumokuākea Marine National Monument, located in the northwest Hawaiian Archipelago.

ONMS fosters public awareness of marine resources and maritime heritage through scientific research, monitoring, exploration, education and outreach, and works closely with its many partners and the public to protect and manage sanctuaries. The ONMS is a world leader in marine management through the protection of living marine resources, environmental quality, and maritime heritage, while maintaining recreational and commercial activities that are sustainable and compatible with long-term preservation.

1.3 Flower Garden Banks National Marine Sanctuary

NOAA designated Flower Garden Banks National Marine Sanctuary (FGBNMS or sanctuary) in 1992, originally consisting of two areas known as East and West Flower Garden Banks (56 FR 63634, Dec. 5, 1991). Stetson Bank was added to the sanctuary by Congress in 1996 through amendments to the NMSA (P.L. 104-283). The boundaries of Stetson Bank and West Flower Garden Bank were later amended to improve administrative efficiencies and increase the precision of all boundary coordinates based on new positioning technology (65 FR 81175, Dec. 22, 2000). Comprehensive resource protection and management for FGBNMS is described in the site's management plan, first developed in 1991 and last updated in 2012, which includes programs for science, education, outreach, regulation, enforcement, permitting, and coordination with other local, state, and federal agencies.

1.4 Project Location: Northern Gulf of Mexico

The Flower Garden and Stetson Banks are only three among dozens of reefs and banks scattered along the edge of the continental shelf of the northern Gulf of Mexico (Figure 1.2). All of these features are part of a regional ecosystem heavily influenced by current patterns within the Gulf of Mexico, the most notable of which include the gulf loop current and eddies that separate from the gulf loop current (Figure 1.3). Inflows from the large Gulf of Mexico watershed, which drains two-thirds of the continental United States, also play a significant role in the ecological function of this region.

Scientists have long been aware that water circulation connects the dozens of banks along the continental shelf in the northern Gulf of Mexico. Recent explorations of the sea floor, however, have also demonstrated much more direct physical connections between these features than previously understood. Technological advances have allowed the creation of high resolution bathymetric maps that reveal networks of low relief geological features (such as rock outcrops) between many of the more prominent reefs and banks in this area. These features provide much more direct connectivity between the banks than previously understood, which may play a crucial role in maintaining the health of the sanctuary's living marine resources.

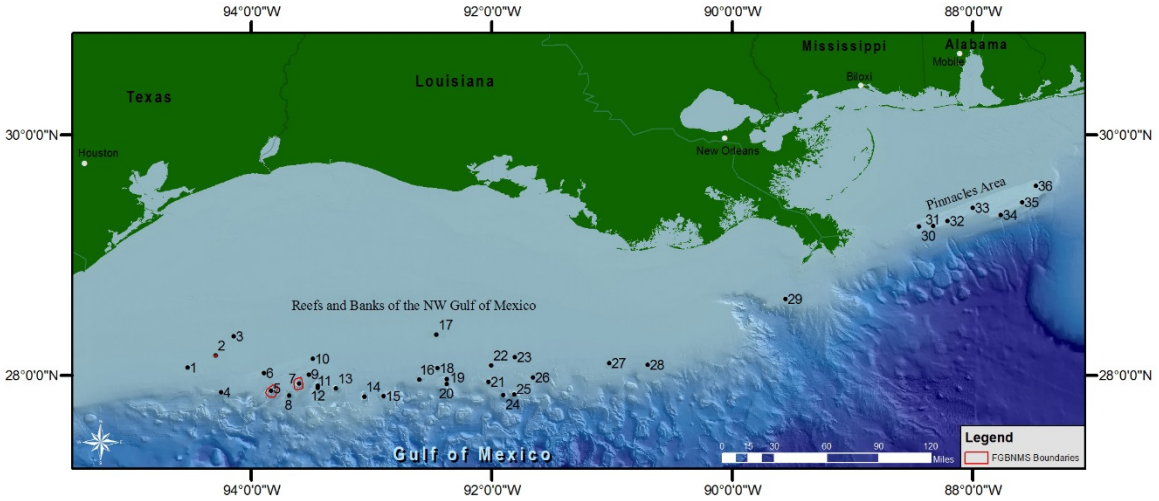

Figure 1.2. Selected Reefs and Banks of the North Central Gulf of Mexico

1. 32 Fathom Bank, 2. Stetson Bank, 3. Claypile Bank, 4. Applebaum Bank, 5. West Flower Garden Bank, 6. Coffee Lump Bank, 7. East Flower Garden Bank, 8. Horseshoe Bank, 9. MacNeil Bank, 10. 29 Fathom Bank, 11. Rankin Bank, 12. 28 Fathom Bank, 13. Bright Bank, 14. Geyer Bank, 15. Elvers Bank, 16. McGrail Bank, 17. Sonnier Bank, 18. Bouma Bank, 19. Rezak Bank, 20. Sidner Bank, 21. Parker Bank, 22. Alderdice Bank, 23. Fishnet Bank, 24. Phleger Bank, 25. Sweet Bank, 26. Jakkula Bank, 27. Ewing Bank, 28. Diaphus Bank, 29. Sackett Bank, 30. Mountain Top, 31. Alabama Alps and 36 Fathom Ridge, 32. West Addition Pinnacles, 33. Shark, Double Top, and Triple Top Reefs, 34. Ludwick-Walton and West Delta Mounds, 35. Yellowtail, Cat's Paw, Roughtongue, and Corkscrew Reefs, 36. Far Tortuga Reef.

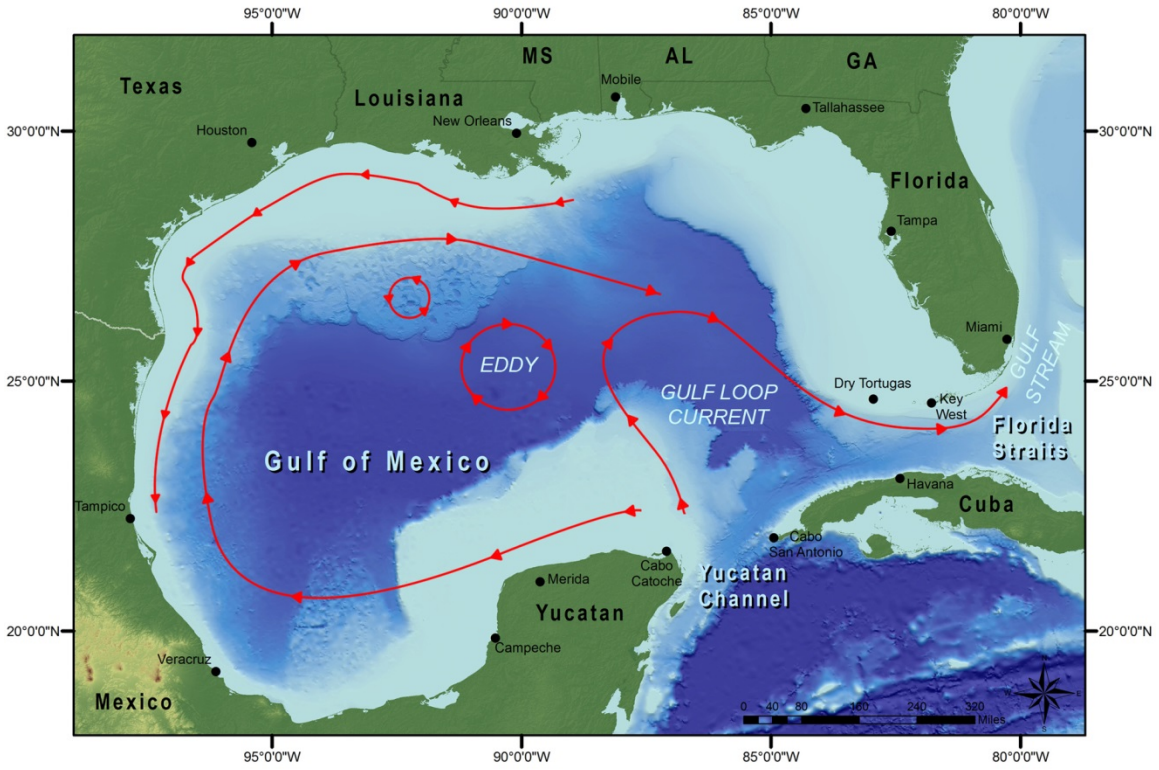

Figure 1.3. Predominant Currents and Eddies in the Gulf of Mexico

The setting within which the current sanctuary exists, including its physical and biological context and the institutional regimes that provide for management of the resources of the region, is described in the 2012 FGBNMS Management Plan. The current sanctuary boundaries are located in the Gulf of Mexico 70 to 115 miles off the coasts of Texas and Louisiana. These areas encompass a wide range of geologic features and habitat conditions that support several distinct biological communities, including the northern-most stony coral reefs in the continental United States. The banks included in the current sanctuary boundaries, and similar formations throughout the north central Gulf of Mexico, provide the foundation for essential benthic habitats that support a wide variety of species. The combination of location and geology makes FGBNMS extremely productive and diverse, and presents a unique set of challenges for managing and protecting its natural wonders. Sanctuary regulations prohibit a relatively narrow range of activities and establish requirements applicable to certain activities (summarized in Table 1.1; for full text of the regulations and relevant definitions see Appendix F, which contains the text of 15 CFR, Subpart L, 922.122, and see also 15 CFR, Subpart A, 922.3).

Offshore areas of the Gulf of Mexico, and the resources present in these areas, are currently managed under multiple authorities by several federal agencies. The Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) (both formerly Minerals Management Service, MMS) have historically protected topographic features (including the Flower Garden Banks) and sensitive hard bottoms from direct impact from oil and gas industry activity, through stipulations on leases and case-by-case reviews of permit applications that attach mitigations/conditions of approval to permits, which distances bottom disturbing activity (including anchor placement and drilling) from sensitive areas. NOAA and the Gulf of Mexico Fishery Management Council (GMFMC) have designated many of these same topographic features as Habitat Areas of Particular Concern (HAPC), a designation that itself does not carry restrictive fishing regulations, but for those banks named as Coral HAPC (East Flower Garden Bank, West Flower Garden Bank, Stetson Bank, and McGrail Bank) limits the types of fishing activities that can occur in the area and prohibits anchoring by fishing vessels. NOAA's National Marine Fisheries Service (NMFS) also manages endangered and threatened species through the Endangered Species Act (ESA) and marine mammals through the Marine Mammal Protection Act (MMPA). In addition, the Environmental Protection Agency (EPA) is responsible for protecting the quality of the nation's waters through the federal Water Pollution Control Act (Clean Water Act or CWA).

Table 1.1. Summary of FGBNMS regulations

Prohibited Activity: Exploring for, developing, or producing oil, gas, or minerals within a NAZ. Exceptions: Oil, gas, or mineral exploration, development, or production is permitted outside of NAZs provided all drilling cuttings and drilling fluids are shunted to the seabed through a downpipe that terminates an appropriate distance, but no more than ten meters, from the seabed, unless such discharge injures a Sanctuary resource or quality.
Prohibited Activity: Anchoring any vessel within the sanctuary.
Prohibited Activity: Mooring a vessel over 100 feet (in registered length) on a sanctuary mooring buoy.
Prohibited Activity: Mooring a vessel in the Sanctuary without clearly displaying the blue and white International Code flag "A" ("alpha" dive flag) or the red and white "sports diver" flag whenever a SCUBA diver from that vessel is in the water and removing the "alpha" dive flag or "sports diver" flag after all SCUBA divers exit the water and return back on board the vessel.
Prohibited Activity: Discharging or depositing any material or other matter in or into the sanctuary. Exceptions: 1) Fish, fish parts, chumming materials or bait used while fishing with conventional hook and line gear within the sanctuary; 2) clean effluent from an operable Type I or II marine sanitation device (MSD) (vessel operators are required to lock all MSDs in a manner that prevents discharge or deposit of untreated sewage); 3) clean water generated by routine vessel operations (e.g. cooling water, deck wash down, anchor wash, and bilge water) excluding oily wastes from bilge pumping; 4) engine exhaust.
Prohibited Activity: Taking any marine mammal or turtle within the sanctuary.
Prohibited Activity: Killing, injuring, attracting, touching, or disturbing rays or whale sharks. Exceptions: Incidental catch by conventional hook and line gear.
Prohibited Activity: Injury to or possession of sanctuary resources: Injuring or removing, or attempting to injure or remove, any coral or other bottom formation, coralline algae or other plant, marine invertebrate (e.g., spiny lobster, queen conch, shell, sea urchin), brine-seep biota or carbonate rock; possessing within the sanctuary (regardless of where collected, caught, harvested or removed), any carbonate rock, coral or other bottom formation, coralline algae or other plant, or fish (except for fish caught by use of conventional hook and line gear); drilling into, dredging or otherwise altering the seabed of the sanctuary; or constructing, placing or abandoning any structure, material or other matter on the seabed of the sanctuary.
Prohibited Activity: Fishing and related activities: injuring, catching, harvesting, collecting or feeding, or attempting to injure, catch, harvest, collect or feed, any fish within the sanctuary by use of any gear, device, equipment or means (e.g. spear guns, nets); possessing (except while passing through the sanctuary without interruption) any fishing gear, device, equipment or means; possessing, or using explosives or releasing electrical charges within the sanctuary. Exceptions: Use of conventional hook and line gear.
General Exception: Oil or gas exploration or development. Prohibitions on anchoring within the sanctuary, drilling or altering the seabed, and using explosives do not apply to necessary activities conducted in areas of the Sanctuary outside NAZs and incidental to exploration for, development of, or production of oil or gas in those areas.
General Exception: Activities necessary to respond to emergencies threatening life, property, or the environment.
General Exception: Activities being carried out by the Department of Defense (DoD).
General Exception: Activities executed in accordance with the scope, purpose, terms, and conditions of a National Marine Sanctuary permit or a Special Use permit.
General Exception: Activities authorized by any lease, permit, license, approval or other authorization provided that the applicant complies with ONMS requirements for notification and review and the applicant complies with any terms and conditions the ONMS deems necessary to protect Sanctuary resources and qualities.

1.5 Public and Agency Involvement

According to Council on Environmental Quality (CEQ) regulations, federal agencies are required to "make diligent efforts to involve the public in preparing and implementing their NEPA procedures" (40 CFR § 1506.6(a)).

1.5.1 Scoping

On February 3, 2015, NOAA published a notice of intent (NOI) in the Federal Register (80 FR 5699), which notified the public of the proposed action, announced the three public scoping meetings, and solicited public comments. ONMS held public scoping meetings in New Orleans, LA on March 3, 2015, Houston, TX on March 5, 2015 and Galveston, TX on March 11, 2015. Fifty-seven people participated in these meetings and provided input on specific issues to be analyzed or addressed as part of the environmental analysis for the proposed expansion of the sanctuary boundaries.

In addition to public scoping meetings, ONMS accepted written comments from February 3, 2015 to April 6, 2015. Comments were provided in the form of letters, and electronic submissions at http://www.regulations.gov. During the comment period, the agency received approximately 200 comments from or on behalf of both organizations and individuals. Individuals submitted 152 written comments and 25 verbal comments, while organizations submitted 14 written comments and 5 verbal comments. Four comments were submitted on behalf of both individuals and organizations, one of which included a petition in support of the proposed boundary expansion on behalf of 966 individuals from all 50 U.S. states, Puerto Rico, the District of Columbia, the U. S. Minor Outlying Islands, and the Netherlands Antilles. One comment letter, expressing conditional support for the proposed boundary expansion and requesting a number of specific analyses be incorporated in this DEIS, was submitted jointly by five trade associations representing the oil and gas industry. NOAA analyzed comments received during this process and considered them in preparation of the DEIS. A website (http://flowergarden.noaa.gov/management/expansionprocess.html) serves as a central location of project information. The website provides a link (http://www.regulations.gov/#!docketDetail;D=NOAA-NOS-2014-0154) to access all of the written comments received on the project.

Comments received during the scoping period fall into several broad categories, including general support, support based on specific resource values or uses, conditional support based on specific requests for analyses in this DEIS or on the preservation of access for particular uses in areas considered for boundary expansion and (in the case of one comment) general opposition. Roughly three quarters (149 of the 200 comments received) cited general support based on the national significance of the resources to be protected by expansion, the value of those resources for the states bordering the Gulf of Mexico, their value for future generations, and their aesthetic, cultural heritage, ecosystem service, and economic values. A number of comments emphasized that the proposed action is supported and justified by new scientific information, discoveries, or

circumstances, and/or that it aligns with and provides restoration for impacts to the Gulf of Mexico ecosystem.

Eighty-seven comments based statements of support on benefits and protections that boundary expansion could provide to, and the value of, specific qualities of or resources present in the areas under consideration. These included biodiversity; connectivity among habitats and populations; habitat, fish, and wildlife; resilience in the context of climate change and ocean acidification; coral reef; spawning aggregations; unique and/or poorly studied biology and habitats; unique and/or poorly studied geology; and protection from the impacts of human activity and industry generally, or specifically impacts from the tourism, diving, oil and gas, fishing, and salvage industries.

Fifty-four comments based statements of support on benefits that boundary expansion could provide to, and the value of, specific resource uses. Fifteen of these comments conditioned support on preserving access to the areas considered for inclusion in the expanded boundaries for these uses, which included recreation, tourism, and diving; fishing; education, research, monitoring, and exploration; and oil and gas development.

Forty-three comments suggested specific areas to be considered among the boundary expansion alternatives. These included support for the FGBNMS Advisory Council's recommendation; support for larger areas generally; support for the inclusion of important shipwrecks; and support for the inclusion of specific additional banks or other natural resources. Supporters of sanctuary expansion also suggested that NOAA consider larger buffer zones, called for greater connectivity among the banks, and include soft bottoms in the sanctuary expansion alternatives.

Seventy-three comments supported the application of a more restrictive regulatory and management framework in the areas considered for boundary expansion, citing the insufficiency of existing regulations in the areas and the need for the comprehensive regulatory and management framework offered by sanctuary designation. Among these, specific comments indicated that improved fishing regulation is needed, that no-take zones should be included, that additional protections against anchor damage are needed (these comments included support for mooring buoy installations, establishment of buffers between recreational use areas and shipping safety fairways, and the establishment of anchorages), and that additional regulations should be applied to the oil and gas industry. At the same time, fourteen comments indicated evidence of the need for additional protections is lacking, and two comments cited problems with the current sanctuary management regime. Eighteen comments indicated that additional budgetary and capacity resources are needed to support sanctuary operations, oversight, management, and enforcement, both in the current sanctuary and in potential boundary expansion areas. Twenty-four comments included requests for the inclusion in the DEIS of specific analyses of environmental consequences related to the areas, uses, and regulations identified above.

A range of reasonable alternatives is described in Chapter 3 of the DEIS. These alternatives were proposed by the public, the FGBNMS Advisory Council, and agency staff both from ONMS and

from the agencies and personnel consulted during the development of the DEIS (see Section 6.1.2). Some alternatives were eliminated from further evaluation for various reasons as described in Section 3.2.

NOAA has worked closely with and sought input from numerous pertinent resource agencies and researchers on the development of the DEIS (see Section 6.1.2). In September 2015, ONMS, BOEM, and BSEE entered into cooperating agency agreements for the development of the Environmental Impact Statement for the FGBNMS boundary expansion. In addition, informal consultations with the GMFMC have been ongoing since the initiation of the public scoping for this Draft Environmental Impact Statement. Formal consultation with the GMFMC pursuant to Section 304(a)(5) of the NMSA will take place as part of the rulemaking process to extend application of the existing regulations to the expanded areas of the sanctuary. Consultation with other natural resource management agencies (e.g., NMFS Protected Resources Division, EPA) will also continue after the publication of the DEIS.

1.5.2 Public Review of the DEIS

The next step of public involvement is to ensure wide circulation of the DEIS and to solicit public comments on this document. A public review period of at least 60 days follows publication of the DEIS. Availability of the DEIS is announced in the Federal Register, on various e-mail lists, on the project website, and in local newspapers. Public hearings will be held no sooner than 30 days after the notice is published in the Federal Register. During the public comment period, oral and written comments are anticipated from federal, state, and local agencies and officials, from organizations, and from interested individuals. After the public comment period is over, the comments will be reviewed. A summary of these comments and the corresponding responses from the agency will be included in the Final EIS. If necessary, changes will be made to the EIS as well as the proposed rule and draft management plans as a result of the public comments. If NOAA moves forward with a final action, it will issue a Final EIS, after which a 30-day mandatory waiting period will occur, and then NOAA may issue its record of decision (ROD). In addition, a final rule that promulgates the regulations and terms of designation of the sanctuary would be published in the Federal Register.

Chapter 2

PURPOSE AND NEED

2.1 Purpose of Action

The proposed action is to expand, as appropriate, the network of protected areas within the sanctuary (i.e., those areas in which existing sanctuary regulations and management actions would apply). The purpose of the proposed action is summarized in one of the pillars of NOAA's mission, to conserve and manage coastal and marine ecosystems and resources (NOAA 2010a). The NMSA authorizes the Secretary of Commerce to designate and manage discrete areas of the marine environment as national marine sanctuaries (16 U.S.C. 1433). Such designation is based on attributes of special national significance, including conservation, recreational, ecological, historical, scientific, cultural, archaeological, education or aesthetic qualities. The NMSA recognizes that "while the need to control the effects of particular activities has led to enactment of resource-specific legislation, these laws cannot in all cases provide a coordinated and comprehensive approach to the conservation and management of special areas of the marine environment" (16 U.S.C. 1431(a)(3)). Therefore, the NMSA promotes a broad and comprehensive, ecosystem-based approach to marine resource protection and management.

The purpose of the proposed action is also to further the FGBNMS mission to "identify, protect, conserve, and enhance the natural and cultural resources, values, and qualities of FGBNMS and its regional environment for this and future generations" (NOAA 2012b). Implementing the Sanctuary Expansion Action Plan described in the 2012 FGBNMS Management Plan (NOAA 2012b) will advance the FGBNMS Goal 6 ("promote ecosystem-based management of the FGBNMS regional environment") and Objective 6C ("evaluate and implement management actions that enhance ecosystem-based management").

The action alternatives (Alternatives 2-5) in this DEIS would expand the network of protected areas within FGBNMS by incorporating selected reefs and banks in the north central Gulf of Mexico for their long-term protection and management. These alternatives would provide protection for nationally significant benthic habitats with biological, ecological, and/or structural links to the existing sanctuary, including vulnerable habitats and living resources in the region. Those alternatives would provide for more comprehensive management and protection of important and vulnerable mesophotic and deep benthic habitat sites and cultural resources across the north central Gulf of Mexico, and would provide important opportunities for research and recovery of resources from observed impacts.

This DEIS describes the various reefs and banks considered for incorporation into FGBNMS, the alternative scenarios for incorporating the additional areas, and NOAA's preferred alternative. As

identified in the Notice of Intent preceding the preparation of this DEIS, NOAA also analyzed various regulatory scenarios for the existing sanctuary and any new potential sanctuary areas. Sanctuary regulations currently in place in FGBNMS (see Appendix F) prohibit, with specific exceptions, most bottom-disturbing activities, certain types of fishing and injury to sanctuary resources, among other requirements established at the time of sanctuary designation. They also include additional requirements that became effective on May 27, 2012 for display of dive flags, maintaining minimum distances from vessels, prohibiting damage to sanctuary property, prohibiting vessel discharges and prohibiting ray and whale shark disturbance.

2.2 Need for Action

The need for the proposed action is based on widespread acute and chronic threats to marine habitat in the north central Gulf of Mexico. These threats can most effectively be addressed through NOAA's evaluation and implementation of the comprehensive suite of habitat conservation and management actions made possible by FGBNMS expansion. The proposed action would ensure that valuable natural resources are available to future generations of Americans. Protecting additional nationally significant habitat in the northwestern Gulf of Mexico emerged as one of the highest priority issues for the sanctuary during the FGBNMS management plan review. Accordingly, a Sanctuary Expansion Action Plan was incorporated into the revised management plan published in April 2012.

The need for expansion has been strongly supported in public scoping for both that management plan review and for this DEIS. The evaluation of important marine resources and the incorporation of places of national significance into the National Marine Sanctuary System further national ocean resource management objectives articulated by many publicly vetted and expert-driven strategic planning efforts. These efforts reference the need for additional conservation protections for important habitat areas nationally and in the northern Gulf of Mexico. These include the recommendations made in NOAA's 2010 Strategic Plan for Deep-Sea Coral and Sponge Ecosystems. Specific recommendations focused on the application of conservation measures in the Gulf of Mexico region notably include those made in the Gulf Coast Ecosystem Restoration Task Force's 2011 Gulf of Mexico Regional Ecosystem Restoration Strategy and reiterated by a variety of constituencies such as the Gulf Coast Ecosystem Restoration Council (2013), the Gulf of Mexico Alliance (2006, 2009), non-governmental organizations and coalitions (e.g., Brown et al. 2011), and the academic community (e.g., Peterson et al. 2011). Sanctuary expansion would also extend the comprehensive conservation and management capacities authorized by the NMSA to new areas, providing a mechanism for implementation of specific restoration, monitoring and research activities for important marine resources. These types of activities could overlap with potential restoration activities associated with the Deepwater Horizon (DWH) oil spill. For example, protecting and managing mesophotic and deep benthic coral communities was identified as a restoration approach in the Final Programmatic Damage Assessment and Restoration Plan for the DWH Oil Spill (2016).

The expansion of sanctuary designation to additional nationally significant habitat is sought for a number of reasons. The northern Gulf of Mexico is a heavily utilized and industrialized region, and there is significant concern about impacts from bottom-disturbing activities (e.g., activities related to oil and gas exploration and production, fishing with bottom-tending gear, infrequent but damaging large ship anchoring on shelf-edge features near shipping fairways, frequent anchoring by smaller commercial or recreational vessels, salvage activities) on the sensitive biological resources and geological features associated with many reefs and banks in the area.

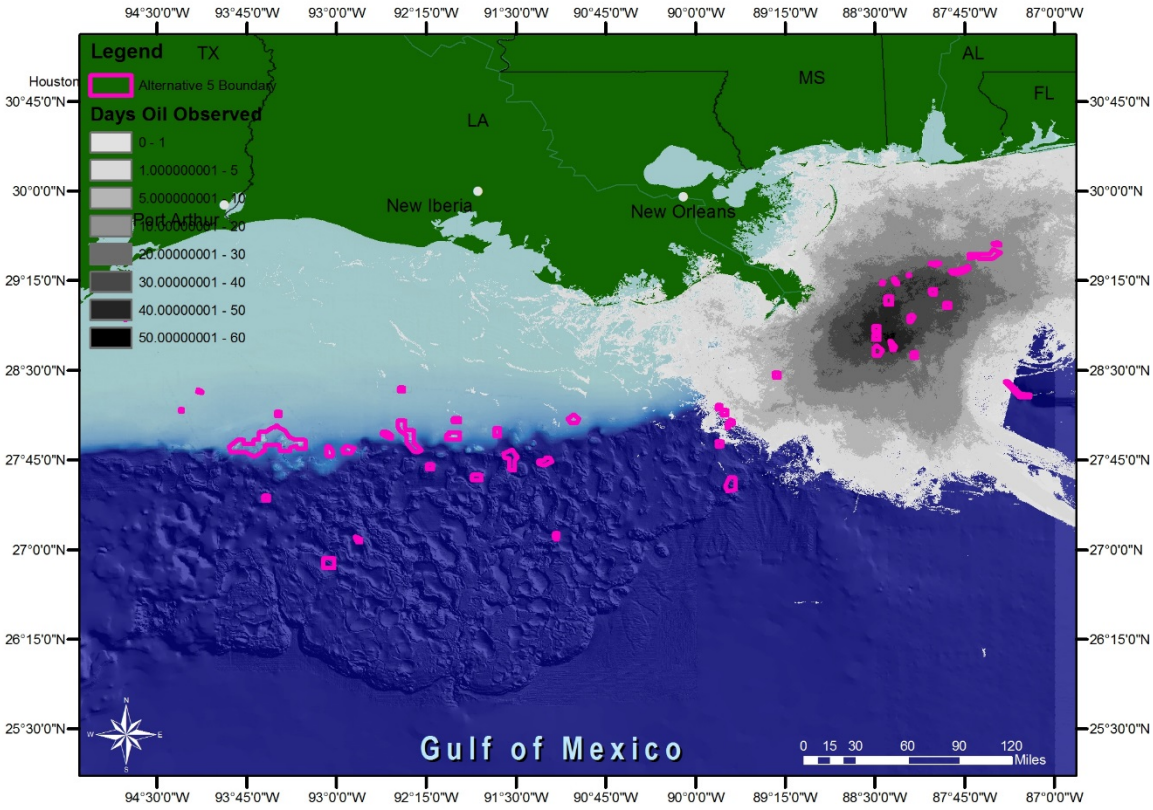

Figure 2.1. Cumulative surface oiling footprint from the Deepwater Horizon oil spill in relation to the most comprehensive boundary proposal (Alternative 5) evaluated in this DEIS.

Risks associated with the oil and gas industry are primarily related to catastrophic, uncontrolled releases resulting from factors such as extreme weather events or human error (see Section 4.5.3). For example, the Deepwater Horizon oil spill in 2010 remains one of the worst environmental disasters in U.S. history, resulting in the release into the ocean of 134 million gallons of oil and 1.84 million gallons of chemical dispersant, creating an oil surface slick covering 43,300 square miles at its cumulative extent (DWH NRDA Trustees 2016; see Figure 2.1). The oil spill and related response activities affected the north central Gulf of Mexico but did not directly affect the existing sanctuary or sites considered for expansion in Alternatives 2 and 3. The incident did affect sites considered in Alternatives 4 and 5. Nevertheless, based on what is currently known about the spill and the planning for restoration in its aftermath, those alternatives may represent

important opportunities for research into and recovery from observed impacts, and their inclusion in this DEIS acknowledges the importance and regional nature of both the Deepwater Horizon oil spill and the proposed sanctuary expansion.

Other potential threats include the physical impact of drilling, placement of structures on the seafloor (e.g., platforms, anchors, pipelines, or cables), discharges from rock-cutting during the drilling process, and intentional or accidental well discharges or release of drilling fluids. The use of anchors, pipelines and cables for oil exploration or extraction can be destructive to sensitive benthic habitats as well. The deployment of oil and gas pipelines can cause localized physical damage to corals. The use of anchors, pipelines and cables for oil exploration/extraction can be destructive to sensitive benthic habitats as well (Lumsden et al. 2007, Heifetz et al. 2009, Gass and Roberts 2006, NOAA 2015c). Current sanctuary regulations allow for the exploration and production of oil and gas inside sanctuary boundaries subject to the restrictions imposed by BOEM for the protection of topographic features, Potentially Sensitive Biological Features (PSBFs) and live bottom as described in section 4.6.1.4.

Implementation of the proposed action would minimize and mitigate threats associated with fishing or the oil and gas industry by restricting the use of anchors and bottom tending gear, and by any reduction in industrial activity that may result from sanctuary regulations making access to oil and gas resources more difficult or costly, as described in Section 5.3.2.8.4. Also, although sanctuary regulations allow for necessary activities related to oil and gas operations, they also prohibit injury to coral or other bottom formations. For example, while sanctuary regulations could allow disturbance of the seabed for the placement of a pipeline (per the exemption in CFR 922.122 (c)), such placement would have to be done in such a way as to avoid injury to "coral or other bottom formation, coralline algae or other plant, marine invertebrate, brine-seep biota, or carbonate rock " (per the prohibition in CFR 922.122(a)(5)). Thus sanctuary regulations would increase protections relative to those imposed by BOEM.

Disturbances to coral ecosystems from bottom-tending fishing gear, especially bottom trawl gear, have been well documented where they have been studied in U.S. waters and in other regions around the world. Bottom trawling is widespread and considered the major threat to corals in most U.S. regions where such fishing is allowed and overlaps with areas where corals are present. The area of seafloor contacted by bottom trawls is relatively large, the force against the seafloor from the trawl gear is substantial, and the spatial distribution of bottom trawling is extensive. Although not as destructive as bottom trawls and dredges, other types of fishing gear can also have detrimental effects on deepwater corals. Bottom-set gillnets, bottom-set longlines, pots and traps all impact the seafloor. Vertical hook and line fishing, used in both recreational and commercial fishing, has the potential for some damage to fragile corals by the weights used, but such damage is minimal compared to other bottom-tending gear (Lumsden et al. 2007, Heifetz et al. 2009, Gass and Roberts 2006, NOAA 2015c). FGBNMS staff have documented fishing gear impacts to Horseshoe Bank, 29 Fathom Bank, Geyer Bank, Rezak Bank, Bouma Bank, Elvers Bank, Sidner Bank, Parker Bank, Sonnier Bank, Rankin Bank, Bright Bank, and McGrail Bank.

In addition, certain areas, such as Sonnier Bank, have already been identified as having been injured as a result of indiscriminate anchoring. Sanctuary designation will bring a similar management approach such as exists at East and West Flower Garden and Stetson Banks, where mooring buoys have been installed to eliminate the need to anchor in these areas. In addition, several areas, such as Sonnier, Bright and Geyer Banks, are becoming popular sites for recreational diving, especially as technical diving technologies become more available. Sanctuary designation could allow for the installation of mooring buoys to provide safe access to these areas for divers. Some areas also contain special features that require higher levels of protection. These areas include McGrail Bank, where a unique mesophotic coral ecosystem is located, and Alderdice Bank, where prominent basalt spires arise from the seafloor, a feature of significant geological interest. Other areas, such as Bright Bank, have sustained significant damage as a result of activities that are not properly regulated (excavation in search of submerged historical resources).

At the same time, the opportunities for research, exploration, and education related to these significant ocean resources are critical for understanding changes occurring in the environment and fostering a stewardship ethic and an understanding of the ecosystem services these resources provide for communities throughout the Gulf of Mexico region. For these and other reasons, a comprehensive management approach offered by National Marine Sanctuary designation is needed.

2.3 Scope of DEIS

NEPA requires federal agencies to thoroughly assess the environmental impacts of major federal actions that could significantly affect the environment. The proposed expansion of FGBNMS has been specifically developed to facilitate improved management and protection of publicly identified priority resources. Therefore, incorporation of new areas into the sanctuary is intended to protect resources and generally reduce impacts of human activities on the environment. Even so, it is necessary to fully disclose and document the potential adverse and beneficial environmental effects of the proposed regulatory actions in a public process, consistent with NEPA and CEQ regulations implementing NEPA.

Section 304(a)(4) of the NMSA requires that “terms of designation may be modified only by the same procedures by which the original designation is made.” When FGBNMS was under consideration for establishment under the NMSA, an EIS was prepared prior to its designation as required by the NMSA. The proposed boundary changes are presented in this DEIS because they represent changes to the sanctuary's terms of designation that describe the geographic area proposed to be included within the sanctuary. Under the NMSA (16 U.S.C. 1434(a)(4)), alterations to the terms of designation require the sanctuary to go through the same procedures as site designation, including the preparation of an EIS, regardless of the significance of the impacts of the alteration. The DEIS also serves as a resource assessment under the NMSA (16 USC 1434(2)(b)), documenting (i) present and potential uses of the areas considered in the alternatives; (ii) commercial, governmental, or recreational resource uses in the areas that are subject to the

primary jurisdiction of the Department of the Interior; and (iii) any past, present, or proposed future disposal or discharge of materials in the vicinity of the proposed sanctuary.

This DEIS evaluates the environmental impacts associated with expansion of FGBNMS. Alternatives accomplishing the proposed action consist of variations in the boundary options. The expansion alternatives considered by NOAA, including a No-Action Alternative (no changes to the boundary or to regulations), are described in detail in Chapter 3, and analyzed in terms of impacts in Chapter 5. Application of sanctuary regulations to the expanded area would result in beneficial effects to most resources. This DEIS focuses on how the boundary alternatives and implementation of sanctuary regulations in new areas could affect the environment. Five sanctuary expansion alternatives were considered: one no action and four spatial alternatives. Alternatives that are outside the scope of the sanctuary's current operational capacity and budgetary resources must still be evaluated in the DEIS if they are reasonable, because the DEIS may serve as the basis for modifying the sanctuary's approvals or funding (40 CFR 1500.1(a)).

This DEIS is not an analysis of all activities set forth in the 2012 FGBNMS Management Plan. Rather, the DEIS is an extension of the Sanctuary Expansion Action Plan presented in the 2012 FGBNMS Management Plan. The implementation of management strategies and actions that sanctuary staff and their partners will use to fulfill other action plans from the 2012 FGBNMS Management Plan in the expansion area include targeted research, monitoring, education, outreach, resource protection, managing visitor use and operations and administration.

Chapter 3

DESCRIPTION OF ALTERNATIVES

3.1 Introduction

NOAA has developed a reasonable range of spatial alternatives for rigorous exploration and objective evaluation in the present analysis, as required by Sections 1502.14 and 1505.1(e) of NEPA. Existing sanctuary regulations and management actions would be applied to proposed expansion areas under each of the alternatives. The starting point for the alternative development was the Advisory Council recommendation outlined in the FGBNMS 2012 Management Plan, and it was further informed by input from the public during scoping and by input from the research community and from agency personnel, both within ONMS and beyond (see Sections 1.5.1 and 6.1.2). The alternatives range from being smaller in scope than the Advisory Council recommendation (Alternative 1, the "No Action" Alternative) to being larger in scope than that recommendation (Alternatives 3, 4 and 5).

NOAA determined that all of the sites evaluated in the alternatives described below possess conservation, recreational, ecological, historical, scientific, educational, cultural, archaeological or aesthetic qualities that give them special national, and in some instances, international, significance. In the early development of the proposed sanctuary expansion, NOAA's emphasis was on the areas and resources in the immediate vicinity of the existing FGBNMS; however, NOAA also recognized that the sanctuary is part of a larger ecological system: the north central Gulf of Mexico. Accordingly, in development of the alternatives, resources throughout that system were considered. Under this approach, NOAA is better able to evaluate the nationally significant features in the region, taking into account the multiple ecological and human use benefits of sanctuary expansion within the larger ecosystem.

In determining the scope of alternatives to be considered, NOAA focused on what is reasonable rather than on whether NOAA is capable of carrying out a particular alternative. Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the agency (46 FR 18026). Alternatives that are outside the scope of what has been previously approved or funded must still be evaluated in the EIS if they are reasonable and fulfill the stated purpose and need for the proposed federal action, because the EIS may serve as the basis for modifying the sanctuary's approvals or funding in light of NEPA's goals and policies (40 FR 18026 and 40 CFR 1500.1(a)). Regulatory alternatives and a number of spatial alternatives were

also briefly considered but eliminated from detailed study, and a brief discussion of the reasons for eliminating these alternatives is presented below.

3.2 Alternatives Considered but Rejected

Alternatives considered but eliminated from detailed study in this evaluation include: 1) additional topographic features; and 2) modifications to regulations in the existing or expanded sanctuary.

There was strong support for the inclusion of additional topographic features in the range of alternatives to be considered in the DEIS during public scoping, and Alternatives 3, 4, and 5, described below do include topographic features beyond those in the current sanctuary boundaries (Alternative 1, the No Action alternative) and the 2007 Advisory Council recommendation (Alternative 2). Additional topographic features eliminated from further consideration were those for which NOAA determined insufficient data are available to adequately characterize the sites or available data does not indicate sufficiently unique, diverse, productive or otherwise nationally significant biological communities or geologic features. These include 32 Fathom Bank, Applebaum Bank, Coffee Lump Bank, Fishnet Bank, Phleger Bank, Sweet Bank, Diaphus Bank, Sackett Bank, and an unnamed site in federal waters off the coast of Orange Beach, Alabama containing the preserved remains of a 50,000+ year-old submerged cypress forest. Sites in biogeographic regions other than the north central Gulf of Mexico were also eliminated from further consideration; areas to both the east and west of the area roughly defined by the 87th and 95th west meridians reflect geologic/sedimentary and hydrologic/oceanographic settings, as well as biological communities, that are distinctly different from those of the north central Gulf of Mexico and are faced with distinctly different threats or other conservation issues. Features eliminated from further consideration based on this distinction include Big Dunn Bar, Small Dunn Bar, Blackfish Ridge, Mysterious Bank, the South Texas Banks (Dream Bank, Southern Bank, Hospital Bank, North Hospital Bank, Aransas Bank, Baker Bank, and South Baker Bank), Madison-Swanson, the Florida Middle Grounds, and Pulley Ridge.

The inclusion of regulatory alternatives was also supported in public scoping as described in Section 1.5.1, though there was no consensus regarding the nature of regulations to be considered. Regulatory alternatives were considered but eliminated from further evaluation pursuant to the Advisory Council recommendation that the current regulatory regime in place in the existing sanctuary should be extended to any expanded sanctuary boundaries. NOAA considered but eliminated from further evaluation regulatory alternatives including fishery closures or permit requirements, greater restrictions on oil and gas development, policies related to decommissioned platforms and artificial reefs, and establishment of anchorages, among others. Current sanctuary regulations include restrictions on exploration for, or development or production of, oil, gas or minerals; anchoring or otherwise mooring; discharging or depositing materials or other matter; alteration of the seabed; possessing various marine resources; injuring or taking or attempting to injure or take sanctuary resources; possessing or using explosives or releasing electrical charges; feeding fish; and possessing (except while passing without interruption through the sanctuary) or

using fishing gear other than conventional hook and line gear. The regulations are summarized in Table 1.1, and the full text of the regulations is found in Appendix F. FGBNMS does not intend to make any change to its regulatory role over areas within sanctuary boundaries without further deliberation by the Advisory Council, public involvement, and the possible issuance of a future NEPA analysis, likely in the context of the next FGBNMS management plan review.

3.3 Alternative 1 – No Action

As required by Section 1502.14(d) of NEPA, NOAA has included the evaluation of a No Action alternative in this DEIS (Alternative 1, Table 3.1 and Figure 3.1). "No Action" in this case means that NOAA would not expand the sanctuary. One public scoping comment supported this alternative. The resulting environmental effects from maintaining the existing sanctuary boundaries and regulations in place are compared with the effects of implementing the various alternatives. Those boundaries encompass three distinct geologic features and associated benthic biological communities at East Flower Garden Bank, West Flower Garden Bank and Stetson Bank, and include an area of approximately 56 square miles.

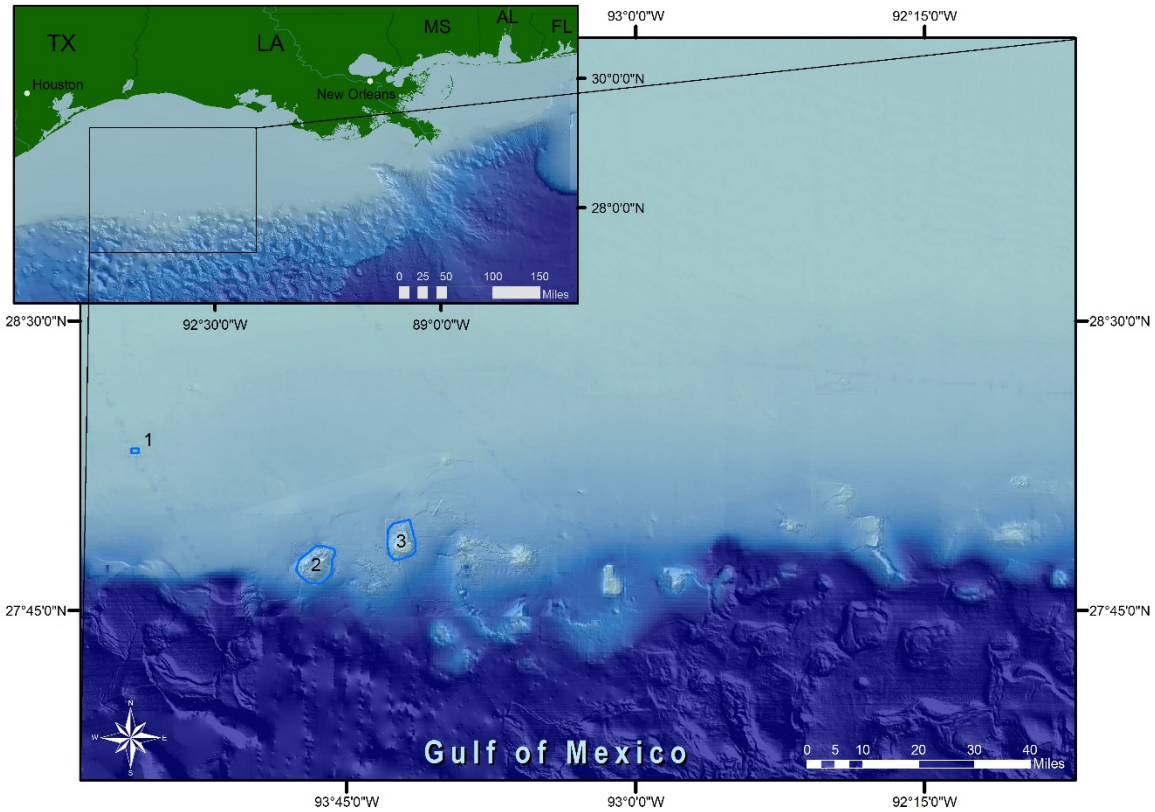

Figure 3.1. Alternative 1, No Action (current sanctuary boundaries). Boundary polygons are numbered as shown in Table 3.1

Table 3.1. Alternative 1, No Action

	Nationally Significant Biological and Geological Features	Area (square miles)
1	Stetson Bank	0.84
2	West Flower Garden Bank	29.94
3	East Flower Garden Bank	25.43
	Net Increase in Area Over Current Sanctuary	**0.00**
	Alternative 1 Total Area	**56.21**

3.4 Alternative 2 – 2007 Advisory Council Recommendation

In 2007, the FGBNMS Advisory Council put forth a recommendation to the sanctuary superintendent for boundary expansion encompassing 12 nationally significant natural features (including the three banks encompassed in the current sanctuary boundaries) over an area of approximately 281 square miles, within 9 discrete proposed boundary polygons. This recommendation is documented in the 2012 FGBNMS Management Plan, which also provides additional detail about the process used to arrive at the recommendation (see also the presentations posted on the FGBNMS website at http://flowergarden.noaa.gov/document_library/mgmtdocs/hickersonpresentation1.pdf; http://flowergarden.noaa.gov/document_library/advdocs/fgbsacboundaryrecommend.pdf). Seventeen comments received during public scoping supported this recommendation.

The recommendation for sanctuary expansion that was developed by the Advisory Council (Alternative 2, Table 3.2 and Figure 3.2) was based on the work of a subcommittee called the Boundary Expansion Working Group (BEWG), which consisted of representatives from the Advisory Council, ONMS and other federal agencies. The BEWG evaluated an initial list of potential sanctuary expansion sites compiled from public scoping comments, advisory council and sanctuary staff recommendations, and information collected and compiled from scientific literature available at the time (Rezak et al. 1981). The BEWG developed and presented seven sanctuary expansion alternatives to the Advisory Council, recommending 9 sites be included in the expansion proposal, based on a ranking process evaluating factors including a "zone priority index," structural connectivity, biological connectivity, a threat index, and public and FGBNMS prioritization (see Appendix A1). Based on additional input from the full Advisory Council membership and from the public, the Advisory Council augmented the BEWG recommendation, adopting a final recommendation for an expansion incorporating 12 of the sites initially evaluated by the BEWG within 9 discrete recommended boundary polygons. Two of these polygons encompass multiple features: the East Flower Garden Bank/Horseshoe Bank complex and the Bright Bank/Rankin Bank/28-Fathom Bank complex.

The Advisory Council recommended that irregularly shaped polygons be developed and submitted for consideration so as to limit conflicts with oil and gas infrastructure and activity.

"Core biological zones" were identified based on visual interpretation of seafloor topography, previous scuba and submersible investigations demonstrating the presence of high-diversity coral reefs, coralline algal reefs and deep coral. Identified "core biological zones" were intended to include the main topographic feature supported by the underlying salt dome, and deepwater carbonate mounds associated with faults and ridges. Prominent features are defined as carbonate mounds greater than 3 meters (10 feet) in vertical relief and 25 meters (82 feet) in diameter, and the boundary of the core biological zones was developed by identifying the outermost series of prominent features as landmarks, forming the vertices of an irregular polygon. Buffer zones of various widths (250-1000 meters; 820-3,280 feet) were considered from the outer landmarks of the core polygon, radiating from an approximate midpoint of the bank. The BEWG proposed, and the full Advisory Council adopted, irregularly shaped boundary proposals for each of the sites reflecting a 500 meter (1,640 foot) buffer zone, based on literature detailing effects of pollutants associated with shunted drilling muds resulting from oil and gas drilling activities. Oil and gas infrastructure was considered, and recommendations were made to either include existing platforms (3) or exclude existing platforms, dependent upon the distance from the core biological area. Additional detailed descriptions of each of the features included in Alternative 2 can be found in Appendix B.

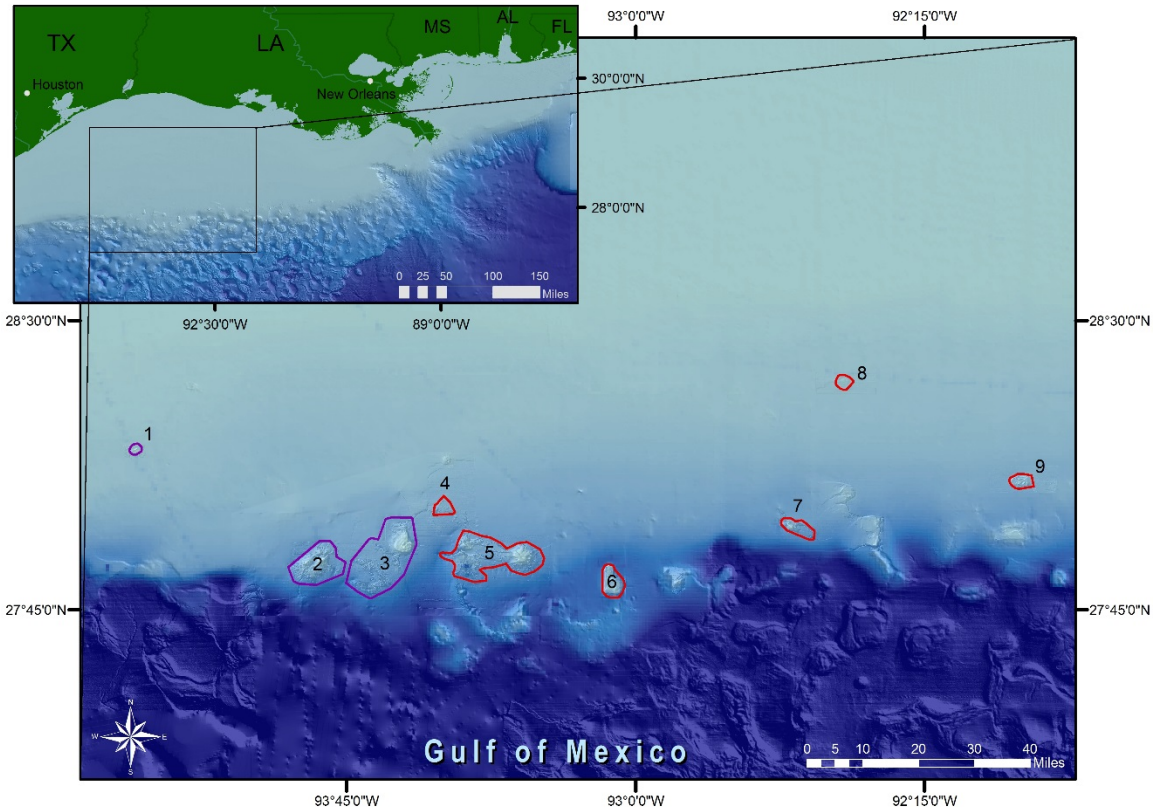

Figure 3.2. Alternative 2, 2007 Advisory Council recommended sanctuary expansion. Boundaries modified from Alternative 1 are shown in purple; additional proposed areas are shown in red. Boundary polygons are numbered as shown in Table 3.2.

Table 3.2. Alternative 2, 2007 Advisory Council Sanctuary Expansion Recommendation

	Nationally Significant Biological and Geological Features	Area (square miles)
1	Stetson Bank	2.90
2	West Flower Garden Bank	46.60
3	East Flower Garden Bank and Horseshoe Bank	99.84
4	MacNeil Bank	7.40
5	Rankin Bank, 28 Fathom Bank and Bright Bank	83.20
6	Geyer Bank	15.96
7	McGrail Bank	11.90
8	Sonnier Bank	5.24
9	Alderdice Bank	8.12
	Net Increase in Area Over Current Sanctuary	**224.94**
	Alternative 2 Total Area	**281.15**

3.5 Alternative 3 – 2015 Staff Recommendation (Preferred)

Alternative 3 (Table 3.3 and Figure 3.3) was developed by ONMS and incorporates additional input from other NOAA offices and federal agencies, the research community, and the public. It encompasses 18 nationally significant natural features over an area of approximately 383 square miles, within 11 discrete proposed boundary polygons. In developing this alternative, NOAA applied the same principle as the Advisory Council in evaluating features separately with discrete potential boundaries, rather than a single all-encompassing boundary, to minimize conflicts with user groups and result in a network of protected areas. Nineteen comments received during public scoping supported the inclusion of natural resources and areas beyond those included in the 2007 Advisory Council recommendation.

The proposed boundary polygons presented in Alternative 3 were developed using a more rigorous, replicable process than the method employed in developing Alternative 2, by applying the same objective, algorithmic approach (i.e., a standardized, stepwise process) to each site in a Geographic Information System (GIS). In particular, the process used by the BEWG to identify "core biological zones" was improved upon by automated identification of areas of high local relief, termed "core sensitivity zones" (CSZs), from the highest resolution bathymetric data available (e.g., Gardner et al. 2002, Gardner and Beaudoin 2005, Brooks et al. in review, and NOAA 2015d) as the initial step in the development of boundaries proposed in Alternatives 3, 4 and 5 (see Appendix A3 for an overview of this process). Alternative 3 modifies and augments the recommendation of the Advisory Council, using substantially the same evaluation criteria applied by the BEWG, but taking into account the considerable additional scientific information about the areas under consideration that has been generated in the nine years since the Advisory Council recommendation was made, and simplifying the recommended boundaries for ease of enforcement and consistency with existing regulatory regimes. For example, proposed expansion

boundaries were aligned where possible with BOEM lease block boundaries, which overlay the entire study area, and HAPC boundaries (14 of the 18 features encompassed by this alternative overlap HAPC boundaries). Refer to BOEM 2015b, BOEM 2015e, NOAA 2015a and NOAA 2015b, and see Appendices A1, A3, B, and C for specific details.

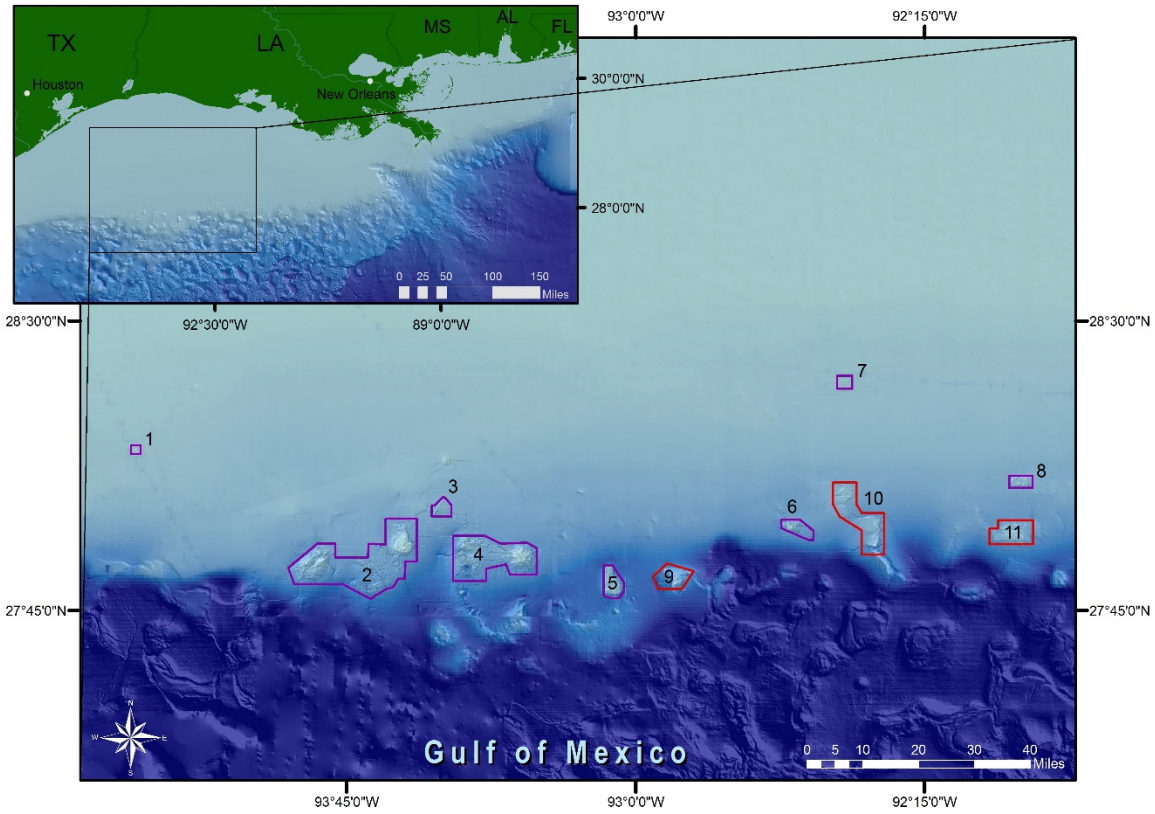

Figure 3.3. Alternative 3, 2015 FGBNMS staff recommendation for sanctuary expansion. Boundaries modified from Alternative 2 are shown in purple; additional proposed areas are shown in red. Boundary polygons are numbered as shown in Table 3.3.

The acquisition of additional high-resolution multibeam bathymetric data and additional site surveys by scuba or Remotely Operated Vehicle (ROV), made both opportunistically and in the context of formal study designs, provide a basis for revision of the site rankings determined by the BEWG and the recommendation made by the Advisory Council as documented in the 2012 FGBNMS Management Plan (see Table 3.3). Since 2002, the FGBNMS research team and partners have conducted over 200 remotely operated vehicle surveys during 17 research cruises to characterize the biological communities of the reefs and banks in the northwestern Gulf of Mexico outside of the current sanctuary boundaries. A cooperative study (BOEM 2015a) characterizing the biological communities of Potentially Sensitive Biological Features (PSBFs), funded by BOEM and undertaken by the Louisiana Universities Marine Consortium and FGBNMS staff, is particularly informative regarding the ecology of low-relief areas surrounding high-relief banks. In that study, five of the features added to the Advisory Council

recommendation in Alternative 3 (Bouma, Rezak, Sidner, Elvers and Parker Banks) were explored. Detailed descriptions of each of the features included in Alternative 3 can be found in Appendix B.

Table 3.3. Alternative 3, 2015 FGBNMS staff recommendation for sanctuary expansion.

	Nationally Significant Biological and Geological Features	**Area (square miles)**
1	Stetson Bank	2.33
2	West Flower Garden Bank, East Flower Garden Bank and Horseshoe Bank	147.41
3	MacNeil Bank	8.31
4	Rankin Bank, 28 Fathom Bank and Bright Bank	82.94
5	Geyer Bank	15.27
6	McGrail Bank	12.02
7	Sonnier Bank	5.58
8	Alderdice Bank	7.98
9	Elvers Bank	20.10
10	Bouma Bank, Bryant Bank, Rezak Bank and Sidner Bank	53.56
11	Parker Bank	27.69
	Net Increase in Area Over Current Sanctuary	**326.98**
	Alternative 3 Total Area	**383.19**

3.6 Alternative 4 – High Priority Mesophotic and Deep Coral Sites

Alternative 4 (Table 3.4 and Figure 3.4) incorporates additional mesophotic and deep coral ecosystem sites across the north central Gulf of Mexico. This alternative encompasses 43 nationally significant natural features over an area of approximately 634 square miles, within 29 discrete proposed boundary polygons. Some of these sites, such as those in the Pinnacles area (also referred to in BOEM documents as the "pinnacle trend"; see section 4.1.1 for full description) off the coast of Louisiana, Mississippi and Alabama, were considered by the Advisory Council but not included in its 2007 recommendation for sanctuary expansion as documented in the 2012 FGBNMS Management Plan. Other sites included in Alternative 4 were not considered by the Advisory Council, but are included and evaluated here. Nineteen comments received during public scoping supported the inclusion of natural resources and areas beyond those included in the 2007 Advisory Council recommendation. Alternative 4 is included in this analysis despite being outside the scope of the sanctuary's current operational capacity and budgetary resources. As described above, it must still be evaluated in the DEIS if it is reasonable. NOAA determined it to be reasonable due to these sites' presence within the distinct

biogeographic region of the north central Gulf of Mexico (i.e., their relatively consistent geologic/sedimentary and hydrologic/oceanographic settings, as well as biological communities) and due to the significant advances in understanding and heightened awareness of the importance of these sites that have developed in the last decade. The sites included in Alternative 4 were also evaluated using substantially the same evaluation criteria applied by the BEWG, supplemented by the factors developed by ONMS in 2014 for evaluating new sanctuary nominations (see Appendices A1 and A2) and simplifying the recommended boundaries for ease of enforcement and consistency with existing regulatory regimes. The proposed boundaries for each site were also developed using the GIS algorithm applied to sites in Alternative 3 (see Appendix A3).

The eleven deep coral sites included in this alternative represent the most important known deep benthic habitat sites in the Gulf of Mexico, discovered through hundreds of hours of cruise preparation, dozens of cruises to dozens of different sites, and years of laboratory analysis of coral diversity, coral population genetics, macrofaunal diversity, geological analysis, water chemistry, and other information. They have been identified for inclusion in Alternative 4 based on information primarily collected during the 2008-2011 "Lophelia II" study (Brooks et al., in review) funded by BOEM and NOAA's Office of Exploration and Research (OER). The final report from this research project includes much of the raw data supporting the evaluations in Chapter 5 and the site descriptions included in Appendix B. In addition, many of these sites were discovered prior to that project as part of the earlier BOEM (then MMS) funded "Chemo I," "Chemo II," "Chemo III," and "Lophelia I" studies (MacDonald et al. 1995, MacDonald et al. 2002, Brooks et al. 2014, CSA 2007), and through other National Science Foundation and NOAA OER work. These investigations date to the early 1990s when researchers began to have access to the expanding MMS 3D seismic database and developed conceptual models for the location and exploration of hard bottom associated with hydrocarbon seepage (MacDonald et al. 1995). These were accompanied by historical records of coral occurrence from trawls, and early observations from the Johnson Sea-Link and Navy NR-1 submersibles. More recently, this information has been extended to predict and map suitable habitat for deep water corals throughout the Gulf of Mexico, providing habitat suitability maps (Kinlan et al. 2013) against which proposed boundaries were compared. Following the 2010 Deepwater Horizon spill, intensive surveys revealed more coral communities in the immediate vicinity of the well-head; several of these sites are also included in Alternative 4. More detailed descriptions of these sites can be found in White et al. 2012 (PNAS), Fisher et al. 2014a (Bioscience), and Fisher et al. 2014b (PNAS). More recently, multiple visits by the NOAA Ship *Okeanos Explorer* (NOAA 2014) led to the discovery of a few additional sites (most significantly the Hidalgo Basin Rim site).

Similarly, observations of mesophotic zone habitats in the Pinnacles area found an unexpected abundance and diversity of sub-tropical fish and corals. The seven sites identified for inclusion in Alternative 4 were first mapped with single-beam echo sounder by Ludwick and Walton in 1957. Successive mapping efforts by BOEM (formerly MMS; Thompson et al. 1999), NOAA (NOAA 2014), and U. S. Geological Survey (Gardner et al. 2002) have incrementally improved the spatial extent and resolution of bathymetric profiles of the area. High-resolution multibeam bathymetric

surveys from 2000 (Gardner et al. 2002; see also https://walrus.wr.usgs.gov/pacmaps/pn-persp.html), combined with ROV and submersible surveys that have occurred in the area since the mid-1980s. These have allowed accurate characterization of the geomorphology of mesophotic reefs (Nash and Randall 2015) and low-relief hard substrates (Nash and Sulak 2015) throughout the tract as well as documenting their importance as benthic habitats for fisheries (Weaver et al. 2001). Nine significant features were characterized in the high resolution multibeam bathymetric map surveys from 2000 (Gardner et al. 2002), though further surveying is needed to characterize the full extent of hard bottom reefs and low-relief features and substrates in the area. The results of recent research are summarized in Appendix B as the basis for inclusion of Pinnacles area sites in Alternative 4 and evaluated for potential inclusion in the sanctuary expansion of FGBNMS.

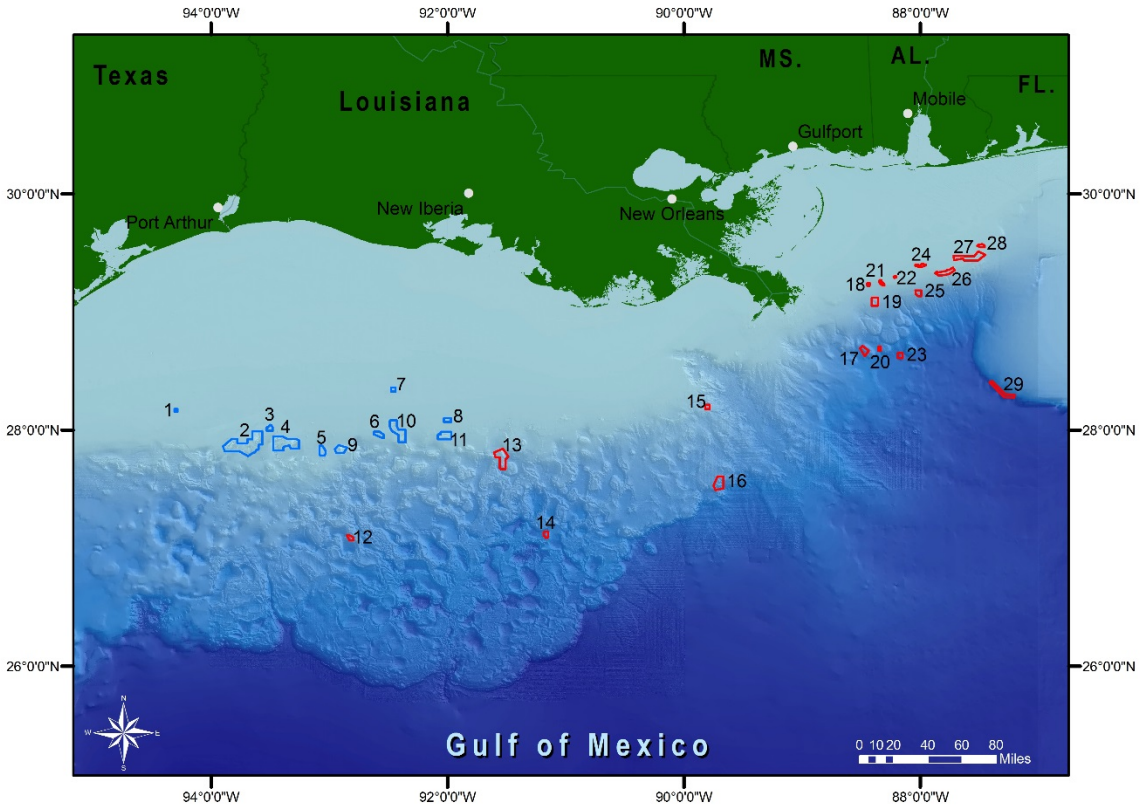

Figure 3.4. Alternative 4, NOAA's 2015 staff recommendation plus high priority mesophotic and deep coral sites. Boundaries carried forward from Alternative 3 are shown in blue; additional proposed areas are shown in red. Boundary polygons are numbered as shown in Table 3.4.

Table 3.4. Alternative 4, NOAA's 2015 staff recommendation plus high priority mesophotic and deep coral sites.

	Nationally Significant Biological and Geological Features	Area (square miles)
1	Stetson Bank	2.33
2	West Flower Garden Bank, East Flower Garden Bank and Horseshoe Bank	147.41
3	MacNeil Bank	8.31
4	Rankin Bank, 28 Fathom Bank and Bright Bank	82.94
5	Geyer Bank	15.27
6	McGrail Bank	12.02
7	Sonnier Bank	5.58
8	Alderdice Bank	7.98
9	Elvers Bank	20.10
10	Bouma Bank, Bryant Bank, Rezak Bank and Sidner Bank	53.56
11	Parker Bank	27.69
12	Hidalgo Basin Rim	6.98
13	Assumption Dome	45.63
14	St. Tammany Basin Rim	7.23
15	Henderson Ridge North	5.85
16	Henderson Ridge South	31.36
17	Biloxi Dome	12.82
18	Mountain Top	2.03
19	Viosca Knolls West	15.92
20	Gloria Dome	3.01
21	Alabama Alps, 36 Fathom Ridge	4.04
22	West Addition Pinnacles	1.03
23	Dauphin Dome	7.61
24	Shark Reef, Double Top, Triple Top	6.26
25	Viosca Knolls East	9.36
26	Ludwick-Walton and West Delta Mounds	19.06
27	Yellowtail, Cat's Paw, Roughtongue, Corkscrew	42.05
28	Far Tortuga	5.01
29	Desoto Canyon/West Florida Escarpment	25.30
	Net Increase in Area Over Current Sanctuary	**577.55**
	Alternative 4 Total Area	**633.76**

3.7 Alternative 5 – High Value Habitats and Cultural Resources

Alternative 5 (Table 3.5 and Figure 3.5) incorporates additional mesophotic and deep coral ecosystem sites, as well as important shipwreck sites, across the north central Gulf of Mexico. This alternative encompasses 57 nationally significant natural features and 8 nationally significant cultural and historic resource sites over an area of approximately 935 square miles, within 45 discrete proposed boundary polygons. Some of these sites, such as 29 Fathom Bank and Jakkula Bank were considered by the Advisory Council but not included in its 2007 recommendation for sanctuary expansion as documented in the 2012 FGBNMS Management Plan. Other sites included in Alternative 5, such as Claypile Bank, Ewing Bank, and the mesophotic and deep benthic sites and shipwrecks, were not considered by the Advisory Council, but are included and evaluated here. Nineteen comments received during public scoping supported the inclusion of natural resources and areas beyond those included in the 2007 Advisory Council recommendation, and seven public comments supported the inclusion of cultural and historic resources. Alternative 5 is included in this analysis despite being outside the scope of the sanctuary's current operational capacity and budgetary resources. As described above, it must still be evaluated in the DEIS if it is reasonable. NOAA determined it to be reasonable due to these sites' presence within the distinct biogeographic region of the north central Gulf of Mexico (i.e., their relatively consistent geologic/sedimentary and hydrologic/oceanographic settings, as well as biological communities) and due to the significant advances in understanding and heightened awareness of the importance of these sites that have developed in the last decade. Shipwrecks are included in this alternative because the NMSA specifically identifies the need to protect nationally significant historical, cultural and archaeological sites. Both public scoping for this DEIS and NOAA's internal and cooperating agency consultations identified the included sites as nationally significant.

The sites included in Alternative 5 were also evaluated using substantially the same evaluation criteria applied by the BEWG, supplemented by the factors developed by ONMS in 2014 for evaluating new sanctuary nominations (see Appendices A1 and A2) and simplifying the recommended boundaries for ease of enforcement and consistency with existing regulatory regimes. The proposed boundaries for each site were also developed using the GIS algorithm applied to sites in Alternatives 3 and 4 (see Appendix A3). Additional detail on the features included in Alternative 5 can also be found in Appendix B. In total, the 45 proposed boundaries included in Alternative 5 would protect the most comprehensive suite of known high-value benthic habitats and cultural resources across the north central Gulf of Mexico region of all of the proposed alternatives.

Alternative 5 combines three of the proposed boundaries included in Alternative 4 into a single large complex of seven significant features extending east from West Flower Garden Bank to Bright Bank in recognition of the substantial structural and functional connectivity among these features, as demonstrated by the extent of the "core sensitivity zone" mapped between these features using the GIS algorithm applied to develop proposed boundaries under Alternatives 3, 4 and 5.

This alternative also modifies one of the other proposed boundaries included in Alternative 4 in the northwestern banks subregion, extending the proposed boundary around the Bouma/Bryant/Rezak/Sidner complex to the south to encompass Tresslar and Antoine banks. Two of the proposed deep coral site boundaries from Alternative 4 are also modified in Alternative 5; the Biloxi Dome site boundary is extended to the southwest to incorporate the historically important wrecks of the S.S. *Robert E. Lee* and the *U-166*, and the Gloria Dome site is extended to the northeast to incorporate the culturally significant and scientifically important wreck of the *Deepwater Horizon* oil platform and wellhead (i.e., as a memorial to the tragic and nationally significant event, which was the first oil spill in U. S. history to be officially designated a "Spill of National Significance" by the U. S. Coast Guard, and for long-term study of recovery, conservation and management benefits; DWH NRDA Trustees 2016).

Advances in understanding of the maritime archeological resources present in the Gulf of Mexico over the last decade (Church et al. 2007, Ford et al. 2008, NOAA 2012c, Brooks et al. in review, Evans et al. 2013, NOAA 2014) support the inclusion and evaluation of such resources in Alternative 5, and aside from the two shipwrecks identified above, six discontiguous boundaries are added in Alternative 5 to encompass eight additional historically significant shipwrecks: the USS *Hatteras* on the continental shelf and the three "Monterrey" wrecks, the *Gulfoil*, the *Gulfpenn*, the "Mardi Gras" wreck, and the wreck of the *Anona* on the continental slope.

Additional discontiguous boundaries are also proposed under Alternative 5 to encompass four biologically and geologically significant sites in the northwest banks subregion on the continental shelf: Claypile Bank, 29 Fathom Bank, Jakkula Bank, and Ewing Bank. 29 Fathom Bank and Jakkula Bank were considered by the Advisory Council but not included in their recommendation for sanctuary expansion, though their inclusion in this analysis is warranted by the advances in scientific understanding of these sites that have been made in the intervening time since that recommendation. Similarly, Claypile Bank and Ewing Banks were not considered by the Advisory Council, but are included and evaluated here due to the significant advances in understanding and heightened awareness of the significance of these sites that have developed in the last decade.

Finally, eight additional discontiguous boundaries are proposed under Alternative 5 to incorporate additional mesophotic and deep coral ecosystem sites across the north central Gulf of Mexico. Proposed boundaries around the Galvez/Frye Basins Rim site, Tunica Mound site, Jeanerette Dome site, Penchant Basin Rim site, Henderson Ridge Mid-South and Mid-North sites, Whiting Dome site and Horn Dome site would extend protections around additional high value mesophotic and deep benthic habitats. These eight additional sites were discovered, characterized, and evaluated in the course of the same studies described above that identified the eleven deep coral sites included in Alternative 4 (Brooks et al., in review, MacDonald et al. 1995, MacDonald et al. 2002, Brooks et al. 2014, CSA 2007, White et al. 2012, Fisher et al. 2014a, Fisher et al. 2014b, and NOAA 2014).

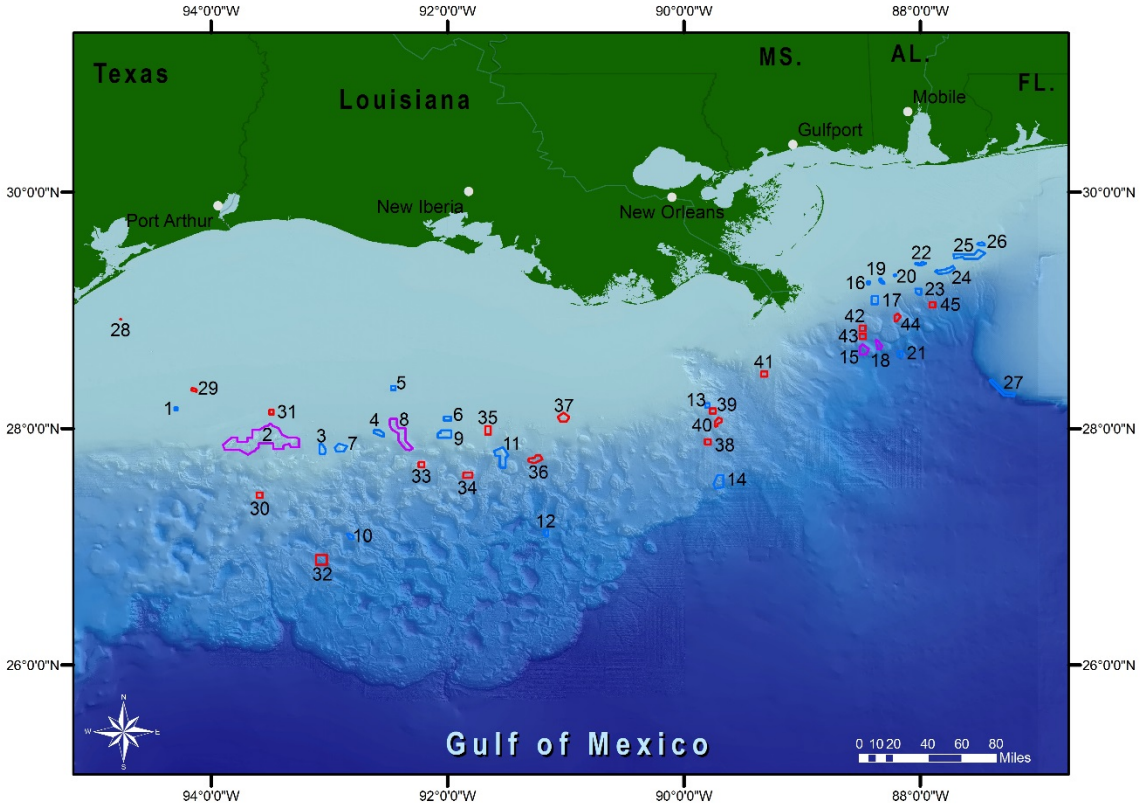

Figure 3.5. Alternative 5, comprehensive protection for high value north central Gulf of Mexico benthic habitats and cultural resources. Boundaries carried forward from Alternative 4 are shown in blue; boundaries modified from Alternative 4 are shown in purple; additional proposed areas are shown in red. Boundary polygons are numbered as shown in Table 3.5.

Table 3.5. Alternative 5, comprehensive protection for high value north central Gulf of Mexico benthic habitats and cultural resources.

	Nationally Significant Biological and Geological Features and/or Cultural and Historic Resources (* = Shipwreck Sites)	**Area (square miles)**
1	Stetson Bank	2.33
2	West Flower Garden Bank, East Flower Garden Bank, Horseshoe Bank, MacNeil Bank, Rankin Bank, 28 Fathom Bank and Bright Bank	306.65
3	Geyer Bank	15.27
4	McGrail Bank	12.02
5	Sonnier Bank	5.58
6	Alderdice Bank	7.98
7	Elvers Bank	20.10
8	Bouma Bank, Bryant Bank, Rezak Bank, Sidner Bank, Tresslar Bank and Antoine Bank	73.68
9	Parker Bank	27.69
10	Hidalgo Basin Rim	6.98

11	Assumption Dome	45.63
12	St. Tammany Basin Rim	7.23
13	Henderson Ridge North	5.85
14	Henderson Ridge South	31.36
15	Biloxi Dome, *R. E. Lee** and *U-166**	19.12
16	Mountain Top	2.03
17	Viosca Knolls West	15.92
18	Gloria Dome and *Deepwater Horizon**	10.02
19	Alabama Alps, 36 Fathom Ridge	4.04
20	West Addition Pinnacles	1.03
21	Dauphin Dome	7.61
22	Shark Reef, Double Top, Triple Top	6.26
23	Viosca Knolls East	9.36
24	Ludwick-Walton and West Delta Mounds	19.06
25	Yellowtail, Cat's Paw, Roughtongue, Corkscrew	42.05
26	Far Tortuga	5.01
27	Desoto Canyon/West Florida Escarpment	25.30
28	USS *Hatteras**	0.17
29	Claypile Bank	3.76
30	Galvez/Frye Basins Ridge	9.00
31	29 Fathom Bank	5.71
32	“Monterrey” Wrecks*	32.25
33	Tunica Mound	9.00
34	Jeanerette Dome	14.15
35	Jakkula Bank	13.72
36	Penchant Basin Rim	18.98
37	Ewing Bank	19.52
38	Henderson Ridge Mid-South	9.00
39	*Gulfoil**	9.00
40	Henderson Ridge Mid-North	10.73
41	*Gulfpenn**	9.00
42	Whiting Dome	9.67
43	“Mardi Gras” Wreck*	9.00
44	Horn Dome	8.34
45	*Anona**	9.00
	Net Increase in Area Over Current Sanctuary	**878.97**
	Alternative 5 Total Area	**935.18**

Chapter 4

AFFECTED ENVIRONMENT

4.1 Introduction

Consistent with NEPA requirements, this chapter provides a narrative description of the physical, biological and social/cultural resources affected by the alternatives presented in Chapter 3. Resource descriptions are provided for the geology and substrates, water, living marine resources, protected species, cultural and historic resources, and marine area use, recreation and socioeconomics of the north central Gulf of Mexico. A description is also provided of the regulatory framework within which this action is proposed.

The information in this section, together with other information in this document, provides the basis for NOAA's evaluation of the potential environmental impacts of the expansion alternatives as described in Chapter 5 (Analysis of Environmental Consequences). The scope of the environmental impacts addressed in this DEIS includes those on the physical environment (air quality and climate, noise, scenic and visual resources, geology and substrates, water), the biological environment (living marine resources and protected species) and the cultural and human environment (cultural and historic resources, marine area use, recreation, and socioeconomics).

In the early development of the proposed sanctuary expansion, NOAA's emphasis was on the areas and resources in the immediate vicinity of the existing FGBNMS; however, NOAA also recognized that the sanctuary is part of a larger ecological system: the north central Gulf of Mexico. Accordingly, in development of the alternatives, resources throughout that system were considered. Under this approach, NOAA is better able to evaluate the nationally significant features in the region, taking into account the multiple ecological and human use benefits of sanctuary expansion within the larger ecosystem.

NOAA considered the 2010 Deepwater Horizon oil spill (DWH) when characterizing the environment affected by the proposed sanctuary expansion alternatives. The oil spill affected the north central Gulf of Mexico but did not directly affect the existing sanctuary or sites considered for expansion in Alternatives 2 and 3. The incident did affect sites considered in Alternatives 4 and 5, though these alternatives are not preferred due to the significant additional programmatic

resources that would be required to support them. Nevertheless, based on what is currently known about the spill and the planning for restoration in its aftermath, those alternatives may represent important opportunities for research into and recovery from observed impacts, and their inclusion in this DEIS acknowledges the importance and regional nature of both the Deepwater Horizon oil spill and the proposed sanctuary expansion.

4.2 Physical Environment

The Gulf of Mexico encompasses over 615,000 square miles of coastal and open ocean, making it the ninth largest body of water in the world. It is one of the most ecologically and economically productive ecosystems in North America. U.S. federal waters encompass approximately 243,926 square miles. Of this, ~5%, or ~12,131 square miles is estimated to have hard bottom substrate (Jenkins 2011).

The area assessed for this DEIS includes the hard bottom features of the north central Gulf of Mexico, generally between 87° and 95° W longitude. U.S. federal waters in this area encompass approximately 122,820 square miles, with ~2%, or ~2,532 square miles, comprising hard bottom substrate (Jenkins 2011). The offshore environment of the north central Gulf of Mexico is characterized by a wide, shallow sloping continental shelf that extends over 100 miles offshore from the Texas-Louisiana border, narrowing to a width of between 40 and 60 miles offshore of eastern Louisiana, Mississippi, and Alabama. The continental shelf and slope of this area is geologically complex and contains a variety of offshore features that support diverse biological communities and numerous submerged cultural resources.

For purposes of this discussion, the study area is comprised of three general geographical components: 1) reefs and banks of the Texas–Louisiana shelf (including the Flower Garden Banks and other banks of the northwestern Gulf of Mexico); 2) hard bottom features of the Mississippi-Alabama shelf (also known as the Pinnacles area); and 3) deep coral ecosystems of the outer continental slope. Significant hard bottom features in the region include dozens of reefs and banks along the edge of the continental shelf between the current sanctuary and the Pinnacles area (Rezak et al. 1985, Gardner et al. 2002, Gardner and Beaudoin 2005, Chowdhury and Turco 2006), as well as mesophotic and deep coral ecosystems comprising the deeper parts of these shelf-edge features and features on the continental slope (Brooke and Schroeder 2007).

In the north central Gulf of Mexico, 50-100 miles off the coasts of Texas, Louisiana, Mississippi and Alabama, dozens of underwater features rise from the seafloor near the edge of the continental shelf to form a complex of reefs and banks (also known as topographic features) (Rezak et al. 1983, Rezak et al. 1985). While the crests of most of these features lie more than 150 feet (46 meters) deep, a small number of them are shallow enough for coral reefs to have become established. Two of these features, East and West Flower Garden Banks, reach within 54 feet (16 meters) of the surface and contain well-developed coral reefs (Bright 1977). West of the Mississippi River delta, numerous other features in this region contain a mix of coral reefs, coral communities and mesophotic coral habitats (Rezak et al. 1985). East of the Mississippi, off the

coasts of Mississippi and Alabama, is the Pinnacles area, also harboring mesophotic coral habitats. Deep coral ecosystems are present off the shelf edge on the continental slope from 755-8,530 feet (230-2600 meters) deep. Some of these sites feature both mesophotic and deep coral communities.

In addition to these natural features, a number of maritime archeological sites are present in the region, with many shipwrecks having been identified as important cultural and historic resources spanning almost half a millennium from the early European colonial period to today.

4.2.1 Air Quality and Climate

The federal Clean Air Act requires the EPA to set National Ambient Air Quality Standards (NAAQS) for six common air pollutants. These commonly found air pollutants (also known as "criteria pollutants") are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides and lead. These pollutants are called "criteria" air pollutants because they are regulated by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible levels.

The main sources of air pollution in the study area for the proposed expansion come from oil and gas industry operations, diesel exhaust from ship engines, and from incineration of garbage on vessels. Vessel traffic within the study area contributes to the degradation of air quality. Diesel exhaust has a high sulfur content, producing sulfur dioxide, nitrogen dioxide, and particulate matter in addition to common products of combustion such as carbon monoxide, carbon dioxide, and hydrocarbons. On the outer continental shelf, sources of air emissions can vary considerably, depending on the specifics of the operation. Offshore oil and gas sector operations, in particular, may include evolving technologies and take place in different settings, making it difficult to generalize air emission potentials. For example, mobile offshore drilling units involved in deepwater drilling in the Gulf of Mexico may emit considerably more emissions than a rig anchored to the sea floor in shallow water. The construction and operation of facilities on the outer continental shelf emit a significant amount of air pollution which adversely impacts coastal air quality in the United States. Operational emissions from an Outer Continental Shelf (OCS) platform and associated marine vessels can routinely exceed 500 tons of nitrogen and one hundred tons of reactive hydrocarbons annually. A single exploratory drilling operation could emit approximately as much air pollution on a daily basis as a large state-of-the-art oil refinery (Ramseur 2012).

There are many air emissions sources related to oil and gas exploration, development and production in the Gulf of Mexico. During the exploration stage, most of the non-platform emissions are from combustion from the equipment used on a drilling rig or from fuel usage of a support vessel. During the production stage, platform emission sources include boilers, diesel engines, combustion flares, fugitives, glycol dehydrators, natural gas engines, turbines, pneumatic pumps, pressure/level controllers, storage tanks, cold vents and others. During the development stage, most of the non-platform emissions are from fuel usage of support or survey vessels to lay

pipelines, install facilities, or map geologic formations and seismic properties. Pollutants released by OCS sources include the NAAQS pollutants carbon monoxide, nitrogen, particulate matter and sulfur dioxide. Pollutants also released by OCS sources (nitrogen and volatile organic compounds (VOCs)) are precursors to ozone, which is formed by photochemical reactions in the atmosphere and is another NAAQS pollutant. Lastly, OCS sources release greenhouse gas emissions, such as carbon dioxide, methane, and nitrous oxide.

The *Year 2008 Gulfwide Emissions Inventory Study* (Wilson et al. 2010) indicates that, for calendar year 2008, OCS oil and gas production platforms and non-platform sources emitted the majority of criteria pollutants and greenhouse gases in the Gulf of Mexico on the OCS, with the exception of particulate matter and sulfur dioxide (primarily emitted from commercial marine vessels) and nitrous oxide (from biological sources). Oil and gas production platform and non-platform sources account for 93 percent of the total carbon monoxide emissions, 74 percent of nitrogen emissions, 76 percent of VOC emissions, 99 percent of the methane emissions, and 84 percent of the carbon dioxide emissions on the outer continental shelf. Natural gas engines on platforms represented the largest carbon monoxide emission source, accounting for 60 percent of the total estimated oil- and gas-related carbon monoxide emissions; and oil- and gas-related support vessels were the highest emitters of nitrogen, accounting for 35 percent of the total estimated emissions. Oil and natural gas production platform vents and fugitive sources account for the highest percentage of VOC and methane emissions. Support vessels (29% of total emissions), production platform natural gas turbines (15% of total emissions) and drilling rigs (12% of total emissions) emit the majority of the carbon dioxide emissions attributable to oil and gas production on the OCS.

Accidental events that could impact air quality include spills of oil, natural gas, condensate, and refined hydrocarbons; hydrogen sulfide release; and fire and could result in the releases of NAAQS air pollutants. Response activities that could impact air quality include in-situ burning, the use of flares to burn gas and oil, and the use of dispersants applied from aircraft. Measurements taken during an in-situ burning show that a major portion of compounds was consumed in the burn; therefore, pollutant concentrations would be expected to be within the NAAQS. Accidents involving high concentrations of hydrogen sulfide could result in deaths as well as environmental damage. BOEM and BSEE regulations and Notices to Lessees are in place to protect workers from hydrogen sulfide releases. These and other emissions are not expected to change onshore air quality classifications due to their concentrations, the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline, though the impacts of catastrophic accidental events are still uncertain.

During the Deepwater Horizon event, a huge number of air samples were collected, and according to the EPA, air pollutants in coastal communities were at levels well below those that would cause short-term health problems. The air monitoring conducted to date has not found pollutants at levels expected to cause long-term harm. However, questions have been raised concerning the effects of the Deepwater Horizon event on public health and the workers, resulting from the releases of particles and toxic chemicals due to evaporation from the oil spill, flaring, oil

burning and the applications of dispersants. More recent assessments of worker health have found that exposure levels were generally below occupational exposure limits. Air quality impacts include the emission of pollutants from the oil that are hazardous to human health and have had the potential to occur during this accidental event. The effects of some of the pollutants accumulate over a life time and can contribute to diseases that can possibly be fatal years after the exposure. However, extensive personal air sampling to ensure worker safety and onshore air monitoring to ensure public safety showed that levels of pollutants remained within acceptable ranges.

Climate is defined as the average statistics of weather, which include temperature, precipitation and seasonal patterns such as storms and wind, in a particular region. Global climate change refers to the long-term and irrevocable shift in these weather related patterns, including the rise in the Earth's temperature due to an increase in heat-trapping or "greenhouse" gases in the atmosphere. Using ice cores and geological records, baseline temperature and carbon dioxide data extends back to previous ice ages thousands of years ago. Over the last 10,000 years, the rate of temperature change has typically been incremental, with warming and cooling occurring over the course of thousands of years. However, scientists have observed an unprecedented increase in the rate of warming over the past 150 years, roughly coinciding with the global industrial revolution, which has introduced tremendous amounts of greenhouse gases into the atmosphere.

Unlike emissions of criteria and toxic air pollutants, which have local or regional impacts, emissions of greenhouse gases (GHGs) that contribute to global warming or global climate change have a broader, global impact. Global warming is a process whereby GHGs accumulating in the atmosphere contribute to an increase in the temperature of the earth's atmosphere. The principal GHGs contributing to global warming are carbon dioxide, methane, nitrous oxide and fluorinated compounds. These gases allow visible and ultraviolet light from the sun to pass through the atmosphere, but they prevent heat from escaping back out into space.

Among the potential implications of global warming are rising sea levels, and adverse impacts on water supply, water quality, agriculture, forestry and habitats. In addition, global warming may increase electricity demand for cooling, decrease the availability of hydroelectric power and affect regional air quality and public health. Like most criteria and toxic air contaminants, much of the GHG production comes from motor vehicles and to a lesser extent motorized marine vessels. Climate change affects public health because the higher temperatures result in more air pollutant emissions, increased smog and associated respiratory disease and heart-related illnesses. Climate change also affects ocean acidity, causing a decrease in the pH of the ocean, as a result of uptake of carbon dioxide from the atmosphere. This condition is called ocean acidification. Ocean acidification has potentially devastating ramifications for all ocean life; from the smallest, single celled algae to the largest whales.

In coastal areas adjacent to the study area, coastal wetlands are undergoing the highest rates of loss anywhere in the U. S., are threatened by sea level rise and in many areas cannot naturally

move inland due to existing developments. This condition has the potential to threaten the region's estuarine-dependent fish species and may allow non-native species to thrive.

4.2.2 Noise Environment

Noise in the offshore Gulf of Mexico environment, both above and below the water, can come from a variety of natural and anthropogenic sources. Anthropogenic sources include oil and gas industry operations, shipping, general vessel traffic, cruise ships, fishing vessels, charter/head boats and other tour boats, aircraft, research, energy and mineral exploration, construction, seismic devices, pingers, and military activities such as use of sonar and explosives. Noise generated from these activities can be transmitted through both air and water, and may be long-lived or temporary. These various activities produce composite noise fields above and below the water. The intensity level and frequency of the noise emissions are highly variable, both between and among the various sources.

Noise associated with oil and gas development results from seismic surveys, the operation of fixed structures such as offshore platforms and drilling rigs, and helicopter and service-vessel traffic. Noise from these activities may affect resources in the proposed expansion areas. Whether a sound is or is not detected by marine organisms depends both on the acoustic properties of the source (spectral characteristics, intensity and transmission patterns) and the sensitivity of the hearing system in the marine organism. Extreme levels of noise can cause harassment, physical damage or death to an exposed animal and, in limited circumstances, can cause "take" of endangered and threatened species as defined in the Endangered Species Act. Source levels well above hearing thresholds can damage hearing or induce behavioral changes (Richardson et al., 1995).

Potential impacts of sound on marine organisms can range from no or very little effect to various levels of behavioral reactions, physiological stress, threshold shifts, auditory masking and direct trauma. Responses to sound generally fall into three categories: behavioral, acoustic and physiological (Nowacek et al. 2007). Noise pollution can be intense and acute or less intense and chronic (Hildebrand 2004). Hildebrand (2004) states that estimates suggest noise levels in the ocean were at least ten times higher in the early 2000's than a few decades prior. Commercial shipping is considered to be the major contributor to low frequency noise in the world's oceans (Hildebrand 2004). Pirotta et al. (2012) investigated the effects of vessel noise on beaked whales (Ziphiidae) and found that broadband ship noise caused a significant change in beaked whale behavior up to at least 3.2 miles (5.2 km) away from the vessel. Rolland et al. (2012) found that reduction in shipping noise in the Bay of Fundy led to a significant reduction in stress-related fecal metabolites in North Atlantic right whales. Visual observations of bowhead and other baleen whales have indicated that individuals can be displaced when exposed to continuous industrial sound that exceeds approximately 120 dB or 1μPa (microPascal; a unit of pressure; Richardson et al. 1995). In addition to commercial shipping, smaller commercial vessels and recreational watercraft add noise to the ocean environment.

Active sonar, as is used by the Navy in Gulf of Mexico waters, emits high-intensity acoustic energy and can be categorized as low-frequency (<1000Hz), mid-frequency (1-20kHz) and high frequency (>20kHz) (Hildebrand 2004). Hildebrand (2004) suggests that low-frequency active sonars have long ping lengths and nearly continuous duty cycles that increase the likelihood they will impact marine mammal populations. Humpback whales in the Atlantic have been found to sing longer songs during low frequency active sonar transmissions by the Navy, and it has been suggested that this indicates that whales are compensating for acoustic interference (Miller et al. 2000). Fristrup et al. (2003) found a similar result and documented a delayed response to low frequency active sonar, with humpback whales showing effects up to two hours after the final sonar signal. Humpback whales near the Hawaiian Islands displayed avoidance behavior in playback experiments to assess the effects of low-frequency sonar on whales (Maybaum 1993). There is growing evidence of a potential link between military sonar exercises and cetacean strandings, particularly with respect to beaked whales (Ziphiidae). Reports of such strandings include events in the Canary Islands, Bahamas and Greece (Simmonds and Lopez-Jurado 1991, Frantzis 1998, Cox et al. 2006). Jepson et al. (2003) has suggested that behavioral reactions to sonar may contribute to strandings and decompression-like symptoms found in stranded cetaceans. Nowacek et al. (2007) provides an extensive overview of research on the effects of sounds on marine mammals.

Numerous species of managed fish species that occur through the range of the alternatives are considered soniferous, or sound sensitive (Normandeau Associates, Inc. 2012) using natural sound (producing sound, or feeling/listening to sound) for navigation, spawning, seasonal migrations, feeding, etc. There is also growing evidence that settlement stage reef fish, crustaceans (Montgomery et al. 2006), and coral larvae (Vermeij et al. 2010) use reef noise as a cue for orientation for suitable settlement substrate – a strategy that could be compromised by masking from noisy marine landscape through masking. This warrants consideration as part of the need for continued successful recruitment to the habitats presented in the alternatives.

4.2.3 Scenic and Visual Resources

The striking visual characteristics of the Flower Garden Banks and the similar features considered for the proposed sanctuary expansion are among the primary aspects of the underwater environment of the region of interest to the general public. For most citizens, the depths of the Gulf of the Mexico are personally inaccessible. Underwater video and photography are valuable tools to bring the seafloor to the general population. Underwater photography is a significant activity among divers visiting the shallower portions of these areas, and is also a crucial element for the sanctuary's education and outreach efforts in increasing awareness and sharing the beauty of the resources. Remotely viewed video such as the live streaming events from exploration vessels from, e.g., the *Okeanos Explorer* and the *Nautilus*, attract large audiences. The live video events during which the Monterey Wreck sites were discovered and surveyed were extremely popular and well attended, and provided for live interaction between the research team, the public, and experts on land. The live stream of oil flowing from the Deepwater Horizon wellhead, and footage of oil slicks at the surface during that event is likely among the most-watched video

footage from the Gulf of Mexico region, emphasizing the value of the scenic and visual resources of healthy marine ecosystems in the region.

The presence of visible drilling and production platforms, as well as heavy vessel and air traffic all affect the scenic and visual environment in the offshore Gulf of Mexico. The aesthetic qualities of visible industrialized infrastructure are subjective, but are generally regarded as negative, particularly in landscape/seascape settings such as National Parks or National Marine Sanctuaries, where the purpose of designation is often associated with an area's defining natural features. Visibility of industrial structures on an open horizon that may be frequented by people precisely for the open horizon is a net negative aesthetic and a conflict in space use (Brody et al. 2006).

The greatest visual impact from industry on the environment in the offshore Gulf of Mexico results from the presence of extensive oil and gas industry infrastructure, with thousands of platforms installed in the U.S. Exclusive Economic Zone (EEZ) as described in Section 4.5.3. The thousands of vessel transits annually in shipping lanes in the Gulf of Mexico also produce significant visual impacts. Additional impacts to visual and aesthetic environment are produced by factors such as oil spills and marine debris. These are the most widely recognized as major threats to the aesthetics of coastal lands, especially recreational beaches, but they also individually and collectively affect the fishing industry, tourism and recreation in the offshore environment. The effects of an oil spill on aesthetics depend on factors such as season, extent of pollution, location, condition and type of oil, oceanographic factors such as tides and currents, and cleanup methods (if any). A number of structures are visible from a vessel within the current FGBNMS boundaries, and additional structures are visible from the proposed expansion areas.

4.2.4 Geology and Substrates

The outer continental shelf and continental slope off the coasts of Texas, Louisiana, Mississippi and Alabama are geologically complex. The continental shelf in this region slopes gradually from the shoreline to depths from 325-650 feet (99-198 meters), and is characterized primarily by sediments of terrigenous origin. However, this region is punctuated by a series of topographic features scattered along an area parallel to the edge of the shelf. Most of these features were formed as the result of the movement of underlying salt deposits (also called salt domes or diapirs).

About 190 million years ago, during the Jurassic Period, the Gulf of Mexico was very shallow. The hot dry climate at the time caused intense evaporation, depositing thick layers of salt on the sea floor. As the Gulf of Mexico deepened, rivers deposited mud, silt and sand on top of the salt layers, forming layers of mudstone, siltstone and sandstone. Over time, the weight of these accumulating deposits caused the underlying salt to flow to areas where the overlying rocks were weak or faulted. The salt rose, bowing up or breaking through the overlying rock layers. This movement of the salt created outcrops of rock and relief on the seafloor of 165 feet (50 meters) or

more. These features are the foundation on which the coral reef and bank biological communities of the north central Gulf of Mexico have established.

The Pinnacles area includes features that are thought to be related to sea level still-stands during the last glaciation (peak of last glacial maximum ~18 thousand years before present time). Surficial sediments are largely related to three late Pleistocene deltas. They are made up of thousands of carbonate hard bottom mounds of varying sizes, formed in varying sea level episodes.

Regional topography of the continental slope consists of basins, knolls, ridges and mounds derived from the dynamic adjustments of salt to the introduction of large volumes of sediment over long time scales. Superimposed on this underlying topography is a smaller class of mounds, flows and hard bottoms that are the products of the transport of fluidized sediment, mineral-rich formation fluids and hydrocarbons to the present sediment-water interface. The geologic response to the expulsion process is related both to the products being transported and the rate at which they arrive at the seafloor. Mud volcanoes and mudflows are typical of rapid flux settings where fluidized sediment is involved. Carbonate mounds formed by chemical precipitation, hard bottoms, crusts and nodules are common to settings where hydrocarbons are involved (Brooks et al., in review).

Activities that could affect geology and substrates, including dredge and fill activities and mineral extraction, are regulated by the U.S. Army Corps of Engineers (USACE) under the Rivers and Harbors Act of 1899 and by BOEM and BSEE under the Outer Continental Shelf Lands Act, as described in section 4.6.

4.2.5 Water

Moving along the coast, near-shore currents tend to flow from east to west. Beyond the coastal zone, water movement on the continental shelf off Texas, Louisiana, Mississippi and Alabama can be variable depending upon forcing mechanisms including tides, wind, heating, river runoff and interaction with shallow flow of the deep basin (Rezak et al. 1983). While these local conditions influence the current patterns in the northwestern Gulf of Mexico, it is the Loop Current and its associated “spin-off” eddies and gyres that are the main drivers of water circulation in the Gulf of Mexico (Sturges and Lugo-Fernandez 2005).

The Loop Current enters the Gulf of Mexico through the Yucatan Channel between Cuba and Mexico as a massive river of warm water, reaching speeds up to 6.5 feet/second (almost 4 knots) (Badan et al. 2005). The current flows northward, at times reaching as far as 28° N before looping clockwise along the west Florida shelf to exit through the Florida Straits. The waters of the Loop Current then join the waters of the Caribbean Current and the Antilles Current to flow northward along the southeastern U.S. coast and become the Gulf Stream. As the Loop Current reaches its maximum northern position in the Gulf of Mexico, it often becomes unstable, shedding large eddies (or gyres) that spin primarily clockwise as they drift westward at speeds of 0.6-5 miles/day. These eddies can have a diameter of 125-250 miles, and last for intervals of 0.5-18.5

months (Schmitz et al. 2005). Before they dissipate, these eddies can have a significant influence on current patterns in the northwestern Gulf of Mexico.

Runoff from precipitation on almost two-thirds of the land area of the continental U.S. eventually drains into the Gulf of Mexico primarily via the Mississippi River and other waterways leading to the Gulf of Mexico. Riverine flows and the sediment they contain have determined the geologic composition of much of the continental shelf as sea levels have risen over the last 100,000 years, drowning river valleys and deltas that previously extended to the edge of the continental shelf and leaving deposits such as the sand banks at Ship Shoal, Sabine Bank, and Heald Bank at prior shoreline or barrier island locations (Anderson and McBride 1996). The combined discharge of the Mississippi and Atchafalaya Rivers alone accounts for more than half the freshwater flow into the Gulf of Mexico and is a major influence on salinity levels in coastal waters on the Louisiana/Texas continental shelf. The annual freshwater discharge of the Mississippi/Atchafalaya River system represents approximately 10 percent of the water volume of the entire Louisiana/Texas shelf to a depth of 295 feet (90 meters) (GMFMC 1998), with a discharge of 600,000 cubic feet per second, or 1.5 billion cubic meters per day, at New Orleans (NPS 2015).

The fresh water and sediment mix with the salt water of the northern Gulf of Mexico, creating extensive areas of biologically rich estuarine and offshore habitats. Freshwater and sediment inflows also serve as a source of pollution from upstream agriculture, stormwater runoff, industrial activities, and wastewater discharges. In bottom water (the lowermost layer of ocean water), low oxygen availability (a condition known as hypoxia) is a major water quality problem in portions of the northern Gulf of Mexico and its estuaries, caused in large part by nutrient loading from river inflows. The input of nutrient-rich fresh water to the coastal area fuels phytoplankton blooms in the water column. Following the eventual transportation of dead and decaying plant material to the ocean floor, this organic-rich biomass undergoes decomposition by bacteria and results in the depletion of oxygen (eutrophication) at depth (DWH NRDA Trustees 2016). The Loop Current and Mississippi/Atchafalaya River system, as well as a semi-permanent, anticyclonic gyre in the western Gulf of Mexico, significantly affect oceanographic conditions throughout the Gulf of Mexico.

The reefs and banks of the northwestern Gulf of Mexico are located from 60-115 miles from the shore, so they are positioned well away from the normal influence of coastal runoff and nearshore eutrophication. Chlorophyll and nutrient levels are typically low, and indicative of oligotrophic oceanic conditions. Water temperatures in the region of the Flower Garden Banks typically range from 64°F (February) to 86°F (August), and salinity ranges from 34-36 parts per thousand (ppt). These values are well within the range of that necessary for coral reef growth, although winter temperatures approach the lower limit of some coral species' tolerance.

Even though the Pinnacles area is closer to shore, the water properties in the lower half of the water column appear to be determined by the presence of Gulf of Mexico waters with salinity typically 36-36.5 ppt, although the upper portions of the water column appear to be determined

by coastal processes and can range from 30-35.5 ppt (Weaver et al. 2001). Mississippi River plume water is typically present in the surface layer during the summer months. This general trend can be influenced by intrusion of Loop Current water or Loop Current eddies. Water temperatures can range annually from around 64°F-79°F on the sea floor. A highly turbid or "nepheloid" layer is present near the sea floor throughout the Pinnacles area and is associated with lower bottom water temperature.

The deep coral sites off the shelf edge are exposed to conditions much colder than those on top of the shelf. The deepwater coral species *Lophelia pertusa* is typically associated with temperatures of 39°F-54°F (Frederiksen et al. 1992, Freiwald et al. 1998), dissolved oxygen concentrations from 3-5 milliliters per liter (mL/L), and a relatively constant salinity of 35-37 ppt (Roberts et al. 2003).

As elsewhere globally, the climate-change driven phenomena of ocean acidification, increasing ocean temperatures, and altered ocean salinities are affecting the north central Gulf of Mexico, representing threats to the habitats and species present in the region (Guinotte et al. 2006, Thresher et al. 2015). Ocean pH and calcium carbonate saturation are decreasing due to an influx of anthropogenic CO_2 to the atmosphere, which may inhibit the ability of marine organisms to build calcium carbonate skeletons, shells, and tests (Guinotte et al. 2006). Several of the deep coral ecosystem sites encompassed by the proposed alternative boundaries presented in this DEIS have been documented to have low concentrations of aragonite (a form of calcium carbonate used by scleractinian corals to build their skeletons) while harboring populations of corals, making these sites important as climate change sentinels for monitoring the effects of changing seawater chemistry on deep coral ecosystems.

Discharges to water of the U.S. Gulf of Mexico outside the FGBNMS boundary are regulated by the EPA under the Clean Water Act, the USACE under the Rivers and Harbors Act of 1899, and by BOEM and BSEE under the Outer Continental Shelf Lands Act, as described in section 4.6. Discharges inside the FGBNMS boundary are also regulated by FGBNMS.

Recent research has shown natural hydrocarbon seeps in the Gulf of Mexico to release between ~159,000 and ~596,000 barrels of hydrocarbons into the water column annually (Macdonald et al. 2015), compared with 3.19 million barrels released over the course of the 87 day Deepwater Horizon oil spill alone, with another ~44,000 barrels of dispersant applied in response to that event (DWH NRDA Trustees 2016). Studies have also documented low-level chronic effects of releases (pollutants ranging from solid wastes, to chemical contaminants, to sewage) from platforms (Kennicutt 1995), ships (Copeland 2008), and land-based sources (NOAA 1998). Produced water discharges, for example, are estimated at roughly 1 billion barrels per year. While concentrations of hydrocarbons contained in this discharge is low (e.g., limited under EPA's Region 6 NPDES general permit for offshore oil and gas activities to 29 mg/L monthly average or 42 mg/L daily maximum), the total volume is quite large (Veil et al. 2004, Veil 2008).

4.3 Biological Environment

The communities comprising the biological environment of the offshore continental shelf in the vicinity of the proposed sanctuary expansion are characterized by the depth zone they inhabit, as described below.

4.3.1 Living Marine Resources

4.3.1.1 Coral Reef Zone

This zone includes the actively accreting reef-building (stony) coral assemblages of the coral reef crest (cap) of East and West Flower Garden Banks (i.e., the substrate in this zone is derived from the corals that comprise it). It can occur at depths from 54-150 feet (16-46 meters). Major habitats within this zone are described by the dominant coral species that characterize the assemblage.

Figure 4.1. Example of high coral cover in the coral reef zones on the crests of East and West Flower Garden Banks. Image credit: FGBNMS/Schmahl.

The primary habitat of the coral reef zone of the Flower Garden Banks is *Orbicella* (formerly *Montastraea*) habitat. This habitat includes at least 24 species of stony corals and is interspersed by sand channels comprised of coral sand (coral debris with molluscan and algal components). *Madracis* habitat occurs on the peripheral parts of the primary reef structure at East and West Flower Garden Banks in depths ranging from 90-140 feet (27-43 meters) where large knolls are characterized by almost monospecific stands of the small branching coral *Madracis auretenra*.

Stephanocoenia habitat is a lower diversity coral community occurring in water depths primarily below 118 feet (36 meters). This habitat occurs in areas surrounding the Flower Garden Banks, and is the primary coral reef habitat at McGrail Bank. The deeper depth ranges of these reefs are considered mesophotic coral habitat. This zone is represented in the reefs and banks of the northwestern Gulf of Mexico (Alternatives 1, 2, 3, 4 and 5).

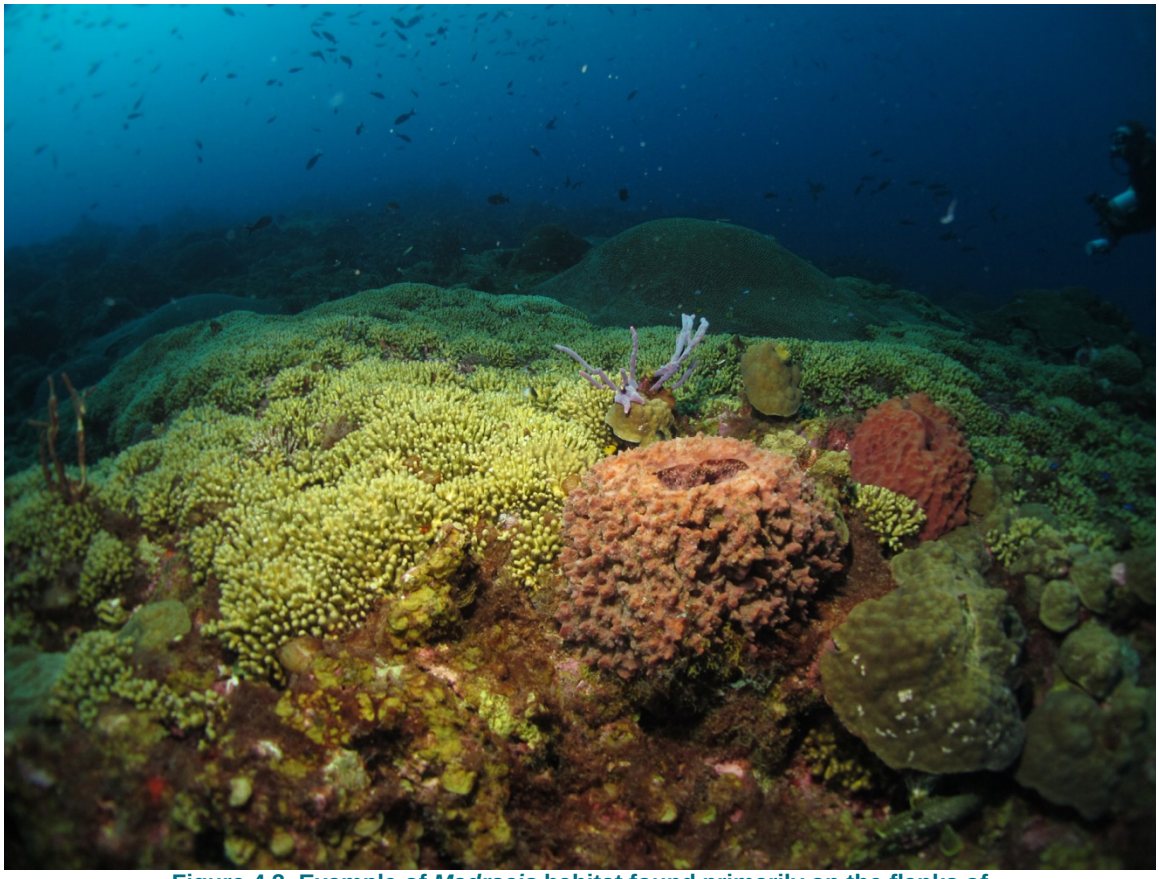

Figure 4.2. Example of *Madracis* habitat found primarily on the flanks of East and West Flower Garden Banks. Image credit: FGBNMS/Hickerson.

4.3.1.2 Coral Community Zone

This zone is comprised of areas that, while not considered to be true coral reefs (primary reef structure is composed of reef-building corals), do contain reef-building coral species at lower densities, or are characterized by other coral reef associated organisms, such as the hydrozoan *Millepora* (fire coral), sponges and tropical macroalgae. Coral communities are found in depth ranges similar to those that contain coral reefs (54-150 feet; 16-46 meters) where other environmental factors have not allowed full development of reef building species to occur. The most distinctive habitat type in this zone is the *Millepora*-sponge community that characterizes the shallowest peaks of the mid-shelf reefs at Stetson and Sonnier Banks. The coral community zone also includes habitats that are characterized by scattered occurrences of stony corals or fire coral at relatively low densities and includes a mix of other components including leafy algae,

coralline algae and sponges. Geyer and Bright Bank are examples of these types of communities. The greater depth ranges of these reefs are considered mesophotic coral habitat. This zone is represented in the reefs and banks of the northwestern Gulf of Mexico (Alternatives 1, 2, 3, 4 and 5).

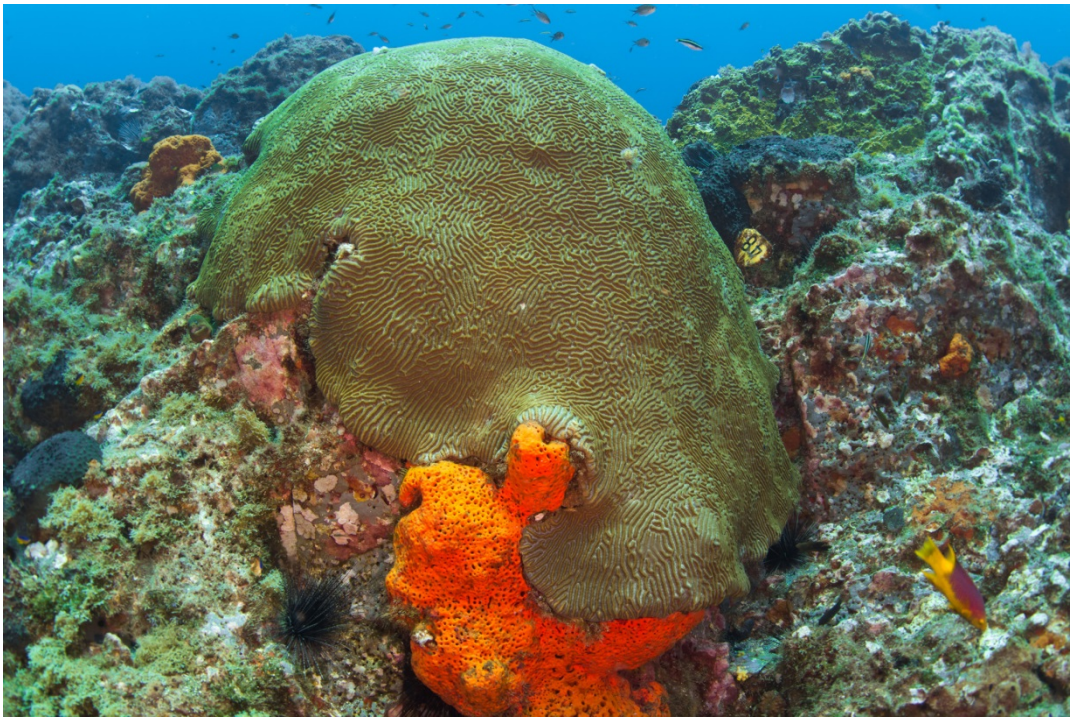

Figure 4.3. Example of a coral community at Stetson Bank. While not classified as a true coral reef, this habitat harbors some reef-building corals, like this brain coral, as well as sponges and a variety of invertebrates. Corals this large are rare on Stetson Bank. Image credit: FGBNMS/Schmahl.

4.3.1.3 Mesophotic Coral Habitats

Mesophotic coral habitats are characterized by the presence of light-dependent corals and associated communities found at water depths where light penetration is low. The term mesophotic literally translates to 'meso' for middle and 'photic' for light. The dominant communities providing structural habitat in the mesophotic depth zone can be made up of coral, sponge, and algal species. The fact that they contain zooxanthellae and require light distinguishes these corals from true deepwater corals, though their depth ranges may overlap (i.e., these habitats may include both light-dependent and non-light-dependent coral species and associated plant, invertebrate, and fish communities). Mesophotic coral habitats are typically found at depths ranging from ~100 feet (30 m) and extending to over 500 feet (~150 m) in tropical and subtropical regions (Puglise et al. 2009, NOAA 2011a, Hourigan et al. 2015, Sulak and Dixon 2015, DWH NRDA Trustees 2016). For the purpose of this DEIS, the term mesophotic habitat is used to refer to biological communities associated with hard bottom features existing between approximately 165 feet (50 meters) and 980 feet (300 meters) deep. The use of 980 feet (300 meters) as the lower limit of this zone is consistent with other regulatory regimes (MMS 2009).

This depth range has also been referred to as the “twilight zone” (Pyle 1996, Kahng et al. 2010). The dominant communities providing structural habitat in the mesophotic zone can be comprised of coral, sponge and algal species (NOAA 2011a).

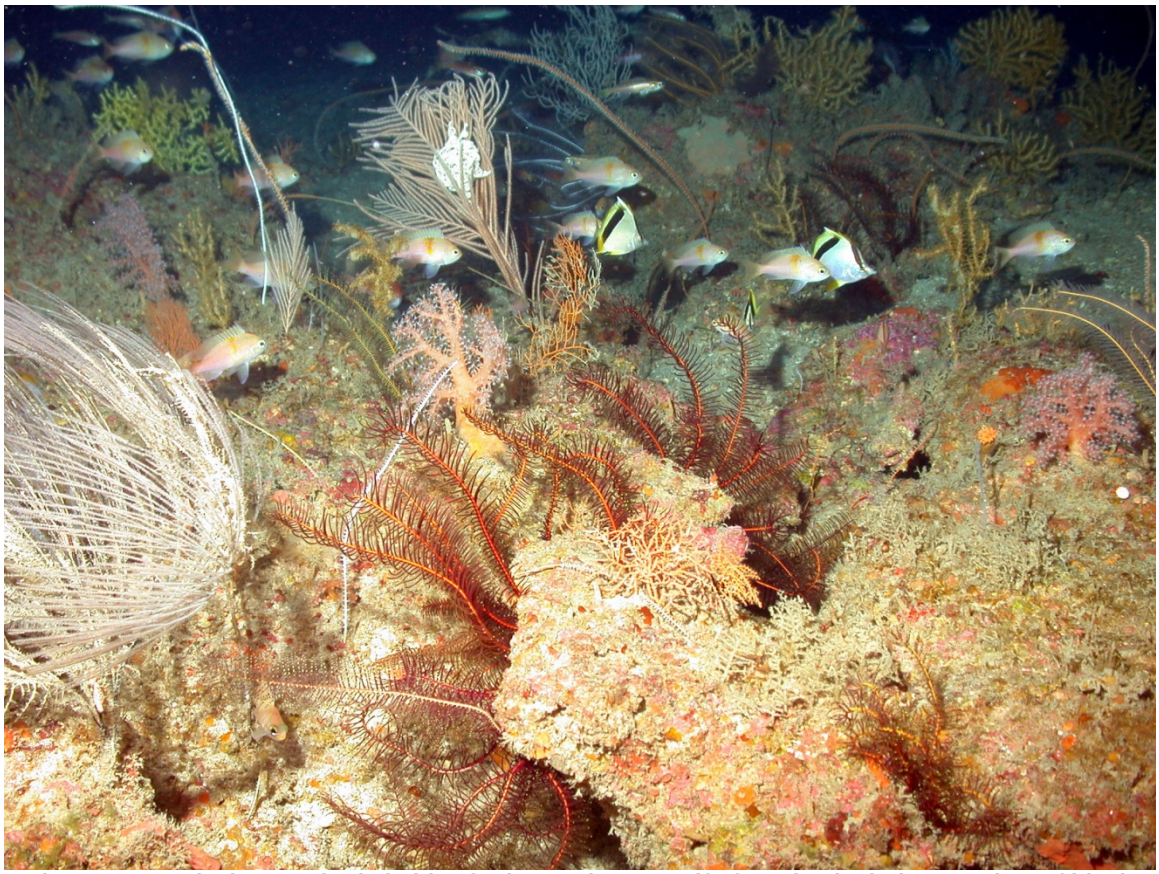

Figure 4.4. Typical mesophotic habitat in the northwest Gulf of Mexico includes a variety of black corals, sea fans, gorgonians, encrusting sponges, coralline algae, soft coral and a variety of invertebrates. Also shown here are Bank butterflyfish, Roughtongue and Threadnose bass. Image credit: FGBNMS/UNCW-UVP.

Mesophotic reefs with horizontal summits harbor large populations of sponges, black corals (antipatharians), sea fans and sea whips (gorgonians), and feather stars. Variation between biological communities on features is attributable, in many cases, to differences in a variety of environmental parameters, especially the potential for sedimentation (Gittings et al. 1992). Mesophotic corals and small, bottom-dwelling reef fish are common and conspicuous components of the mesophotic zone along the Pinnacles area, 165-500 feet (50-152 meters) deep in the northeastern Gulf of Mexico (Rezak et al. 1990, Gittings et al. 1992, Weaver et al. 2001). Mesophotic communities also make up the majority of hard bottom habitats in the deeper areas of the reefs and banks in the northwestern Gulf of Mexico. Most mesophotic corals are non-reef-building, though they include reef-building corals in the deeper areas of the coral caps at East and West Flower Garden Banks and discreet areas on McGrail Bank. White stony branching corals (*Madracis* and *Oculina)* and branching hydrocoral (*Stylaster*) occur in patches, as well as the clustering solitary cup coral (*Rhizopsammia*). The stony corals can utilize photosynthetic

symbionts when ambient light is sufficient, or live without symbionts, feeding upon plankton. The branches of the corals form habitat for reef fishes and build new, though limited, calcareous reef.

Octocorals (gorgonians) and black corals are also common and conspicuous on reefs in the north central Gulf of Mexico mesophotic zone. Octocorals are closely related to reef-building corals and sea anemones. Black corals are often mistaken for gorgonian corals, but unlike gorgonians, do not produce any type of calcium carbonate skeletal structures. The skeleton is organic and made of protein and chitin.

Collectively, octocorals and black corals comprise a diverse assemblage of sessile, benthic suspension feeders that occur on hard bottom and soft bottom habitats from the sublittoral to the abyssal zone in the Gulf of Mexico (Bayer 1954, Cairns and Bayer 2002). Colonies of both types on rocky outcrops and promontories provide habitat to demersal fish and small invertebrates. These colonies are vulnerable to surface originated water pollution because they rely partly upon surface-originated organic matter for sustenance (Ribes et al. 1999, Sulak et al. 2008).

Mesophotic communities are found in depth ranges and habitats both with and without coralline algae. These habitats are represented at sites on the continental shelf, edge and slope (Alternatives 1, 2, 3, 4 and 5).

4.3.1.3.1 Mesophotic Coral Habitats Within the Coralline Algae Zone

This zone, extending from ~148 feet (45 meters) to ~320 feet (98 meters) deep, is characterized by crustose coralline algae and includes both algal nodule habitat and rocky outcrops where coralline algal crusts cover a substantial percentage of the hard substrate. Leafy algae are abundant in this zone to depths of at least 230 feet (70 meters). Algal nodules, or rhodoliths, are formed by coralline algae that lay down successive, concentric layers of carbonate around an initial “nucleus” (e.g., a rock fragment) to form irregular spheres 0.4 inches to over 8 inches (1 to 20 cm) in diameter. Between 165 feet (50 meters) and 250 feet (76 meters), the nodules cover 60–100% of the bottom at the Flower Garden Banks. (Minnery 1984). Several species of reef-building corals are scattered throughout the algal nodule zone, and can be locally abundant, including saucer shaped specimens of *Agaricia* spp. and *Leptoseris cucullata*. Leafy algae and sponges, most notably the toxic sponge *Neofibularia nolitangere*, are also common in this habitat. The coralline algae zone also includes coralline algal reefs, which are typically low-relief (3-6 feet high; 0.9-1.8 meters high), flat-topped rocky outcrops, ridges and patch reefs. While coralline algae are the dominant benthic group on these reefs, the rocky outcrops provide habitat for a variety of gorgonians, black corals, sponges and other organisms.

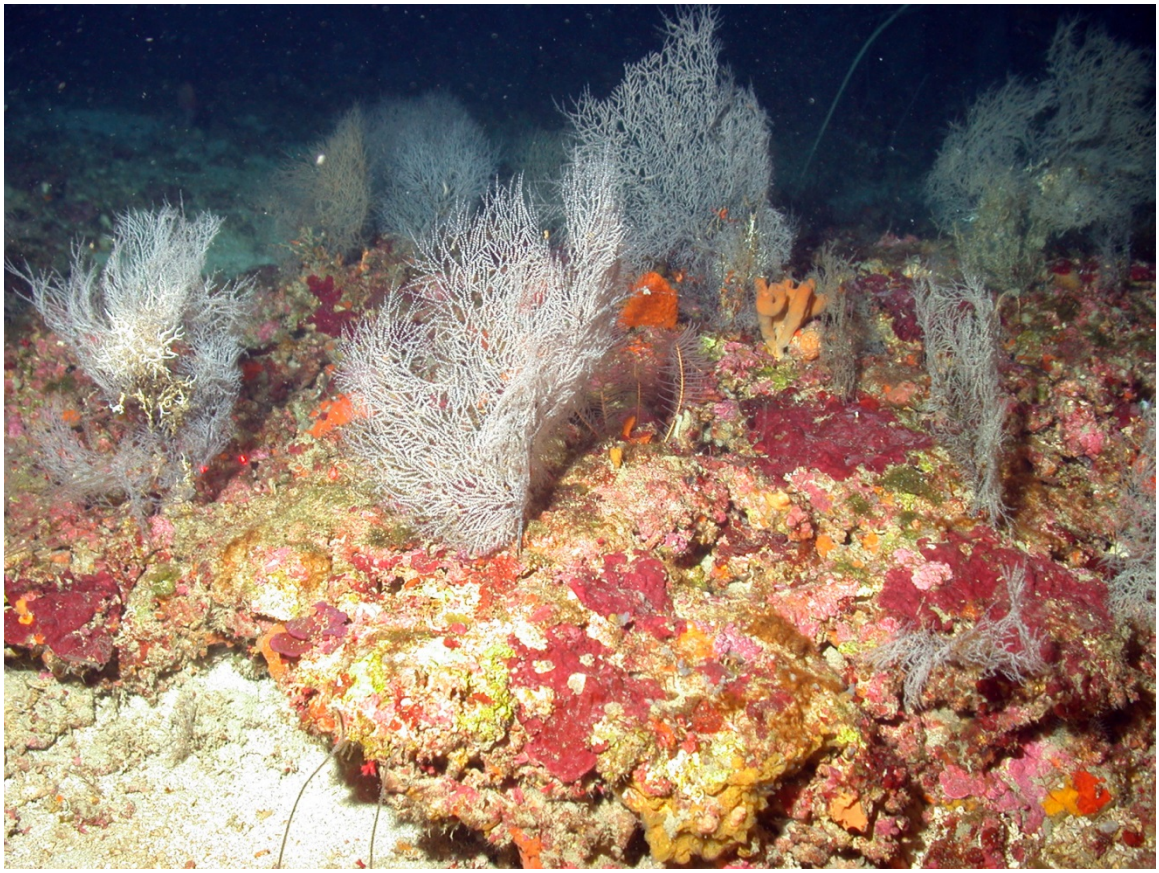

Figure 4.5. Typical coralline algae mesophotic reef colonized by a variety of black coral sea fans and whips, crinoids, encrusting and branching sponges, coralline algae and leafy algae. Image credit: FGBNMS/UNCW-UVP.

4.3.1.3.2 Mesophotic Coral Habitats Beyond the Coralline Algae Zone

This zone occurs in water depths below where light levels are less than 1% of surface levels and/or in conditions where active photosynthesis by algae is not possible. This generally occurs below 295 feet (90 meters), but can be as shallow as 165 feet (50 meters) in turbid conditions. Solitary corals and deepwater branching corals, such as *Madrepora* and *Oculina,* are also found here. This zone has a diverse assemblage of black corals (antipatharians), gorgonians (octocorals), soft corals, crinoids, bryozoans, sponges, azooxanthellate branching corals and small, solitary hard corals. It includes both low and high relief rock outcroppings of various origins. Rock outcrops are often highly eroded, and lack coralline algal growth. Reef outcrops may be covered with a thin layer of silt in areas subject to frequent resuspension of sediments. This area of high sediment resuspension and turbid water was called the “Nepheloid” zone by Bright et al. (1985) and Rezak et al. (1985).

Mesophotic coral habitats are represented in the reefs and banks of the northwestern Gulf of Mexico (Alternatives 1, 2 and 3), the Pinnacles area (Alternatives 4 and 5) and the deep coral ecosystems on the continental slope (Alternatives 4 and 5).

Figure 4.6. Typical mesophotic coral habitat beyond the coralline algae zone in the northwestern Gulf of Mexico. Shown here are a variety of black corals and gorgonians, and branching stony corals, as well as Roughtongue and Threadnose bass. Image credit: FGBNMS/UNCW-UVP.

4.3.1.3.3 Soft Bottom Community

Deeper areas of the reefs and banks are characterized by a soft, level bottom community composed of both land-based sediments, originating from coastal rivers, and carbonate sediments, composed of calcareous plankton remains or resulting from erosion of rocky outcrops and shallower coral and coral reef communities. Lower densities of conspicuous fishes and invertebrates occur on soft bottom communities when compared to coral reef or rocky zones. Soft bottom communities are often characterized by sand waves, burrows and mounds. Transitional zones between soft bottom communities and hard bottom features are characterized by exposed rubble, isolated patch reefs or exposed hard bottom. Areas with buried or exposed rubble are often colonized by black corals, gorgonians or solitary hard corals. These areas provide crucial habitat for infaunal populations.

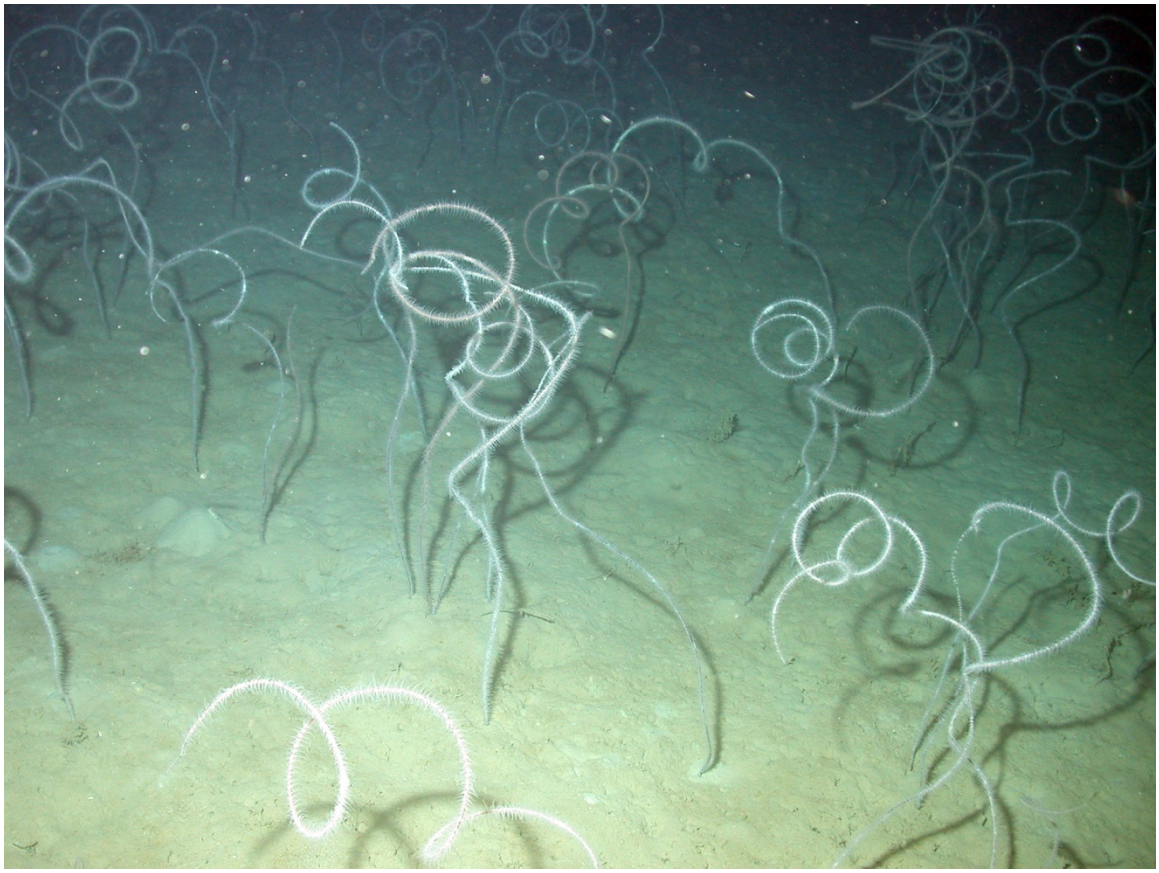

Figure 4.7. Example of soft bottom habitat colonized by black coral sea whips, indicating hard substrate beneath the sediment serving as attachment points. Image credit: FGBNMS/UNCW-UVP.

4.3.1.4 Deep Coral Ecosystems

Deep hard bottom communities of the Gulf of Mexico typically inhabit natural carbonate substrates, below 980 feet (300 meters) deep. These communities consist of foundation species, those species that form large complex habitats at these sites, and their associated fauna ranging in size from large mobile fishes to microscopic organisms. The most prominent foundation species in these communities are the deepwater corals. The term “deepwater corals” includes relatives of the tropical reef-building corals, but also refer to a variety of other cnidarian taxa including black corals, gorgonians (including bamboo corals), soft corals and hydrocorals. Other taxa, including anemones and sponges are also significant contributors to the framework of these deepwater reef systems.

In the Gulf of Mexico, deepwater corals are commonly found on seep-related carbonate formations (areas of hard bottom formed by microbially driven anaerobic oxidation of methane, which increases pore water alkalinity by the production of bicarbonate, thus favoring the precipitation of authigenic carbonate minerals in the shallow subsurface (Naehr et al. 2007). The most common species of structure-forming deepwater coral in the Gulf of Mexico is *Lophelia pertusa*. Individuals of this species were first collected in the late 1800s by the *U.S. Coast Survey*

Steamer Blake (Cairns 1978). *Lophelia pertusa* reefs in the Gulf of Mexico were first reported from a deepwater trawl taken by the M/V Oregon in 1955 (Moore and Bullis, 1960). Recently, submersible observations have located high densities of *L. pertusa* in numerous additional locations on the upper slope of the northern Gulf of Mexico (Schroeder 2002, Schroeder et al. 2005, Cordes et al. 2006, Cordes et al. 2008, CSA 2007).

Figure 4.8. An orange basket star on a large *Lophelia pertusa* reef at 1,476 (450 m) feet on Viosca Knoll 826. *Beryx* fish are swimming over the top of the reef. Image credit: Brooks et al. (in review).

Species of deepwater corals can inhabit waters ranging from 165 feet (50 meters) to over 9,850 feet (3,002 meters) deep. However, researchers often define deepwater organisms (including deepwater corals) as organisms that live deeper than the continental shelf (> 650 feet deep (198 meters; Hourigan et al. 2007). Depth ranges may overlap with other mesophotic and shallow water corals, though deepwater coral communities are distinctly different from shallow coral communities because they do not require sunlight for their energy needs since they lack symbiotic algae (i.e., zooxanthellae; Hourigan et al. 2007). Deepwater coral species include stony, reef-building corals, black corals and soft corals such as sea fans and sea whips (Hourigan et al. 2007). Deepwater corals can be locally abundant, but their distribution is highly restricted in the ocean; their existence relies on hard bottom substrate, which comprises less than one percent of the global ocean floor, and specific underwater conditions (Roberts et al. 2006). These corals colonize rocky outcroppings that are located in the path of underwater currents that bring suspended, particulate, organic matter or zooplankton to the corals as a food source (Roberts et al. 2006). Corals may exist as a single colony on a small boulder on the sea floor, or more typically

in groups of up to hundreds of individual colonies on larger rocky outcroppings (Hourigan et al. 2007). There are only a few documented sites with more than a thousand coral colonies in the Gulf of Mexico (Doughty et al. 2014, Fisher et al. 2014a).

Hard bottom in the Gulf of Mexico is typically created from carbonate precipitation that results indirectly from the activity of microbes at active hydrocarbon seeps (Thiel et al. 2001, Formolo et al. 2004). Hard bottom corals may be co-located with high-density chemosynthetic communities (characterized by tubeworms, mussels, clams, bacterial mats and other associated organisms) if the natural hydrocarbon seeps are still active (Hourigan et al. 2007, Cordes et al. 2008). Corals do not rely on hydrocarbons as a source of energy, but consume plankton or surface-derived particulate matter from the water column.

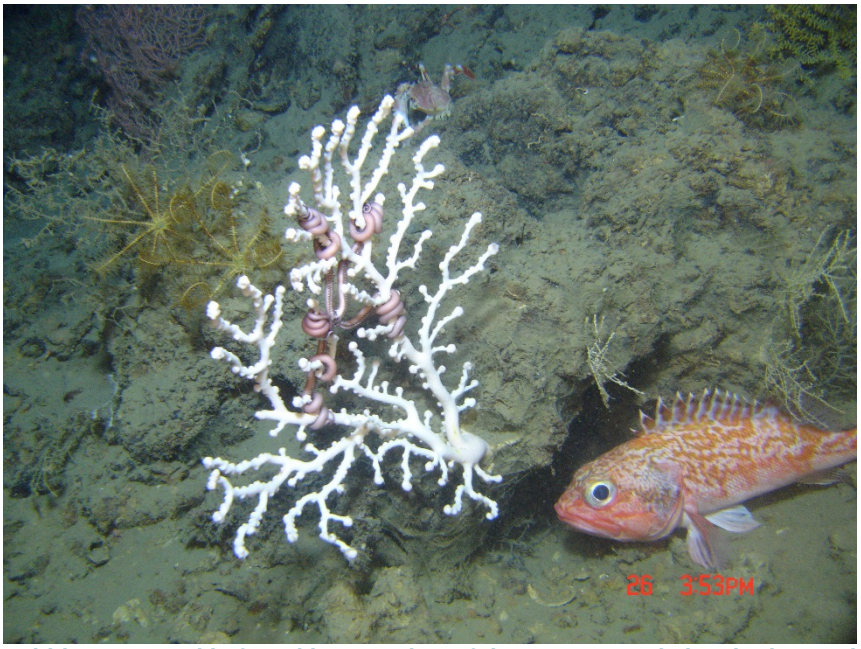

Figure 4.9. Bubble gum coral is found in a number of deepwater coral sites in the northern Gulf of Mexico. Image credit: Brooks et al. (in review).

Hard bottom corals are ecologically significant components of the deep benthic habitat. They create three-dimensional structure in the deep ocean, which provides protective cover for a variety of animals such as large brittle stars, crabs and fish (Brooks et al. in review, Buhl-Mortensen et al. 2010). Corals may also play a unique role in the reproduction of some fish species (Reed 2002, Baillon et al. 2012) and, due to their rarity, are important reservoirs of deepwater biodiversity (Buhl-Mortensen et al. 2010). Unfortunately, the full ecological benefits and ecosystem services of hard bottom coral communities are poorly understood due to the difficulty of researching corals in deepwater environments. To date, researchers have only visited a small fraction of the potential number of these ecologically significant deep coral ecosystem sites with an ROV or manned submersible.

Deepwater corals are often extremely slow-growing and long-lived. For example, radiocarbon dating of a Gulf of Mexico *Leiopathes* sp. black coral indicates the animal has been continuously growing for at least the last two thousand years (Prouty et al. 2011, Doughty et al. 2014). Researchers dated *Paramuricea* sp. at 600 years old with radial growth rates of less than 14 microns (µm) per year. Studies of deepwater coral suggest that radial growth rates decrease over a coral's lifespan (Prouty et al. 2011).

This zone is represented in the deep coral ecosystem sites on the continental slope (Alternatives 4 and 5).

4.3.2 Essential Fish Habitat and Habitat Areas of Particular Concern

Activities that affect living marine resources and their habitats in the Gulf of Mexico are regulated by NOAA and the U.S. Fish and Wildlife Service (USFWS) under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Endangered Species Act (ESA), and the Marine Mammal Protection Act (MMPA). These federal laws are further described in section 4.6.

Congress enacted amendments to the MSA (P.L. 94-265) in 1996, establishing procedures for identifying Essential Fish Habitat (EFH) and requiring interagency coordination to further the conservation of federally managed fisheries. Rules published by NOAA's National Marine Fisheries Service (NMFS) (50 CFR 600.805 – 600.930) specify that any federal agency that authorizes, funds or undertakes, or proposes to authorize, fund or undertake an activity which could adversely affect EFH is subject to the consultation provisions of the MSA as described in the implementing regulations. This section and the associated impacts sections were prepared to meet these requirements.

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (GMFMC 1998, GMFMC 2005, NOAA 2009). The EFH rules encourage regional Fishery Management Councils to designate HAPCs within areas identified as EFH to focus conservation priorities on specific habitat areas that play a particularly important role in life cycles of federally managed fish species. HAPCs help focus research and conservation efforts on localized areas that are especially important ecologically or are vulnerable to degradation, and are subsets of the total area necessary to support healthy stocks of fish throughout all of their life stages.

Detailed information on EFH for federally managed coral, shrimp, reef fish and coastal migratory pelagic species is provided in both the 1998 and the 2005 Generic Amendments of the Fishery Management Plans (FMPs) for the Gulf of Mexico prepared by the Gulf of Mexico Fishery Management Council (GMFMC). EFH for species managed by the GMFMC consists of the following waters and substrate areas in the north central Gulf of Mexico:

Red Drum FMP: all estuaries; Vermilion Bay, Louisiana, to the eastern edge of Mobile Bay, Alabama, out to depths of 25 fathoms; Crystal River, Florida, to Naples, Florida, between depths

of 5 and 10 fathoms; and Cape Sable, Florida, to the boundary between the areas covered by the GMFMC and the South Atlantic Fishery Management Council (SAFMC) between depths of 5 and 10 fathoms (Appendix D, Figure D-1a).

Reef Fish and Coastal Migratory Pelagics FMPs: all estuaries; the US/Mexico border to the boundary between the areas covered by the GMFMC and the SAFMC from estuarine waters out to depths of 100 fathoms (Appendix D, Figure D-1b).

Shrimp FMP: all estuaries; the US/Mexico border to Fort Walton Beach, Florida, from estuarine waters out to depths of 100 fathoms; Grand Isle, Louisiana, to Pensacola Bay, Florida, between depths of 100 and 325 fathoms; Pensacola Bay, Florida, to the boundary between the areas covered by the GMFMC and the SAFMC out to depths of 35 fathoms, with the exception of waters extending from Crystal River, Florida, to Naples, Florida, between depths of 10 and 25 fathoms and in Florida Bay between depths of 5 and 10 fathoms (Appendix D, Figure D-1c).

Coral and Coral Reef FMP: the total distribution of coral species and life stages throughout the Gulf of Mexico 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; hard bottom areas scattered along the pinnacles and banks from Texas to Mississippi, at the shelf edge and at the Florida Middle Grounds, the southwest tip of the Florida reef tract, and predominant patchy hard bottom offshore of Florida from approximately Crystal River south to the Florida Keys (Appendix D, Figure D-1a).

Information on EFH for most highly migratory species (tuna, billfish, and sharks) is contained in the 2009 Amendment 1 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan prepared by NMFS. Chapter 5 the 2009 Amendment 1 includes maps of designated EFH for each highly migratory species. The area of the proposed sanctuary expansion alternatives includes HAPCs and EFH for reef fish, shrimp, coastal migratory pelagic fish, corals and highly migratory species (NOAA 2015a, NOAA 2015b). Appendix D, Figures D-1a, D-1b, and D-1c provide overlays of the proposed expansion areas and EFH for GMFMC managed species. Appendix D, Figures D-2a, D-2b, D-2c, D-2d, D-2e, D-2f, D-2g, D-2h, D-2i, D-2j, D-2k, D-2l, D-2m, D-2n, D-2o, D-2p, D-2q, and D-2r provide overlays of the proposed expansion areas and EFH for HMS managed by the NMFS. Categories of EFH in the vicinity of the expansion alternatives include non-vegetated marine mud, sand, shell, rock substrates, live hard bottoms, corals and coral reefs, continental shelf and geologic features and marine water column. HAPCs have been designated in the area of proposed alternatives at individual reefs and banks of the northwestern Gulf of Mexico (Appendix D, Figure D-3): East and West Flower Garden Banks, Stetson Bank, Sonnier Bank, MacNeil Bank, 29 Fathom, Rankin/Bright Bank, Geyer Bank, McGrail Bank, Bouma Bank, Rezak/Sidner Bank, Alderdice Bank and Jakkula Bank. Coral HAPC designations have been made for East Flower Garden Bank, West Flower Garden Bank, Stetson Bank and McGrail Bank. This designation carries with it restrictions on anchoring and gear type (e.g., pots, traps and bottom-tending gear types are prohibited). Additional coral HAPC designations in the study area are under consideration by the GMFMC.

In addition to being designated EFHs for federally managed species, the areas of the proposed expansion alternatives also provide nursery and forage habitats that support various life stages of ecologically and recreationally important marine fish species that serve as prey for other fish managed under the MSA by the GMFMC (e.g., mackerels, snappers and groupers) and for highly migratory species managed by NMFS (e.g., billfishes and sharks). Habitats within the proposed expansion areas also provide important fishery support functions, such as a physically recognizable structure and substrate for refuge and attachment above and/or below the sediment surface. Moreover, the expansion alternatives include areas that provide habitat for many benthic animals, including marine worms and crustaceans, which are consumed by higher trophic level predators. Benthic organisms also have a key role in the food web because they (1) mineralize organic matter, releasing important nutrients to be reused by primary producers; (2) act as trophic links between primary producers and primary consumers; and (3) aggregate dissolved organics within marine waters, which are another source of particulate matter for primary consumers.

4.3.3 Protected Species

Activities that may affect protected species are regulated by NOAA and the USFWS under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA), as described in section 4.6. Additional detail about protected species is presented here.

The ESA of 1973 (16 U.S.C. §§1531, et seq.) requires federal agencies to conserve endangered and threatened species and to conserve the ecosystems upon which these species depend. Table 4.2 provides a list of federally recognized endangered or threatened species, as well as species utilizing designated critical habitat, reported to reside in or migrate through federal waters of the Gulf of Mexico. The habitats in the proposed sanctuary expansion alternatives provide multiple ecosystem services supporting threatened and endangered species migrating through or utilizing these areas. Species presently listed under the ESA, which occur regularly in the vicinity of the proposed expansion alternatives include Sperm Whales, Fin Whales, and five species of sea turtles (Green, Hawksbill, Kemp's Ridley, Leatherback and Loggerhead). Listed species that occur rarely and are believed to be strays include North Atlantic Right Whales, Blue Whales, Sei Whales and Humpback Whales (refer to Table 4.2 for corresponding scientific names and listing status for species mentioned in this subsection).

There are also four coral species listed as "threatened" under the ESA that are found in the Gulf of Mexico, and all four are found within the current sanctuary boundaries – Lobed Star Coral, Mountainous Star Coral, Boulder Star Coral and Elkhorn Coral. The three star coral species make up 35-40% of coral cover at East and West Flower Garden Banks (Johnston et al. 2015). There is one colony of Elkhorn Coral known to occur on each bank.

The Warsaw Grouper, Nassau Grouper, Speckled Hind, Alabama Shad, Atlantic Bluefin Tuna, Dusky Shark, Sand Tiger Shark and Ivory Tree Coral all occur in the Gulf of Mexico and are listed as species of concern, which means they have been identified as species potentially at risk of becoming threatened or endangered, but require further study for listing.

Table 4.1. Species listed as Threatened or Endangered under the ESA, or identified as Species of Concern in federal waters of the Gulf of Mexico.

Common Name	Scientific Name	Federal Status
Sperm Whale	*Physeter macrocephalus*	Endangered
Fin Whale	*Balaenoptera physalus*	Endangered
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered
Blue Whale	*Balaenoptera musculus*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Humpback Whale	*Megaptera novaeangliae*	Endangered
Green Sea Turtle	*Chelonia mydas*	Threatened
Loggerhead Sea Turtle	*Caretta caretta*	Threatened
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Endangered
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Endangered
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered
Lobed Star Coral	*Orbicella annularis*	Threatened
Mountainous Star Coral	*Orbicella faveolata*	Threatened
Boulder Star Coral	*Orbicella franksi*	Threatened
Elkhorn Coral	*Acropora palmata*	Threatened
Warsaw Grouper	*Epinephelus nigritus*	Species of concern
Nassau Grouper	*Epinephelus striatus*	Species of concern
Speckled Hind	*Epinephelus drummondhayi*	Species of concern
Alabama Shad	*Alosa alabamae*	Species of concern
Atlantic Bluefin Tuna	*Thunnus thynnus*	Species of concern
Dusky Shark	*Carcharhinus obscurus*	Species of concern
Sand Tiger Shark	*Carcharias taurus*	Species of concern
Ivory Tree Coral	*Oculina varicosa*	Species of concern

4.4 Cultural and Historic Resources

At the end of the eighteenth century and beginning of the nineteenth century, the Gulf of Mexico was an arena of commerce, political unrest, war and piracy, each one intertwined with the other. A variety of Spanish, English and French vessels from merchants, slavers, smugglers, privateers or pirates, ended up on the bottom of the Gulf of Mexico as a result of conflict, weather or shipworm damage. In the twentieth century, during WWII, 56 German U-boats operated in the Gulf of Mexico using shipping lanes and navigational beacons to locate and torpedo unsuspecting prey (Brooks et al. in review). More recently, a wreckage associated with the worst environmental disaster in U.S. history marks the graves of eleven workers who died aboard the *Deepwater Horizon* drilling rig in 2010, as it sank to the sea floor 45 miles from the Louisiana coast in water depths of nearly one mile.

Historical records show that there are over 3,200 shipwrecks in the Gulf of Mexico. Just over 700 shipwrecks or likely shipwrecks have been located, mostly from sonar imaging. About 35 of these have been positively identified as actual historic wrecks that would be eligible for designation on the National Register of Historic Places. The ten shipwrecks included in Alternative 5 have been evaluated as the most historically important and nationally significant. Additional information about these shipwrecks is presented in Appendix C.

Activities that may affect historic resources are regulated by the National Historic Preservation Act, as described in section 4.6.

4.5 Marine Area Use, Recreation and Socioeconomics

There are six primary groups or industries that utilize the resources of, and whose interests may be affected by changes to, the Flower Garden Banks National Marine Sanctuary and/or the areas currently being evaluated for inclusion through sanctuary expansion. These interests include commercial fishing, recreational fishing, scuba diving, oil and gas exploration, development and production, commercial shipping and those who have passive economic use value for protection and restoration of the natural and cultural resources of the sanctuary.

4.5.1 Fisheries

Disturbances to coral ecosystems from bottom-tending fishing gear, especially bottom trawl gear, have been well documented where they have been studied in U.S. waters and in other regions around the world. Bottom trawling is widespread and considered the major threat to corals in most U.S. regions where such fishing is allowed and overlaps with areas where corals are present. The area of seafloor contacted by bottom trawls is relatively large, the force against the seafloor from the trawl gear is substantial, and the spatial distribution of bottom trawling is extensive. Although not as destructive as bottom trawls and dredges, other types of fishing gear can also have detrimental effects on deepwater corals. Bottom-set gillnets, bottom-set longlines, pots and traps all impact the seafloor. Vertical hook and line fishing, used in both recreational and commercial fishing, has the potential for some damage to fragile corals by the weights used, but such damage is minimal compared to other bottom-tending gear (Lumsden et al. 2007, Heifetz et al. 2009, Gass and Roberts 2006, and NOAA 2015c). FGBNMS staff have documented fishing gear impacts to habitats at Horseshoe Bank, 29 Fathom Bank, Geyer Bank, Rezak Bank, Bouma Bank, Elvers Bank, Sidner Bank, Parker Bank, Sonnier Bank, Rankin Bank, Bright Bank, and McGrail Bank.

In the United States, the Gulf of Mexico generated over 1.4 billion pounds in fishery landings, yielding a value of $660 million, annually from 2007-2009 (NOAA 2011b). In 2011, 1.8 billion pounds of fish and shellfish were landed by commercial fisheries in the region, earning $818 million in landings revenue (NOAA 2012a). The Gulf of Mexico supports a wide variety of commercial and recreational fisheries including reef fish, tuna, mackerel, shark, grouper/snapper, tilefish, menhaden, oysters, shrimp, lobster, stone crab, blue crab and red crab, some of which are concentrated in areas influenced by seafloor features (e.g., the Pinnacles area and shelf-edge banks). Methods of harvest include trawling, longlining, hook and line (including vertical longlines/bandit reels) and spear fishing. In the area affected by the proposed action, the primary fisheries identified target: reef fish (snapper, grouper, triggerfish, jack, tilefish); coastal migratory pelagics (mackerels, cobia); and highly migratory species (sharks, tuna, billfish, swordfish). Current sanctuary regulations do not allow bottom longlining, traps, nets, bottom trawls, spear fishing, or any other gear, device, equipment, or means except conventional hook and line gear

(inclusive of vertical longlines/bandit reels). Though not technically a fishing regulation, anchoring is also prohibited under current sanctuary regulations.

NOAA evaluated Vessel Monitoring System (VMS) data for the years 2008-2014 and electronic logbook (ELB) data for the years 2004-2014 for the entire area of interest to assess the potential impacts of the proposed action on both recreational and commercial fishing user groups (e.g., based on information those data sets provide related to head boats and limited access fisheries). An overview of the total effort reflected in that data is provided below. Though VMS requirements apply only to those vessels with reef fish permits and permits to fish with pelagic longline, bottom longline, or shark gillnet for highly migratory species (tunas, swordfish, and sharks), VMS data for charter/headboats and other limited access fisheries nevertheless provides the most complete and precise overview available of locations where recreational and commercial fishing vessels spend their time in the Gulf of Mexico and provides the primary basis for NOAA's analysis of the study area presented here and the evaluation of the environmental consequences of the alternatives presented in Chapter 5. ELBs provide similar information for a portion of the vessels in the shrimp fishery. Several studies performed earlier in the FGBNMS expansion process are useful for evaluating the FGBNMS Advisory Council recommendation for expansion, but are too limited in their geographic scope or in their coverage of fishing sectors to provide a complete quantitative basis for evaluating the range of alternatives presented in this DEIS. Nevertheless, these studies do provide ancillary support to the characterization of the study area presented in the commercial and recreational fishing sections below and to the evaluations presented in Chapter 5.

For instance, in 2008, FGBNMS requested from NMFS and the Texas Parks and Wildlife Department (TPWD) any catch and effort data that could inform the assessment of commercial and recreational fisheries in the vicinity of FGBNMS and the banks being evaluated by the BEWG for inclusion through sanctuary expansion. NOAA's Office of National Marine Sanctuaries (ONMS) Chief Economist Bob Leeworthy reviewed the data and made additional data requests from NMFS' Southeast Fisheries Science Center (SEFSC) on commercial fisheries catch, reviewing all available commercial and recreational fishing data and presenting his findings to the FGBNMS Advisory Council (Leeworthy 2009). Leeworthy also presented satellite imagery data showing the location of boats in FGBNMS. Discussion with fisheries representatives on the Advisory Council revealed that the satellite information did not seem adequate for characterizing the occasional, but heavier use of Stetson Bank for fishing during times when the weather would allow access to smaller boats. Satellite imagery never revealed more than four boats maximum in a day, whereas one Advisory Council fishing representative indicated that as many as 30-40 recreational fishing boats have been observed on Stetson Bank on five to six days a year (John Stout, Sanctuary Advisory Council Recreational Fishing representative, personal communication).

Similarly, in 2009, FGBNMS entered a contract with Geo-Marine, Inc. (Levesque and Richardson 2009, Levesque and Richardson 2011) to analyze all available commercial and recreational fishing data on catch and effort with the objective of determining trends and the

"best" estimate of catch or effort that could be considered "sustainable in the future." Results of this study are discussed in Sections 4.5.1.1. and 4.5.1.2.

Also, in 2013 Dr. Will Heyman (Texas A&M University), on contract to the National Marine Sanctuary Foundation, conducted surveys with all known commercial fishing operations, for-hire recreational fishing operations and for-hire diving operations operating in the northwest Gulf of Mexico on various banks, including the existing banks in the sanctuary (Leeworthy et al. 2016). Results of this study are discussed in Sections 4.5.1.1. and 4.5.1.2.

Both Levesque and Heyman's investigations were focused on the Advisory Council's recommendation for sanctuary expansion to include reefs and banks of the northwestern Gulf of Mexico.

Fisheries in federal waters of the Gulf of Mexico are managed by NOAA and the GMFMC under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as described in section 4.6.

4.5.1.1 Commercial Fishing

Fishery catch data (e.g., dockside landings reports) are not collected on a scale fine enough to discern fishing effort specifically for the areas encompassed by the various alternatives. However, VMS data are collected at much finer resolution and provide an indication of the use of proposed expansion areas by commercial fishery permit holders targeting reef fish, coastal pelagics and highly migratory species. For the period of 2008-2014, an annual average of ~238 vessels operated in the north central Gulf of Mexico with reef fish (RR and RRLE) permits, ~128 vessels operated in the study area with permits to fish for king mackerel (KM permits are the only limited access coastal migratory pelagic permit type and are not required to carry VMS but give an indication of the fishery for coastal migratory pelagic species), ~155 vessels operated in the study area with permits to fish for tunas, swordfish, or sharks (ATL, SFD, SFH, SFI, SKD, and SKI permits), and 28 vessels operated in the study area with permits to fish for shrimp (SPGM permits, also not required to carry VMS) in the Gulf of Mexico. Many vessels carried more than one permit type. Using data from trip report forms, NOAA also identified vessels that made trips with bottom longline gear from those identified in the study area. An annual average of 37 vessels carrying bottom longline gear was present in the study area over the same period. The numbers of vessels carrying each permit type inside each of the proposed boundary alternatives is presented in Chapter 5.

Levesque and Richardson (2009, 2011) analyzed commercial fishing data from three federal data collection programs: NMFS General Canvass Landings Reporting System (GCLRS), Trip Interview Program (TIP) and NMFS Historical Landings Program (HLP). They reported that commercial landings in the Gulf of Mexico were stable during the 2003-2007 period, however lower than in the late 1980s. Types of fish landed commercially within the vicinity of FGBNMS were snapper, jacks, tuna/mackerel, shark, grouper and a variety of reef fish.

In June 2010, ONMS identified 76 commercial fishing vessels observed in the vicinity of the Advisory Council's recommended sanctuary expansion area from VMS data and provided this information to Dr. Will Heyman for the purpose of conducting surveys of the commercial fishing interests operating in the area (Leeworthy et al. 2016). All 76 vessel owners were contacted in 2013. Many of the operators owned several vessels. Forty different operations from Texas to Florida operated the 76 vessels. Operators were contacted by both mail and telephone and asked if they fished on any of the banks in the vicinity of the Advisory Council sanctuary expansion recommendation (maps of the study area were sent via mail). Those who said they operated on the banks in the study area were also asked about other vessels they observed in the area or if they knew of others that operated on the banks. Six commercial fishing interests were identified through these surveys as utilizing banks in the vicinity of the Advisory Council sanctuary expansion recommendation. Three operations refused the survey. They were informed of the process underway to evaluate the potential socioeconomic impact of expanding the FGBNMS to other banks, but they said they didn't think it would significantly impact them and it wasn't worth the effort to complete the survey. For the purposes of that study, those interests were considered as close to a census as practical of all commercial fishing operations targeting the banks recommended for inclusion in the sanctuary expansion by the Advisory Council (Leeworthy et al. 2016).

4.5.1.2 Recreational Fishing

The recreational fishery of the Gulf of Mexico includes private individuals, rental boats, charter vessels, head boats and party boats. An average of 3.2 million recreational anglers took 23 million recreational fishing trips in the Gulf of Mexico annually between 2002 and 2011, contributing billions of dollars to the region's economy and supporting tens of thousands of jobs (NOAA 2011b, NOAA 2012a). The remoteness and difficulty of accessing the areas proposed for sanctuary expansion results in much lower use of these areas for recreational fishing than for the Gulf of Mexico as a whole. The private recreational sector in the Gulf of Mexico was surveyed through the NOAA's Marine Recreational Fisheries Statistics Survey (MRFSS) and is now surveyed through NOAA's Marine Recreational Information Program (MRIP), except for the state of Texas, where the TPWD uses a statistical area system with very large grid cells similar to NOAA's statistical areas. Between state and federal data sets, effort data are available for most of the Gulf of Mexico, but this data and the charter/headboat catch data collected by NOAA provides insufficient resolution to determine catch or understand other activity in the FGBNMS or other areas being evaluated for sanctuary expansion. NOAA has analyzed VMS data to estimate the level of use of proposed expansion alternatives by charter/headboats, which showed an annual average of 60 charter/headboats operating in the study area with permits to fish for coastal migratory pelagic fish and 64 charter/headboats operating in the study area with permits to fish for reef fish. These vessels also may carry more than one permit type. The numbers of vessels carrying each permit type inside each of the proposed boundary alternatives is presented in Chapter 5.

Levesque and Richardson (2009, 2011) analyzed three data sets for the recreational fisheries. Head-boat catch data was obtained from the NMFS Beaufort North Carolina Laboratory for statistical areas 25 (Freeport-Galveston) and 26 (Port Aransas). Catch data were analyzed for years 1986 through 2006. For charter boats, Levesque and Richardson (2009, 2011) analyzed data from "The Daily News Reel Report" (see http://www.galvnews.com/sports/fishing_report/), which provides self-reporting by the larger vessels operating out of Galveston, Texas. Catch and effort data from the Reel Report were analyzed for the period 2006-2008. For private household boats and party boats (charter boats by most definitions), TPWD catch and effort data were analyzed for years 2003-2008. Results from Levesque's study indicated that for 2003-2007 recreational landings were dominated by red snapper, vermilion snapper and gray triggerfish, varying by month and location.

In 2013, Dr. Will Heyman (Texas A&M University) surveyed recreational fishermen, focusing on all Texas ports and harbors that would access the area in the vicinity of the Advisory Council sanctuary expansion recommendation (Leeworthy et al. 2016). All charter fishing operations that were identified to have fished on any of the banks in the study area were asked who they saw or if they knew of others that also operated in the area. Eight fishing operations were identified that utilized the area. There were three operators that refused the survey. They were informed of the process underway to evaluate the potential socioeconomic impact of expanding the FGBNMS to other banks. They all said that it would not significantly impact them and it wasn't worth the effort to complete the survey. As with commercial fishing operations, this was considered as close to a census as practical of all for-hire recreational fishing operations that fished on the banks in Advisory Council recommended sanctuary expansion study area. These data were further analyzed by Leeworthy et al. (2016). Only ~2600 person days of for-hire recreational fishing were reported for the year and area they examined. Of these person days of fishing, only 127 person days was for spear fishing and all the rest was for hook-and-line fishing.

4.5.2 Recreational Scuba Diving

A limited number of natural features among the proposed alternatives are accessible to recreational scuba divers – the three banks within the current sanctuary boundaries (East Flower Garden Bank, West Flower Garden Bank and Stetson Bank), and Bright, Geyer and Sonnier Banks. Other likely dive destinations include oil and gas platforms.

There is very little information available on scuba diving off either Texas or Louisiana. There are no existing institutions that regularly gather information about scuba diving off Texas or Louisiana. In 1999-2000, the National Survey on Recreation and the Environment (NSRE) estimated the number of participants that went scuba diving off Texas and Louisiana. In 1999-2000, approximately 70,000 people age 16 or older went scuba diving off Texas and about 11,000 off Louisiana. Even with a sample size of 52,000, it was not a significant sample size to reliably estimate person-days of scuba diving for Texas and Louisiana (Leeworthy and Wiley 2001).

The only scuba diving data available for Texas and FGBNMS was produced by Ditton and Baker (1999) for the year 1996. The study documented Texas scuba divers that accessed offshore waters through dive charter or for-hire recreational dive operations. Dive charters ran a total of 360 trips to offshore Texas accounting for 4,335 dive trip days. About 21% of the boat trips and 54% of the dive trip days were spent at FGBNMS. Current estimates put the number of dive trip days between 2,500 and 3,000 for FGBNMS.

Currently, one dive operator conducts trips to the sanctuary. Private vessels visit FGBNMS to conduct scuba diving operations on rare occasions, primarily for the specific event of the annual coral spawning. A small number of private vessels also likely conduct scuba trips to Sonnier Bank, primarily from Louisiana.

Recreational scuba diving could include spear fishing or the taking of invertebrates ("consumptive" scuba diving). Spear fishing is prohibited at FGBNMS, but is known to occur on artificial reef sites, such as oil and gas platforms, in the vicinity. Currently, there are no estimates of the amount of consumptive scuba diving activity. Ditton and Baker (1999) indicated spear fishing only took place on the artificial reefs off of Texas.

4.5.3 Oil and Gas

Offshore oil and gas in the Gulf of Mexico is a major source of oil and natural gas production in the United States. The western and central planning areas in the Gulf of Mexico, which includes offshore Texas, Louisiana, Mississippi and Alabama, make up one of the major petroleum-producing areas of the U.S. The Gulf of Mexico OCS region contributed 16% of total U.S. crude oil production and 5% of total U.S. natural gas production in 2014 (EIA 2015b). This percentage has dropped from highs of 27% of total U.S. crude oil production in 2003 and 26% of total U.S. natural gas production in 1997 (EIA 2015b) as a result of factors such as declining Gulf of Mexico gas production and increased onshore production by hydraulic fracturing (EIA 2014 and EIA 2015c). Over 45% of total U.S. petroleum refining capacity is located along the Gulf of Mexico coast, as well as 51% of total U.S. natural gas processing plant capacity (EIA 2015a).

The oil and gas industry is a significant component of the regional economy, supporting 120,676 jobs in 2009 and paying $15.6 billion in wages to workers in the region in the same year (NOAA 2011b). These benefits come with risks associated with the industry, primarily related to catastrophic, uncontrolled releases (e.g., due to extreme weather events or human error). Hurricane Ivan in 2004 destroyed seven platforms, significantly damaged 24 more platforms, and damaged 102 pipelines in the Gulf of Mexico. Hurricanes Katrina and Rita in 2005 destroyed more than 100 platforms and damaged 558 pipelines (NOAA 2011b). In 2005, after striking the submerged remains of a pipeline service platform that collapsed during Hurricane Rita, the tank-barge DBL152 discharged approximately 1.9 million gallons of heavy fuel oil, which sank to the bottom in about 50 feet (15 meters) of water on the continental shelf, approximately 40 miles southeast of Sabine Pass, Texas and ~75 miles inshore from the proposed sanctuary expansion

alternatives. The Deepwater Horizon oil spill in 2010 remains one of the worst environmental disasters in U.S. history.

Other potential threats include the physical impact of drilling, placement of structures on the seafloor (e.g., platforms, anchors, pipelines or cables), discharges from rock-cutting during the drilling process and intentional or accidental well discharges or release of drilling fluids. The use of anchors, pipelines and cables for oil exploration/extraction can be destructive to sensitive benthic habitats as well. Deployment of oil and gas pipelines can cause localized physical damage to corals. The use of anchors, pipelines and cables for oil exploration/extraction can be destructive to sensitive benthic habitats as well (Lumsden et al. 2007, Heifetz et al. 2009, Gass and Roberts 2006, and NOAA 2015c). Routine oil and gas activities are distanced from topographic features, pinnacles, live bottoms, PSBFs, and deepwater benthic communities through leasing stipulations and mitigations placed on permits.

Nevertheless, NOAA and its partners have documented oil and gas industry-related impacts (other than the simple presence of infrastructure) to habitats at Bright Bank (first leased in 1973, timing of impacts unknown), East Flower Garden Bank (first leased in 1977, impacts occurred prior to sanctuary designation), West Flower Garden Bank (first leased in 1980, impacts occurred prior to sanctuary designation), Viosca Knolls East (first leased in 1988, timing of impacts unknown), Henderson Ridge North (first leased in 2003, timing of impacts unknown), Alabama Alps (impacts resulted from the 2010 DWH oil spill), 36-Fathom Ridge (impacts resulted from the 2010 DWH oil spill), Yellowtail Reef (impacts resulted from the 2010 DWH oil spill), Cat's Paw (impacts resulted from the 2010 DWH oil spill), Roughtongue Reef (impacts resulted from the 2010 DWH oil spill), Corkscrew (impacts resulted from the 2010 DWH oil spill), Biloxi Dome (impacts resulted from the 2010 DWH oil spill), Gloria Dome (impacts resulted from the 2010 DWH oil spill), and Dauphin Dome (impacts resulted from the 2010 DWH oil spill). BOEM began protecting topographic features in 1973, and such impacts should not have occurred since that time due to BOEM's protective measures. However, oil and gas production activities are not known to have occurred until after 1973 at those locations where the timing of impacts reported above was prior to sanctuary designation or is unknown (BOEM 2015c).

In 2010, Dr. Eric Wolfe, Chief Economist for NOS, conducted an analysis of the impact of boundary expansion of the FGBNMS on the Oil and Gas Industry (Wolfe 2010). Current sanctuary regulations allow for the exploration and production of oil and gas inside sanctuary boundaries, subject to the restrictions imposed by BOEM for the protection of topographic features, PSBFs and live bottom as described in section 4.6.1.4, and provided all drilling cuttings and drilling fluids are shunted to the seabed through a downpipe that terminates an appropriate distance, but no more than ten meters, from the seabed. Wolfe's study focused on the costs associated with that shunting requirement and on the FGBNMS Advisory Council recommendation for boundary expansion, and the study concluded that such costs would represent "only a de minimus one-time addition to development drilling costs" (Wolfe 2010).

BOEM divides the Gulf of Mexico into three planning areas: (1) Western, (2) Central and (3) Eastern. The alternatives presented in this DEIS fall within all three planning areas. There were approximately 2,323 active oil and gas platforms in the Gulf of Mexico in November 2015 (BOEM 2015d), though that number was greater in recent years. The platforms in the Gulf of Mexico were producing oil and gas from 4,158 wells in 2014; note that more than one well can tie to a platform. The most comprehensive sanctuary expansion alternative (Alternative 5) encompasses fourteen platforms, of which eleven are active, two have been reefed onsite, and one, the *Deepwater Horizon*, wrecked onsite. The 2015 staff recommendation (Alternative 3) encompasses seven platforms, of which five are active and two have been reefed onsite (see Table 5.7). Only one platform (designated HIA-389A, which is active but is currently in the process of being decommissioned) exists within the current sanctuary boundary (Alternative1, the "No Action" alternative).

Deepwater Gulf of Mexico discoveries account for an increasing proportion of U.S. total reserves of oil and gas. BOEM provides estimates for oil and gas reserves, contingent resources, and undiscovered resources. Reserves are those quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions. Contingent resources are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations by application of development projects but which are not currently considered to be commercially recoverable due to one or more contingencies. Undiscovered resources are resources postulated, on the basis of geologic knowledge and theory, to exist outside of known fields or accumulations. Finally, industry-announced discoveries are those made by operators but are not evaluated by BOEM. The number of reserve additions from shallow waters peaked in 1967 and has declined every decade thereafter. In contrast, the number of deepwater reserves has increased significantly since 1975 (Covington et al. 2000).

BOEM delineates projects in less than 984 feet (300 meters) water depths as shallow-water projects and those in greater than 984 feet (300 meters) as deepwater projects. For gas production, the shallow water is further subdivided according to the True Vertical Depth (TVD) of the producing zones and the water depth. The "shallow-water deep" zone refers to gas production from well completions at or below 15,000 feet (4,572 meters) TVD subsea and in water depths less than 656 feet (200 meters). All other shallow-water completions are referred to as part of the "shallow-water shallow" zone. In 1999, oil production from deepwater wells surpassed that produced from shallow wells for the first time in the history of oil production in the Gulf of Mexico (Covington et al. 2000).

Oil and gas exploration and production in the Gulf of Mexico are regulated by BOEM and BSEE under the Outer Continental Shelf Lands Act as described in section 4.6.

4.5.4 Shipping

The Gulf Coast region contained 13 of the top 20 U.S. ports by tonnage in 2009, and 50% of all U.S. international trade tonnage passed through Gulf Coast ports in the same year (NOAA 2011b). The Ports of Houston, Galveston and New Orleans are among the world's busiest ports. Shipping fairways running close to, and in six instances through, the proposed expansion areas, funnel thousands of ships to the ports annually. For example, in the safety fairway south of East Flower Garden Bank, approximately 500 vessel tracks were recorded from 244 unique vessels during the period June 2014-September 2015 (Tony Reyer, ONMS Physical Scientist, personal communication).

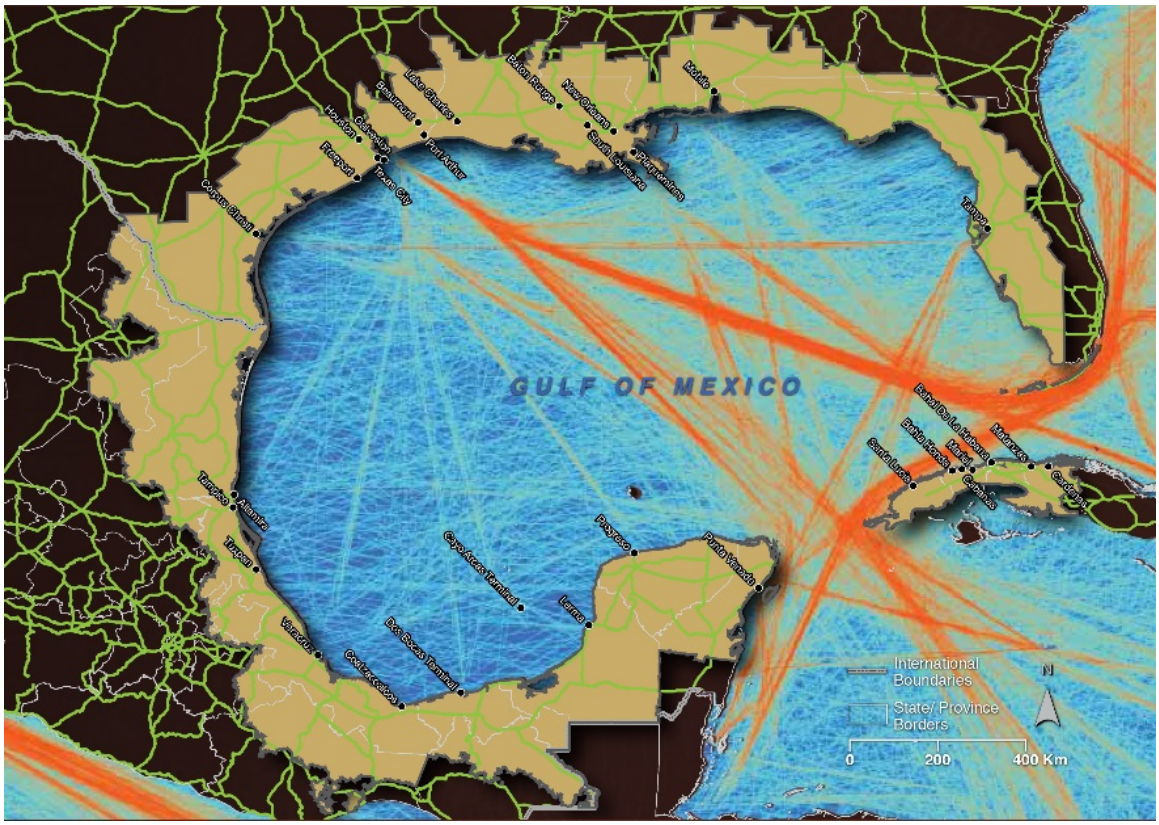

Figure 4.10. Commercial shipping routes in the Gulf of Mexico. Image credit: Yoskowitz et al. (2013).

Each year, more than 200 million tons of cargo move through the Port of Houston, carried by more than 8,000 vessels and 200,000 barge calls (Port of Houston 2015). A 2015 study by Martin Associates indicated that Houston channel-related businesses contributed 1,174,567 jobs throughout Texas, and helped generate more than $264.9 billion in statewide economic impact. Additionally, more than $5 billion in state and local tax revenues are generated by business activities related to the Port of Houston (Martin Associates 2015). In 2013, the Port of Galveston docked 912 ships, including 179 cruise ship calls. Over 1.2 million cruise passengers passed through the port, generating over $12 million in revenue. Close to 4.5 million tons of cargo were

moved through Galveston that same year (Port of Galveston 2015). In 2014, over 31 million tons of cargo were moved through the Port of New Orleans, and over 1 million cruise passengers embarked on cruises (Port of New Orleans 2015).

In U.S. waters, shipping is controlled by the U.S. Coast Guard, though many areas of international admiralty law apply to this industry.

4.5.5 Passive Economic Use

National Marine Sanctuaries are national resources and sometimes they are recognized and designated internationally. Many people have economic value (a willingness to pay) to ensure natural and cultural resources are protected in a certain condition. Passive economic value is a term currently used by economists to describe this source of value. In the past, it was more commonly referred to as non-use value and was described as being motivated by desires to protect resources for future generations (bequeath value) or to simply know that the resources would be protected in a certain condition in the future (existence value). The reason for the change in terminology is that people must know about the current conditions of the resources to place a value on them. People learn about the conditions of resources and the threats against their future conditions through various media sources (e.g., newspapers, magazines, television, radio, books, and the Internet).

A Duke University PhD candidate mentored by ONMS Chief Economist Bob Leeworthy studied the passive economic use value of the FGBNMS boundary expansion beginning in 2009, ultimately incorporating the results in a dissertation and a peer-reviewed publication in the Marine Resources Economics journal (Stefanski and Shimshack 2016). The study is based on a national sample of households. In that recently publication, passive economic use value was estimated for expanding the boundaries of the FGBNMS from its current three banks to an additional nine banks recommended by the FGBNMS Advisory Council. A national survey of 1,526 households in the U.S. was conducted in May 2012. It was estimated that the average household was willing to pay $35-$107 per year to add the current protections in the FGBNMS to the other nine banks. Using the lower bound estimate of $35 per household per year and extrapolating this to 114 million U.S. households, and applying discounts rates of 3%, 5%, and 7% (recommended by the U.S. Office of Management and Budget for water projects), the authors calculated the value over a five-year period. The estimates ranged from $16.4 to $18.3 billion for the five-year period. This was compared to the $15 million estimated for the costs of implementing the boundary expansion for the same five-year period in the 2012 FGBNMS management Plan.

4.6 Regulatory Framework

4.6.1 Federal Laws and Policies

A number of Federal agencies provide regulatory oversight to the resources identified above pursuant to the laws and policies summarized below. Three of these are particularly relevant to

the proposed expansion of Flower Garden Banks National Marine Sanctuary, as they provide the primary current regulatory framework for resources found in the proposed expansion areas, including existing and proposed designations of sensitive habitats in the region. EPA oversees discharges under the Clean Water Act; Department of Commerce establishes EFHs and HAPCs under the Magnuson-Stevens Fisheries Conservation and Management Act (MSA); and BOEM protects topographic features within no activity zones (NAZs), live bottom (pinnacle trend features), live bottom (low relief features), Potentially Sensitive Biological Features (PSBFs) located outside of NAZs surrounding topographic features, hard bottoms, deepwater corals, and chemosynthetic communities through stipulations attached to Outer Continental Shelf leases and mitigations/conditions of approval applied to permits after case-by-case reviews of permit applications.

4.6.1.1 National Environmental Policy Act (42 U.S.C § 4321)

NEPA was signed into law on January 1, 1970. In 1978, the President's Council on Environmental Quality (CEQ) issued regulations (40 CFR Parts 1500-1509) to implement NEPA. NEPA requires all Federal actions to be evaluated for potential impacts to the human environment, and for these impacts to be assessed and reported to the public. The present DEIS fulfills NEPA requirements related to the proposed expansion of the FGBNMS.

4.6.1.2 Magnuson-Stevens Fishery Conservation and Management Act

The MSA was originally passed by Congress in 1976 and was updated in 1996 and 2006. Section 302 of the Act (§ 302) created eight regional fishery management councils, including the GMFMC, to develop Fishery Management Plans (FMPs) to regulate fisheries in an effort to prevent overfishing. Each council prepares FMPs for each fishery under its jurisdiction and submits these plans to the Secretary of Commerce for final approval.

Membership on Councils includes the directors of state fishery agencies, the Regional Administrator of NMFS and knowledgeable citizens appointed by the Secretary of Commerce as voting members, as well as representatives from the USFWS, Coast Guard, regional Marine Fisheries Commissions and Department of State as nonvoting members.

The MSA provides Councils and the NMFS authority to establish EFH and HAPCs. A Generic Amendment for Essential Fish Habitat was partially approved in 1999; no regulations resulted from the amendment. The generic amendment describes the habitat constituting that essential for each life history stage of 26 representative species, which result in most of the landings from the Gulf of Mexico. It describes the habitat types and distribution, threats to these habitats, predator-prey relationships, factors resulting in EFH losses, conservation and enhancement measures for EFH and recommendations to minimize impacts from non-fishing threats.

In 2005, the GMFMC adopted the Final Generic Amendment Number 3 for Addressing Essential Fish Habitat Requirements, Habitat Areas of Particular Concern, and Adverse Effects of Fishing in the following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of

Mexico, United States Waters; Red Drum Fishery of the Gulf of Mexico; Reef Fish Fishery of the Gulf of Mexico; Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic; Stone Crab Fishery of the Gulf of Mexico; Spiny Lobster in the Gulf of Mexico and South Atlantic; and Coral and Coral Reefs of the Gulf of Mexico. This amendment and the regulations it put into place were last reviewed in October 2010. HAPC designations made in that amendment affect both the current FGBNMS and proposed expansion alternatives.

In 2009, NMFS adopted the Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Essential Fish Habitat. This amendment and the regulations it put into place were last reviewed in 2015. Because the primary data type used to identify EFH for highly migratory species was species specific distribution data, NMFS identified geographic areas rather than specific habitat types as EFH, as shown in Appendix D. Maps of Highly Migratory Species EFHs are located in Chapter 5 of the Consolidated Highly Migratory Species FMP, as well as the online EFH Mapper Tool (http://www.habitat.noaa.gov/protection/efh/habitatmapper.html).

The MSA requires that Fishery Management Plans describe and identify EFH, and requires that management measures be based on the best scientific information available (16 USC 1851(a)(2)).

The MSA defines Essential Fish Habitat as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (MSA Act § 3(10)). The EFH Final Rule (50 CFR Part 600) elaborates that the words “essential” and “necessary” mean identification of sufficient EFH to “support a population adequate to maintain a sustainable fishery and the managed species’ contributions to a healthy ecosystem.”

EFH regulations encourage regional Fishery Management Councils to designate HAPCs within areas identified as EFH to focus conservation priorities on specific habitat areas that play a particularly important role in the life cycles of federally managed fish species. EFH potentially encompasses a very broad range of habitat used by managed species. While a designation as a HAPC does not carry with it any specific regulations, designation as a Coral HAPC does provide a level of protection from anchoring, bottom longlining, bottom trawling and buoy gear, as well as dredge, pot or trap gear.

4.6.1.3 Clean Water Act (33 U.S.C. Section 1251 et seq.)

The CWA is the principal federal statute governing water quality. The CWA’s objective is to restore and maintain the chemical, physical, and biological integrity of the nation’s waters. The CWA regulates both the direct (point source) and indirect (non-point source) discharge of pollutants into the nation's waters. Section 402 of the CWA established the National Pollution Discharge Elimination System (NPDES) program. The EPA has 10 regional offices around the country. EPA’s regional offices 4 and 6 work closely with the Gulf of Mexico states to implement the NPDES program. The CWA allows EPA to authorize state governments to implement the NPDES program in state waters. Section 301 prohibits the discharge into navigable waters of any pollutant by any person from a point source unless it is in compliance with a NPDES permit.

Section 319 directs states to identify best management practices and measures to reduce non-point source pollution. Sections 311 and 312 of the CWA regulate, among other things, the discharge of oil and other hazardous substances into navigable waters, adjoining shorelines and waters of the contiguous zone, and sewage discharges from vessels.

The current NPDES General Permits for oil and gas extraction in the Gulf of Mexico (permit # GMG290000 for Region 6 and permit # GMG460000 for Region 4) do not allow discharges from oil and gas activity within "areas of biological concern" or within national marine sanctuaries. Under the General Permit for Region 6 (http://www3.epa.gov/region6/water/npdes/genpermit/gmg290000final/gmg290000finalpermit2012.pdf), an exception to this prohibition indicates that facilities located within a national marine sanctuary boundary are authorized to discharge in accordance with these permits if all of the following conditions are met: (1) the platform was installed prior to the designation of the national marine sanctuary; (2) the platform is located outside of the NAZ defined by BOEM; (3) all materials are discharged through a shunt pipe that terminates within 10 meters (33 feet) of the sea floor; (4) sanitary waste is treated with an approved marine sanitation device that complies with pollution control standards and regulations under section 312 of the Clean Water Act; and (5) the materials discharged are associated with and incidental to oil and gas exploration, development or production and originate from wells located within the boundaries of the national marine sanctuary and outside the NAZ.

Section 402 of the CWA establishes authority for the NPDES permitting program to regulate discharges incidental to the normal operation of a commercial (i.e., non-military, non-recreational) vessel when operating as a means of transportation (i.e., "incidental discharges"). This includes a broad range of incidental discharges such as ballast water, bilgewater, graywater (e.g., water from sinks, showers), and deck washdown and runoff. EPA controls these incidental discharges primarily through two NPDES general permits: the Vessel General Permit (for commercial vessels greater than 79 feet in length) and the Small Vessel General Permit (for vessels less than 79 feet in length).

The CWA allows the federal government to remove discharged substances and assess the removal costs against the responsible party. The CWA defines removal costs to include costs for the restoration or replacement of natural resources damaged or destroyed as a result of a discharge of oil or a hazardous substance. Section 404 of the Act authorizes the USACE to issue permits, after notice and opportunity for public hearing, for the discharge of dredged or fill material into the waters of the United States. Section 401 of the CWA provides that any applicant for a federal permit or license to conduct any activity that may result in any discharge into navigable waters must obtain certification of compliance with state water quality standards.

4.6.1.4 National Invasive Species Act (P.L. 104-332)

The Nonindigenous Aquatic Nuisance Species Prevention and Control Act (16 U.S.C. § 4701, et seq.) was initially passed by congress in 1990 and was amended by the National Invasive Species Act in 1996. This statute and implementing regulations at 33 CFR 151 provides the U.S. Coast

Guard with authority to establish ballast water management for control of nonindigenous or invasive species in waters of the United States. Specifically, 33 C.F.R. 151.2050(a) requires owners or operators of vessels equipped with ballast tanks to avoid the discharge or uptake of ballast water in areas within, or that may directly affect, marine sanctuaries. The regulation does not prohibit the uptake or discharge of ballast water in a marine sanctuary when necessary for safe operation.

4.6.1.5 Coastal Zone Management Act, 16 U.S.C. § 1451, et seq.

The goal of the Coastal Zone Management Act (CZMA) is to encourage and assist states to preserve, protect, develop and, where possible, restore and enhance valuable natural coastal resources. Participation by states is voluntary. Section 1456 of the CZMA requires that any federal action inside or outside of the coastal zone that affects any land or water use or natural resources of the coastal zone shall be consistent to the maximum extent practicable with the enforceable policies of approved state management programs. It states that no federal license or permit may be granted without giving the state the opportunity to concur that the project is consistent with the state's coastal policies. The regulations implementing the CZMA, 15 CFR Part 930, outline the consistency procedures. The selected project would occur outside the coastal zone of the states bordering the Gulf of Mexico, and implementing the project in the proposed locations would not require a federal consistency determination under the CZMA. Accordingly, NOAA does not anticipate the need to coordinate with the states bordering the Gulf of Mexico. Should this determination change, NOAA anticipates the states will concur that the selected project is fully consistent with their respective Coastal Zone Management Program goals and policies.

4.6.1.6 Outer Continental Shelf Lands Act

4.6.1.6.1 Authority for Establishing No Activity Zones

The Outer Continental Shelf Lands Act, as amended (43 U.S.C. 1331 et seq., 31 U.S.C. 9701), authorizes the Secretary of the Interior to prescribe rules and regulations to administer leasing of the OCS. Such rules and regulations will apply to all operations conducted under a lease. Operations on the OCS must preserve, protect and develop oil and natural gas resources in a manner that is consistent with the need to make such resources available to meet the nation's energy needs as rapidly as possible; to balance orderly energy resource development with protection of human, marine and coastal environments; to ensure the public a fair and equitable return on the resources of the OCS; and to preserve and maintain free enterprise competition. Sections 11 and 25 of the amended OCS Lands Act require the holders of OCS oil and gas or sulphur leases to submit exploration plans or development and production plans to the Secretary for approval prior to commencing these activities.

4.6.1.6.2 Notice to Lessees (NTL) No. 2009-G39 Biologically-Sensitive Underwater Features and Areas

The purpose of this NTL is to provide and consolidate guidance for the avoidance and protection of biologically sensitive features and areas (i.e., topographic features, pinnacles, live bottoms (low relief features) and other PSBFs) when conducting OCS operations in water depths shallower than 980 feet (300 meters) in the Gulf of Mexico. This NTL remains in effect pursuant to NTL No. 2015-N02.

4.6.1.6.2.1 Topographic Features

The Topographic Features stipulation is added to OCS leases in the Western Planning Area and Central Planning Area in the Gulf of Mexico for blocks that have a topographic feature, an NAZ surrounding a topographic feature, or a shunting zone surrounding a topographic feature to protect biologically sensitive underwater features. An NAZ is defined by a bathymetric contour (isobath) ranging from 55-85 meters (180-279 feet) in depth. Within the NAZ, no operations, anchoring or structures are allowed. Additionally, no bottom-disturbing activities, including the use of anchors, chains, cables, and wire ropes from a semisubmersible drilling rig or from a pipeline construction vessel may occur within 152 meters (500 feet) of the designated "No Activity Zone" of a topographic feature. Outside the NAZ, additional restrictive zones are established where oil and gas operations could occur, but where drilling discharges would be shunted to the seafloor. Shunting zones of 1,000 meters, 1-mile and 3-miles surround topographic features, with the more complex features having a larger shunting zone. The East and West Flower Garden Banks, as special cases, have a 4-mile shunt zone beyond the NAZ for all drilling muds and cuttings. Also, if more than two wells that are not from development operations are to be drilled from the same surface location and that surface location is within the 3-mile Zone of an identified topographic feature, all drill cuttings and drilling fluids from the drilling operations are to be shunted to the sea bottom through a structurally sound downpipe that terminates an appropriate distance, but no more than 10 meters (33 feet), from the bottom.

4.6.1.6.2.2 Live Bottoms (Pinnacle Trend Features)

Live bottoms (pinnacle trend features) are defined as small, isolated, low to moderate relief carbonate reefal features or outcrops of unknown origin or hard substrates exposed by erosion that provide surface area for the growth of sessile invertebrates and attract large numbers of fish.

Provisions are made to identify and avoid these features. Stipulations are added to leases on 74 OCS lease blocks in the northeastern Central Planning Area of the Gulf of Mexico that prohibit bottom disturbing activity (including those caused by anchors, chains, cables or wire ropes from a semisubmersible drilling rig or from a pipeline construction vessel) from occurring within 30 meters (100 feet) of any hard bottom/pinnacle that has a vertical relief of 8 feet (2.4 meters) or more. BOEM also conducts case-by-case reviews of permit applications to ensure bottom disturbing activity is distanced from live bottom (pinnacle trend features).

4.6.1.6.2.3 Live Bottoms (Low Relief Features)

Live bottoms (low relief features) are defined as seagrass communities or those areas that contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken or smooth topography; or areas whose vertical relief favors the accumulation of turtles, fishes and other fauna.

No bottom-disturbing activities, including the use of anchors, chains, cables or wire ropes from a semisubmersible drilling rig or from a pipeline construction vessel, may cause impacts to live bottoms (low relief features). These features are protected through lease stipulations attached to OCS leases in waters less than 100 meters (328 feet) deep in the northeast corner of the Central Planning Area and in the Eastern Planning Area of the Gulf of Mexico. However, the areas in the Central and Eastern Planning Areas with these features are not currently leased due to a Congressional moratorium pursuant to the Gulf of Mexico Energy Security Act of 2006 (GOMESA). The GOMESA bans oil and gas leasing within 125 miles (201 kilometers) of the Florida coastline in the EPA and in a portion of the CPA until 2022. As additional protection, BOEM also conducts case-by-case reviews of permit applications in blocks outside of the restricted areas to ensure bottom disturbing activity is distanced from live bottom (low relief features).

4.6.1.6.2.4 Potentially Sensitive Biological Features

Potentially Sensitive Biological Features (PSBFs) are those features not protected by a biological lease stipulation that are of moderate to high relief (about 8 feet/2.5 meters or higher), provide surface area for the growth of sessile invertebrates and attract large numbers of fish. These features are located outside the NAZ of any of the named topographic features (banks) or live bottom (pinnacle trend features) stipulated blocks.

No bottom-disturbing activities, including the use of anchors, chains, cables or wire ropes from a semisubmersible drilling rig or from a pipeline construction vessel, may cause impacts to PSBFs. There are no stipulations attached to OCS leases to distance bottom disturbing activities from PSBFs, but PSBFs are protected by BOEM through case-by-case reviews of permit applications to ensure bottom disturbing activity is distanced from PSBFs.

4.6.1.6.3 Notice to Lessees (NTL) No. 2009-G40 Deepwater Benthic Communities

The purpose of this NTL is to provide a consistent and comprehensive approach to protecting high-density deepwater benthic communities from damage caused by OCS oil and gas activities in water depths greater than 980 feet (300 meters). This NTL remains in effect pursuant to NTL No. 2015-N02.

High-density deepwater benthic communities are defined as:

1. Features or areas that could support high-density chemosynthetic communities; or

2. Features or areas that could support high-density deepwater corals and other associated high-density hard bottom communities.

Damage to high-density deepwater benthic communities could result from oil and gas activities that disturb the seafloor in the immediate vicinity of these communities. Such activities include (but are not limited to) drilling, anchoring, placing seafloor templates, discharging muds and cuttings and installing pipelines. Current setback requirements from high density deep coral sites are 2000 feet (610 meters) for proposed mud and cuttings discharge locations and 250 feet (76 meters) for location of all other seafloor disturbances (anchors, anchor chains, pipelines, etc.).

4.6.1.6.4 Presidential Directives

In a 1990 presidential directive to the Department of the Interior, President George H.W. Bush placed a moratorium on the issuance of new leases for offshore oil and gas drilling in national marine sanctuaries and in areas off the coasts of California, Florida, New England, Washington, and Oregon for ten years. In 1998, President Clinton extended the order through 2012 and barred any new leasing in the twelve existing national marine sanctuaries. Though President G.W. Bush rescinded the directive on July 14, 2008, he did not rescind the moratorium as it applied to national marine sanctuaries. The Presidential directive to the Secretary of the Interior, which prohibits the issuing of new leases for oil and gas drilling activities in sanctuaries does not affect leases that were in effect as of July 14, 2008 and only applies to sanctuaries existing at that time.

4.6.1.7 Endangered Species Act (16 U.S.C. Section 1531 et seq.)

The ESA protects animals and plants threatened with extinction. When a project is proposed that affects a listed threatened or endangered species, the ESA requires all regulatory agencies to consult with the USFWS (or NMFS) prior to issuing any permit or taking any other action that could harm the listed species. Once a species is listed, the ESA prohibits the 'take' of that species by direct or indirect actions. Pursuant to section 3 of the Endangered Species Act, "the term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." "Harm" is further defined as any act which actually kills or injures fish or wildlife, and emphasizes that such acts may include significant habitat modification or degradation that significantly impairs essential behavioral patterns of fish or wildlife. The USFWS or NMFS completes a formal consultation and issues a biological opinion, documenting the determination of whether the impact of the project results in a jeopardy to that species, and includes recommended measures, that may include denial of the permit, to reduce or eliminate the threat posed by the project or activity.

4.6.1.8 Marine Mammal Protection Act (16 U.S.C. 1361 et seq.)

The MMPA established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the United States. Under the MMPA, the Secretary of Commerce (authority delegated to NMFS) is responsible for the conservation and management of

cetaceans and pinnipeds (other than walruses). The Secretary of the Interior is responsible for walruses, sea and marine otters, polar bears, manatees and dugongs.

Part of the responsibility that NMFS has under the MMPA involves monitoring populations of marine mammals to make sure that they stay at optimum levels. If a population falls below its optimum level, it is designated as "depleted," and a conservation plan is developed to guide research and management actions to restore the population to healthy levels.

In 1994, Congress amended the MMPA to govern the taking of marine mammals incidental to commercial fishing operations. This amendment required the preparation of stock assessments for all marine mammal stocks in waters under U.S. jurisdiction, development and implementation of take-reduction plans for stocks that may be reduced or are being maintained below their optimum sustainable population levels due to interactions with commercial fisheries, and studies of pinniped-fishery interactions.

4.6.1.9 Federal Policy on Artificial Reefs

A National Artificial Reef Plan, developed under the Secretary of Commerce by direction of the National Fishing Enhancement Act of 1984 and the EPA based upon Federal and international law, provides guidance for development of artificial reefs. Also, guidance is provided by the Coastal Artificial Reef Planning Guide adopted by the Gulf, Atlantic and Pacific States Marine Fisheries Commissions, and Guidelines for Marine Artificial Reef Materials produced by the Gulf States Marine Fisheries Commission.

The Gulf States, Atlantic States and Pacific States Marine Fisheries Commissions asked NMFS to allow the states to develop revisions to the National Artificial Reef Plan. The revised plan places stronger emphasis on the habitat implications of artificial reefs than on other functions or outcomes. The revised plan does not list approved material for artificial reef construction, but specifies criteria for materials. The revised plan recommends conducting baseline and follow-up evaluations and monitoring to determine if reefs meet objectives set for them. Under the revised plan, artificial reefs may be used to restore and enhance habitat, as sanctuaries, as reef management areas for effort control or to resolve spatial and use-conflict.

Chapter 5

ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

5.1 Introduction

This chapter evaluates the anticipated environmental impacts resulting from the implementation of each of the sanctuary expansion alternatives presented in Chapter 3. The potential impacts would be applicable to the affected environment described in Chapter 4. Also discussed are potential cumulative impacts; unavoidable adverse impacts; the relationship between short-term uses and long-term productivity; and the irreversible and irretrievable commitment of resources. As described in Chapter 3, the alternatives are exclusively spatial in nature; that is, only alternatives related to the potential expansion of the sanctuary boundary are considered, and each of the alternatives assumes that the current regulatory regime in place in the existing sanctuary would extend to areas encompassed in any expanded boundaries.

Under NEPA (42 U.S.C. 4321 et seq.), an environmental assessment would have sufficed to analyze the impacts of this action since NOAA has determined that no significant impacts are likely under any of the alternatives. However, the NMSA requires NOAA to publish a DEIS regardless of the intensity of the impacts of the proposed action if NOAA is considering changing the terms of designation of a sanctuary (16 U.S.C. 1434).

5.2 Affected Resources and Potential Impacts

The following sections describe the environmental consequences of the alternatives. Table 5.1 identifies the terms used to describe potential impacts in this DEIS. The potential impacts, both beneficial and adverse, have been described by their characteristics—type (direct, indirect, or cumulative), duration (short- or long-term), geographic extent (localized or beyond project site), and magnitude/intensity; and an adverse or beneficial qualifier is applied. While the application of comprehensive sanctuary management activities, regulations, and resource protection programs to nationally significant biological and geological features constitutes the primary and most direct benefit of the proposed action and the alternatives, there are several other anticipated benefits and minor adverse impacts to the human environment within and beyond the alternative areas as well. These consequences are common to expansion Alternatives 2-5, though proportional to the number and areal extent of the sites included in each alternative. Benefits to cultural and historic resources are unique to Alternative 5 and are discussed separately below. Table 5.3 presents a summary of the environmental consequences of the action alternatives.

Evaluations are provided for each resource type that may be impacted by the alternatives, as follows:

- Air quality and climate
- Noise environment
- Scenic and Visual resources
- Geology and substrates
- Water resources
- Living marine resources
- Threatened and endangered species
- Cultural and Historic resources
- Marine area use, recreation, and socioeconomics

5.2.1 Types of Potential Impacts

Direct, indirect and cumulative impacts are defined at 40 CFR 1508.7 and 1508.8, and these definitions are presented below. These categories are used to describe the nature, timing and proximity of potential impacts on the affected area. Cumulative impacts as defined below are discussed in Section 5.3.4.

- **Direct Impact:** A known or potential impact caused by the proposed action or project that occurs at the time and place of the action.
- **Indirect Impact:** A known or potential impact caused or induced by the proposed action or project that occurs later than the action or is removed in distance from it, but is still reasonably expected to occur.
- **Cumulative Impact:** A known or potential impact resulting from the incremental effect of the proposed action added to other past, present or reasonably foreseeable future actions.

5.2.2 Duration of Potential Impacts

The duration of the potential impact can be defined as either short-term or long-term and indicates the period of time during which the environmental resource would be impacted. Duration takes into account the permanence of an impact or the potential for natural attenuation of an impact. In general, the impacts of all of the proposed alternatives would be long-term or permanent. The duration of each potential impact is defined as follows:

- **Short-Term Impact**: A known or potential impact of limited duration, relative to the proposed action and the environmental resource. For the purposes of this analysis, these impacts may be instantaneous or may last minutes, hours, days, or up to 5 years.
- **Long-Term Impact**: A known or potential impact of extended duration, relative to the proposed action and the environmental resource. For the purposes of this analysis, these impacts would last longer than 5 years.
- **Permanent Impact**: A known or potential impact that is likely to remain unchanged indefinitely.

5.2.3 Geographic Extent

National marine sanctuary designation can cause impacts at a variety of geographic scales. For the purposes of this analysis, impacts are assessed in two ways:

- **Localized:** Site-specific and generally limited to the area within and the immediate surroundings of the proposed boundaries.
- **Beyond Proposed Boundaries:** Unconfined or unrestricted to the proposed boundaries. These impacts may extend only in the immediate vicinity of a proposed boundary or throughout the north central Gulf of Mexico region.

5.2.4 Magnitude of Potential Impacts

To determine the proposed action's magnitude or intensity, NOAA qualitatively assessed the degree to which the alternatives would impact a particular resource. The magnitude or intensity of a known or potential impact is defined on a spectrum ranging from no impacts to major impacts. The potential impacts could be either beneficial or adverse for a particular resource. This DEIS considers the relative magnitude or intensity of both adverse and beneficial impacts. The intent of NOAA's proposed action is to provide beneficial impacts to habitat. The qualitative assessment is based on a review of the available and relevant reference material, and is based on professional judgment using standards that include consideration of the permanence of an impact or the potential for natural attenuation of an impact; the uniqueness or irreplaceability of the resource; the abundance or scarcity of the resource; the geographic, ecological, or other context of the impact; and the potential that mitigation measures can offset the anticipated impact. Impact magnitude descriptions are defined as follows.

With respect to the physical and biological environment (resource categories including geology and substrates, water, living marine resources and threatened and endangered species):

- **Minor impacts** to the structure or function of a resource might be perceptible but are typically not amenable to measurement. These are typically localized but may in certain circumstances extend beyond a proposed boundary. Generally, minor impacts are those that, in their context and due to their low level of severity, do not have the potential to

meet the considerations of 'significance' set forth in CEQ regulations (40 CFR 1508.27) and NOAA policy (NAO 216-6).

- **Moderate impacts** to the structure or function of these resources are more perceptible and, typically, more amenable to quantification or measurement. These can be both localized, or may extend beyond a proposed boundary. Generally, moderate impacts are those that, in their context and due to their low level of severity, do not have the potential to meet the considerations of 'significance' set forth in CEQ regulations (40 CFR 1508.27) and NOAA policy (NAO 216-6).

- **Major impacts** to these resources are typically obvious, amenable to quantification or measurement, and result in substantial structural or functional changes to the resource. These can be localized, or may extend beyond a proposed boundary. Generally, major impacts are those that in their context and due to their severity, have the potential to meet the considerations of 'significance' set forth in CEQ regulations (40 CFR 1508.27) and NOAA policy (NAO 216-6).

With respect to the human environment (resource categories including cultural and historic resources, marine area use, recreation and socioeconomics):

- **Minor impacts** might be perceptible but, in their context, are not amenable to measurement and do not alter the overall, fundamental condition of the resource from status quo. Such impacts generally would be isolated to that resource alone and would not have any meaningful influence on other resource categories. Generally, minor impacts are those that, in their context and due to their low level of severity, do not have the potential to meet the considerations of 'significance' set forth in CEQ regulations (40 CFR 1508.27) and NOAA policy (NAO 216-6).

- **Moderate impacts** to these resources are more perceptible and, typically, more amenable to quantification or measurement and would likely alter the overall, fundamental condition of the resource from status quo. These may be so impactful as to meaningfully alter or affect another resource category in the proposed boundary. Generally, minor impacts are those that, in their context and due to their low level of severity, do not have the potential to meet the considerations of 'significance' set forth in CEQ regulations (40 CFR 1508.27) and NOAA policy (NAO 216-6).

- **Major impacts** to these resource categories are obvious, amenable to quantification or measurement, and result in substantial changes to the fundamental condition of the resource from status quo. Such impacts may be so severe or profound as to substantially alter or affect more than one other resource category in the proposed boundary. Generally, major impacts are those that in their context and due to their severity, have the potential to meet the considerations of 'significance' set forth in CEQ regulations (40 CFR 1508.27) and NOAA policy (NAO 216-6)

Table 5.1. Summary of terms used to describe potential environmental impacts

Type of Impact	Duration of Impact	Geographic Extent	Magnitude/ Intensity	Qualifier	Significance Determination
No Effect Direct Indirect Cumulative	Short-term Long-term Permanent	Localized Beyond proposed boundaries	Minor Moderate Major	Adverse Beneficial	Less than Significant (<) Significant (>)

Minor beneficial impact
Moderate beneficial impact
Major beneficial impact
Minor adverse impact
Moderate adverse impact
Major adverse impact

Figure 5.1. Color coding legend for Tables 5.3 and 5.4

5.3 Analysis of Environmental Consequences of Alternatives

5.3.1 Alternative 1: No Action

Table 5.2. Summary of the environmental consequences of Alternative 1, the "No Action" alternative (refer to Section 5.3.1 for details)

Resource	Row #	Type of Impact	Duration of Impact	Geographic Extent	Magnitude/ Intensity	Quality	Significance
Air Quality and Climate	1	Indirect	Long-term	Localized	Minor	Adverse	<
Noise Environment	2	Indirect	Long-term	Localized	Minor	Adverse	<
Scenic and Visual Resources	3	Indirect	Long-term	Localized	Minor	Adverse	<
Geology and Substrates	4	Indirect	Long-term	Localized	Moderate	Adverse	<
Water	5	Indirect	Long-term	Localized	Minor	Adverse	<
Living Marine Resources	6	Indirect	Long-term	Localized	Moderate	Adverse	<
	7	Indirect	Long-term	Beyond proposed boundaries	Minor	Beneficial	<
Protected Species	8	Indirect	Long-term	Localized	Minor	Adverse	<
Marine Area Use, Recreation, and Socioeconomics	9	Indirect	Long-term	Localized	Minor	Beneficial	<
	10	Indirect	Long-term	Localized	Minor	Adverse	<
Cultural and Historic Resources	11	Indirect	Long-term	Localized	Minor	Adverse	<

The No Action alternative would not change the boundaries of FGBNMS (Figure 5.1). Since implementation of the No Action alternative is expected to leave the existing environment

unchanged except for continuation of existing impacts, the effect of this alternative is the same as that described in Chapter 4.0, *Affected Environment*, and impacts are summarized in this section.

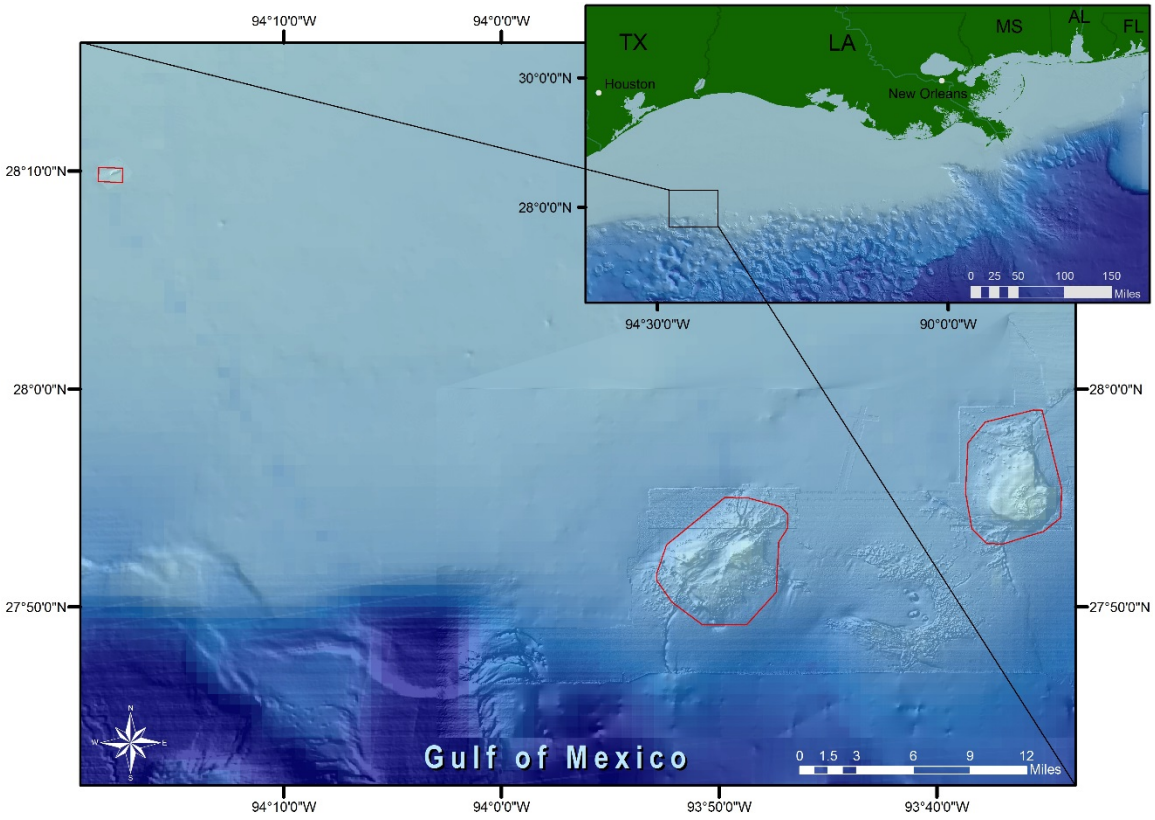

Figure 5.2. Current FGBNMS boundaries

The No Action concept provides a baseline against which environmental consequences of the sanctuary expansion alternatives may be compared. No direct changes to air quality and climate, the noise environment, scenic and visual resources, geology and substrates, water resources (e.g., circulation patterns, oceanographic conditions or water quality parameters such as temperature, dissolved oxygen levels, salinity or potential contaminant levels), living marine resources and EFH, threatened and endangered species, cultural and historic resources, marine area use and recreation or socioeconomics are expected to result from the No Action Alternative.

The failure to implement the regulatory protections and management actions in the proposed sanctuary expansion areas would indirectly allow ongoing deleterious changes to the physical and biological environment to continue due to pressures from current uses of areas considered for expansion under the various alternatives (e.g., discharges from vessels, impacts from oil and gas exploration and production, salvage activities, etc.). This results in indirect, long-term, localized, minor adverse impacts to air quality and climate (see Table 5.2, Row 1); the noise environment (see Table 5.2, Row 2); scenic and visual resources (see Table 5.2, Row 3); water resources (see Table 5.2, Row 5); protected species (see Table 5.2, Row 8); marine area use, recreation, and

socioeconomics (see Table 5.2, Row 10); and cultural and historic resources (see Table 5.2, Row 11). These impacts are less than significant under any of the alternatives due to their low level of intensity in the context of the extensive ongoing use of these resources in the north central Gulf of Mexico.

Failure to implement the regulatory protections and management actions in the proposed sanctuary expansion areas would indirectly have slightly greater adverse impacts to the resource categories most impacted by current uses (e.g., habitat damage from anchoring, habitat damage from fishing with bottom-tending gear, or reductions in fish biomass from all currently allowed types of fishing, unmitigated recruitment of invasive species such as lionfish), resulting in indirect, long-term, localized, moderate adverse impacts to geology and substrates (see Table 5.2, Row 4) and to living marine resources (see Table 5.2, Row 6). These impacts are less than significant under any of the alternatives due to their low level of intensity in the context of the extensive ongoing use of these resources in the north central Gulf of Mexico.

The pressures adversely affecting the resource categories described above derive primarily from extractive industries that provide important economic benefits to the Gulf of Mexico region. While the economic incentives that drive these activities will continue to exist with or without sanctuary expansion, the No Action alternative would avoid some of the minor adverse impacts to living marine resources and minor adverse impacts socioeconomic resources associated with the action alternatives as described in Section 5.3.2.8 below. For example, by avoiding the spatial substitution of fishing effort that could occur if fishing restrictions are implemented in the proposed expansion areas, the No Action alternative indirectly produces long-term, minor beneficial impacts beyond the proposed boundaries to living marine resources (see Table 5.2, Row 7). Similarly, the No Action alternative produces indirect, long-term, localized minor benefits to socioeconomic resources (see Table 5.2, Row 9) by allowing the economic activity occurring in proposed expansion areas to continue unimpeded by the implementation of sanctuary protections in those areas. These impacts are less than significant under any of the alternatives due to their low level of intensity in the context of the extensive ongoing economic activity related to use of the north central Gulf of Mexico.

There is a greater likelihood of loss or degradation of habitat and other environmental resources under the No Action Alternative than under the other alternatives that expand the boundaries and impose current sanctuary regulations within expanded boundaries to minimize such impacts. The No Action Alternative leaves nationally significant marine habitat resources at risk of loss or degradation, and fails to fulfill the missions of ONMS and FGBNMS or the purpose and need for sanctuary expansion identified in this DEIS.

With or without sanctuary expansion, implementation of fishery management activities by NMFS pursuant to the MSA, including consultations on federal actions that might negatively affect EFH (e.g., dredge and fill, mining, OCS activities, coastal development, etc.) would continue under current Federal laws and policies. Consultations would occur with NMFS under the EFH regulations and the 2006 reauthorization of the MSA. Consultations would occur under

authorities such as Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Additionally, several fishery management actions taken by NMFS and the GMFMC prior to the EFH regulations that effectively protect biogenic structures such as coral reefs, siltstone or claystone banks and other marine habitats would be maintained and provide protection to habitats that are functionally important to one or more managed species. These include prohibitions on the use of explosives, chemicals and anchoring in sensitive areas; designation of no trawl zones and other marine protected areas such as at FGBNMS; and some fishing gear restrictions. The protection of topographic features in NAZs, live bottoms, hard bottoms, PSBFs, and deepwater benthic communities (deepwater coral and chemosynthetic communities) from oil and gas activities in the Gulf of Mexico would continue under the jurisdiction of BOEM.

5.3.2 Consequences Common to Expansion Alternatives 2, 3, 4 and 5

The boundaries proposed under each of the expansion alternatives encompass progressively greater numbers of nationally significant biological and geological features and progressively greater areal extent as indicated in Chapter 3. The consequences described below, while common to expansion Alternatives 2, 3, 4 and 5, are proportional to the number of features and areal extent encompassed under each alternative.

Table 5.3. Summary of the environmental consequences of the action alternatives (refer to Section 5.3.2 for details)

Alternative (s)	Resource	Row #	Type of Impact	Duration of Impact	Geographic Extent	Magnitude/ Intensity	Quality	Significance
2, 3, 4 & 5	*Air Quality and Climate*	1	Direct	Long-term	Localized	Minor	Beneficial	<
		2	Direct	Long-term	Localized	Minor	Adverse	<
		3	Indirect	Long-term	Localized	Minor	Beneficial	<
	Noise Environment	4	Indirect	Long-term	Localized	Minor	Beneficial	<
		5	Direct	Long-term	Localized	Minor	Adverse	<
	Scenic and Visual Resources	6	Indirect	Long-term	Localized	Minor	Beneficial	<
		7	Direct	Long-term	Localized	Minor	Beneficial	<
	Geology and Substrates	8	Direct	Long-term	Localized	Minor	Beneficial	<
		9	Direct	Long-term	Localized	Minor	Adverse	<
		10	Direct	Long-term	Localized	Moderate	Beneficial	<
	Water	11	Direct	Long-term	Localized	Minor	Beneficial	<
		12	Indirect	Long-term	Localized	Minor	Beneficial	<
		13	Direct	Long-term	Beyond proposed boundaries	Minor	Beneficial	<
		14	Indirect	Long-term	Beyond proposed boundaries	Minor	Beneficial	<
	Living Marine Resources	15	Indirect	Long-term	Beyond proposed boundaries	Moderate	Beneficial	<
		16	Indirect	Long-term	Beyond proposed boundaries	Minor	Adverse	<
		17	Direct	Long-term	Localized	Major	Beneficial	<
	Protected Species	18	Direct	Long-term	Localized	Minor	Beneficial	<
	Marine Area Use, Recreation, and Socioeconomics	19	Direct	Long-term	Localized	Minor	Beneficial	<
		20	Direct	Long-term	Beyond proposed boundaries	Major	Beneficial	<
		21	Indirect	Long-term	Localized	Minor	Beneficial	<
		22	Indirect	Long-term	Beyond proposed boundaries	Minor	Beneficial	<
		23	Direct	Long-term	Localized	Minor	Adverse	<
2, 3 & 4	*Cultural and Historic Resources*	24	Indirect	Long-term	Localized	Minor	Adverse	<
5	*Cultural and Historic Resources*	25	Direct	Long-term	Localized	Major	Beneficial	<

5.3.2.1 Air Quality and Climate

Exhausts from vessels and oil and gas infrastructure are permitted to be released inside sanctuary boundaries under existing regulations, and this exemption from discharge prohibitions would be applied in any expansion areas. Direct, long-term, localized, minor beneficial impacts to air quality could result (see Table 5.3, Row 1) from any reduction in vessel traffic or oil and gas infrastructure that may result from the imposition of sanctuary regulations (e.g., fishing gear restrictions, anchoring, bottom disturbing, or discharge prohibitions, etc.) in expansion areas (see section 5.3.2.8). Though this impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative, it is less than significant under any of the alternatives due to its low level of intensity in the context of the total vessel traffic and industrial use of the north central Gulf of Mexico.

Direct, long-term, localized minor adverse impacts to air quality could result (see Table 5.3, Row 2) from any increase in vessel traffic related to regulatory enforcement, research, education, recreational, or other activities that are promoted by designation and management in expanded sanctuary areas. This impact is also common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative, and it is less than significant under any of the alternatives due to its low level of intensity in the context of the total vessel traffic and industrial use of the north central Gulf of Mexico.

Indirect, long-term, minor beneficial impacts beyond the proposed boundaries could result (see Table 5.3, Row 3) from decreased emissions resulting from any oil and gas production that is avoided as a result of the imposition of sanctuary regulations in expansion areas (described in Section 5.3.2.8.4) and from any increase in the uptake of atmospheric contaminant loads (CO_2, mercury, etc.) due to increased biological productivity resulting from sanctuary protections. This impact is likewise common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative, and it is less than significant under any of the alternatives due to its low level of intensity in the context of the total contaminant uptake due to biological productivity in the north central Gulf of Mexico.

5.3.2.2 Noise Environment

Alternatives 2-5 would have indirect, long-term, localized, minor beneficial and adverse impacts on the noise environment in the proposed expansion areas. Sanctuary regulations do not directly restrict noise in the current sanctuary boundaries. However, sanctuary regulations do prevent disturbance to sanctuary resources, which may include noise disturbance. None of the alternatives make any changes to current sanctuary regulations regarding disturbance related to noise.

Reductions in noise generation may achieve an indirect, long-term, localized, minor benefit (see Table 5.3, Row 4) by any reduction in vessel traffic or oil and gas exploration and production activities that may result from the imposition of sanctuary regulations (e.g., fishing gear restrictions, anchoring, bottom disturbing, or discharge prohibitions, etc.) in expansion areas (see section 5.3.2.8). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional

to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the noise environment of the heavily trafficked and industrialized north central Gulf of Mexico.

Direct, long-term, localized minor adverse impacts to the noise environment could result (see Table 5.3, Row 5) from any increase in vessel traffic related to regulatory enforcement, research, education, recreational, or other activities that are promoted by designation and management in expanded sanctuary areas. This impact is also common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative, and it is less than significant under any of the alternatives due to its low level of intensity in the context of the noise environment of the heavily trafficked and industrialized north central Gulf of Mexico.

5.3.2.3 Scenic and Visual Resources

Alternatives 2-5 would have indirect, long-term, localized, minor beneficial impacts on the scenic and visual resources of the proposed expansion areas (see Table 5.3, Row 6) by reducing marine debris including derelict fishing gear, vessel traffic, and industrial infrastructure that detract from the aesthetic values of the sanctuary that were strongly supported in public scoping for this DEIS through the imposition of sanctuary regulations (e.g., fishing gear restrictions, anchoring, bottom disturbing, or discharge prohibitions, etc.) in expansion areas (see section 5.3.2.8). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the heavy vessel traffic and industrial use of the north central Gulf of Mexico.

In addition, Alternatives 2-5 would have direct, long-term, localized, minor beneficial impacts on the scenic and visual resources of the proposed expansion areas (see Table 5.3, Row 7) by fostering more thorough exploration and research in expansion areas through sanctuary designation, allowing the public to visualize previously unknown, unobserved areas and resources, even if visiting them is not possible. This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the total U. S. ocean exploration and research enterprise.

5.3.2.4 Geology and Substrates

The geological and substrate resources of the features encompassed by the various sanctuary expansion alternatives are less vulnerable to disruptions than are the biogenic features. Nevertheless, adverse impacts have occurred on geological structure and substrates in the north central Gulf of Mexico. Activities that have and continue to adversely affect geological structure and substrates in the region include fishing with bottom-tending gears, dredging, scraping, sand and mineral mining, oil and gas exploration and extraction activities, laying pipelines, modifying deposition and coastal development (Turner and Cahoon 1987, Louisiana Coastal Wetlands

Conservation and Restoration Task Force and Wetlands Conservation and Restoration Authority 1998). Some of these actions could homogenize the seabed surface, cause sedimentation to cover surface features or cause subsidence.

There is clear evidence of historical damage to the substrates of the Flower Garden Banks by anchoring from large ships (Federal Register 2001), damage to substrates from indiscriminate anchoring at proposed expansion areas such as Sonnier Bank (NOAA 2012b) and damage to geological and substrate resources from salvage activities at proposed expansion areas such as Bright Bank. Anchoring by smaller vessels leaves scars if anchors drag or snag hard bottom. Scars or tracks of pulverized coral have been documented by studies conducted by submersibles and divers.

Of these potential impacts, anchoring, fishing, oil and gas exploration and extraction and laying pipelines are most common and likely to continue in the region of the sanctuary. Applying current sanctuary regulations regarding altering the seabed to expansion areas would provide direct, long-term, localized, moderate benefits to geologic and substrate resources (see Table 5.3, Row 10) by prohibiting most bottom disturbing activities, including fishing with bottom-tending gear, anchoring or mooring, drilling into, dredging or otherwise altering the seabed for any purpose, or unintentionally (with exceptions such as those providing for necessary activities conducted in areas outside the NAZs and incidental to exploration); and by prohibiting construction or abandonment of any structure, material or other matter on the seabed of the sanctuary. This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of all bottom disturbing activities occurring in the north central Gulf of Mexico.

Sanctuary regulations requiring shunting of drilling muds to the seafloor within sanctuary boundaries would have both beneficial and adverse direct, long-term, localized, minor impacts on geological and substrate resources by concentrating the area in which drilling muds and associated contaminants are released into the environment (see Table 5.3, Rows 8 and 9). Most importantly, this requirement avoids potential impacts to biological resources within the sanctuary that could be affected by disposal of this material at the sea surface and its transport through the water column by ocean currents to the sea floor, and similar benefits may derive to geological and substrate resources at greater distance from the production infrastructure from which it is disposed (see Table 5.3, Row 8). At the same time (see Table 5.3, Row 9), this requirement has been documented to result in a “halo effect” or gradient of contaminated sediments in the immediate vicinity of shunt pipe discharge points that decreases rapidly with distance from platforms (Kennicutt 1995), and differences in substrate grain size can persist where smothering occurs (Boland et al. 2004, Roberts and Nguyen 2006). This requirement is already in place within buffer zones around NAZs under the BOEM stipulations that are attached to leases, and therefore does not represent a change for most areas proposed for inclusion under the expansion alternatives. These impacts are common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. They

are less than significant under any of the alternatives due to its low level of intensity in the context of all drilling operations for which shunting is required.

5.3.2.5 Water Resources

None of the sanctuary expansion alternatives have any direct effects on the oceanographic characteristics of the Gulf of Mexico. The application to expansion areas of current sanctuary regulations regarding discharges into waters of the sanctuary would provide both direct and indirect, long-term, localized (i.e., within the proposed boundaries) minor benefits to water resources (see Table 5.3, Rows 11 and 12) as well as direct and indirect, long-term, minor benefits to water resources beyond the proposed boundaries (see Table 5.3, Rows 13 and 14).

Direct, long-term, benefits would result from prohibitions on discharge and deposit of any material within the sanctuary. These benefits would be both localized (see Table 5.3, Row 11) and extending beyond the proposed boundaries (see Table 5.3, Row 13), to the extent that such prevented discharges and deposits could be carried by currents, animals, vessels, etc. outside those proposed boundaries. These impacts are common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. They are less than significant under any of the alternatives due to their low level of intensity in the context of the many factors influencing water quality in the north central Gulf of Mexico, including oceanographic conditions and contaminant loads (e.g. Mississippi River nutrient loads contributing to the hypoxic zone on the continental shelf) affecting the north central Gulf of Mexico.

Exceptions to these prohibitions provide for discharge of fish, fish parts, chumming materials or bait used in or resulting from fishing with conventional hook and line gear in the sanctuary; biodegradable effluents incidental to vessel use and generated by marine sanitation devices approved in accordance with section 312 of the Clean Water Act; water generated by routine vessel operations (e.g., cooling water, deck wash down and graywater as defined by section 312 of the Clean Water Act) excluding oily wastes from bilge pumping, and drilling cuttings and fluids incidental to oil and gas operations (outside of NAZs and buffer zones).

Any reductions in vessel traffic or oil and gas infrastructure that could result in sanctuary expansion areas due to the imposition of sanctuary regulations (see section 5.3.2.8) would provide further indirect, long-term, localized water quality benefits (see Table 5.3, Row 12). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the extensive vessel traffic and industrial use of the north central Gulf of Mexico.

BOEM's Oil Spill Modeling Program has analyzed the risks posed by potential oil spills in the Gulf of Mexico through its Oil Spill Risk Analysis model, and has identified both the likelihood of spill occurrence and the probability that a given spill will result in contact with environmental receptors, including the areas considered in each of the expansion alternatives (Ji et al. 2004, Ji et

al. 2012, Ji et al. 2013). While oil spills and spills of chemicals and compounds used operationally in the oil and gas industry could seriously impact water quality in expansion areas and beyond, the likelihood of such contact for the various alternatives is low (Ji et al. 2004, Ji et al. 2012, Ji et al. 2013), and it is further reduced to the extent that the sanctuary expansion alternatives could result in reductions in oil and gas infrastructure in or near the expansion areas (see Section 5.3.2.8). Such reductions would yield both indirect, long-term, localized minor benefits (see Table 5.3, Row 12) and indirect, long-term benefits beyond the proposed boundaries (see Table 5.3, Row 14). These impacts are common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. They are less than significant under any of the alternatives due to their low level of intensity in the context of the potential for oil spill impacts across the north central Gulf of Mexico.

5.3.2.6 Living Marine Resources

The primary environmental consequences of the proposed sanctuary expansion would result from the imposition of the current sanctuary regulations in expansion areas. Current sanctuary regulations include restrictions on exploration for, or development or production of oil, gas or minerals; anchoring or otherwise mooring; discharging or depositing materials or other matter; alteration of the seabed; possessing various marine resources; injuring or taking or attempting to injure or take sanctuary resources; possessing or using explosives or releasing electrical charges; feeding fish; and possessing (except while passing without interruption through the sanctuary) or using fishing gear other than conventional hook and line gear. The full text of the regulations is found in Appendix F).

Indirect, long-term, moderate, beneficial impacts to living marine resources beyond the proposed expansion boundaries would result (see Table 5.3, Row 15) from increased production due to fishing restrictions and habitat protections inside the sanctuary boundary “spilling over” to areas outside it. This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of total biological productivity in the north central Gulf of Mexico.

To the extent that restrictions on fishing activity inside the sanctuary boundary increase fishing pressure and associated impacts outside the expanded boundaries (i.e., to the extent that sanctuary regulations result in “spatial substitution” of fishing effort to areas outside the expanded boundaries), indirect, long-term, minor adverse impacts beyond the proposed boundaries may also occur (see Table 5.3, Row 16). This impact is likewise common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative, and it is less than significant under any of the alternatives due to its low level of intensity in the context of total fishing effort applied across the north central Gulf of Mexico), and is mitigated by current fishery management regulations in place throughout the Gulf of Mexico.

Direct, long-term, localized major benefits to living marine resources are the primary benefit sought by the proposed sanctuary expansion and the imposition of protections concomitant with

such designation (see Table 5.3, Row 17). The paragraphs that follow in this section identify the sources of these benefits. This impact is also common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. Despite the magnitude of this benefit it is considered less than significant under any of the alternatives considering the context of extensive (but less studied) hard bottom areas in the north central Gulf of Mexico as shown in Table 5.4 and the context of total fishing effort applied across the north central Gulf of Mexico), mitigated by current fishery management regulations in place throughout the Gulf of Mexico.

The sessile benthic communities targeted for protection under the proposed expansion alternatives would benefit because they are much more susceptible to bottom-disturbing activities like anchoring, oil and gas development, fishing activities and marine debris. Benefits may include increases in coral cover or density over time (Selig and Bruno 2010). Benefits to resources such as fish biomass (Edgar et al. 2011, Harborne et al. 2008) and abundance are anticipated (Jeffrey et al. 2012), particularly where fishing pressure is reduced (Edgar et al. 2011, Kramer and Heck 2007). Although benefits to corals may require as many as 10 years after the designation of expanded sanctuary boundaries (Selig and Bruno 2010), the designation is anticipated to be long-term, if not permanent. Other benefits could include reducing impacts due to limitations on fishing that can otherwise alter predator-prey relationships, disturb bottom habitats and increase loss of fish biomass. Management actions could reduce marine debris and impacts of debris on corals and other organisms, such as entanglement of sea turtles in derelict fishing gear and fish that can be incidentally caught in “ghost” fishing gears. Management actions also include prohibition of bottom-tending fishing gear, limits on anchoring and the discharge of pollutants, removal of marine debris such as derelict fishing gear and invasive species removal, all of which would improve habitat for benthic coral communities. Sanctuary protections and management provide important opportunities for research and recovery of living marine resources from observed impacts.

Bottom trawls, traps and pots are prohibited in some parts of the Gulf of Mexico Exclusive Economic Zone (EEZ), including the current sanctuary. Bottom longlines are prohibited shallower than the 50 fathom (300 foot) isobaths. These regulations implement the GMFMC’s Fishery Management Plans, HAPC designations and FGBNMS regulations. In areas considered for inclusion in the expanded sanctuary but outside the current sanctuary, bottom longlines are not currently prohibited seaward of the prescribed 50 fathom line. Shrimp trawls are a prohibited gear within the sanctuary by sanctuary regulations as are other commercial fishing gears except conventional hook and line gear (which may terminate in one or more hooks).

Commercial and recreational fishing of reef fish (mostly snapper and grouper) in FGBNMS is conducted with conventional hook and line gear. The effort is mostly directed towards the fringe of the coral banks and in deep reef areas. These may also be the preferred areas frequented by schooling snappers and groupers, especially in or around spawning season when aggregations start to form. Prohibitions on certain types of fishing and on anchoring in the expanded sanctuary areas will reduce fishing pressure and impacts on vulnerable aggregating reef fish species and

bottom habitats, benefiting critical nursery and feeding sites for reef fish juveniles and adults and for live bottom.

5.3.2.7 Protected Species

Sea turtles, *Orbicella* star coral, acroporid corals and marine mammals, are protected by the ESA and the MMPA, and sanctuary regulations also prohibit the take of any ESA listed species or marine mammal. However, accidental catch (bycatch) or injury to these species is still possible during fishing activities or due to interactions with both large (> 100 feet long) and small (< 100 feet long) vessels. Individual marine mammal, sea turtle, and fish species are often found entangled in fishing gear. This fishing gear may also be ingested by protected vertebrate species. Release of various discharges or marine debris from vessels is also a potential impact and has been found to be a contributing factor in many protected vertebrate species mortalities due to ingestion. Vessel collisions could impact marine mammal and sea turtle species. However, based on NOAA's experience, the level of vessel interactions with marine mammals and sea turtles in the proposed expansion areas is very low. Potential interactions resulting from NOAA field operations in the areas are mitigated by the sanctuary's standard operating procedures and will be further analyzed in the Programmatic Environmental Assessment of Field Operations in the Southeast and Gulf of Mexico National Marine Sanctuaries.

Prohibition of anchoring and bottom-disturbing activities including some types of fishing, as well as prohibitions on discharges in the expanded sanctuary would provide further protections to these species, yielding direct, long-term, localized, minor beneficial impacts (see Table 5.3, Row 18) to threatened and endangered species that make use of habitats in the proposed expansion areas. This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the extensive ongoing uses of the north central Gulf of Mexico that affect these species.

Interactions with marine mammals and other protected species could still occur outside the sanctuary. Threatened and protected fish species could be less affected by some recreational and commercial fishing activities in expansion areas, as no gear but conventional hook and line would be allowed. This is particularly important in species such as the Warsaw Grouper (*Epinephelus nigritus*) and Nassau Grouper (*Epinephelus striatus*), Atlantic Bluefin Tuna (*Thunnus thynnus*), Dusky Shark (*Carcharhinus obscurus*), and Ivory Tree Coral (*Oculina varicosa*). All occur in the region and are listed as species of concern, which means they have been identified as species potentially at risk of becoming threatened or endangered, but which require further study for listing.

5.3.2.8 Marine Area Use, Recreation and Socioeconomics

Expanding sanctuary boundaries would provide direct, long-term, localized, minor beneficial and adverse impacts; direct, long-term, major beneficial impacts beyond the proposed boundaries; and indirect, long-term, minor beneficial impacts, both localized and beyond the proposed boundaries,

to marine area use, recreation, and socioeconomics by prohibiting certain activities and enhancing others. Prohibition on bottom disturbing activities will reduce or eliminate opportunities to engage in some activities (e.g., anchoring, certain types of fishing, some oil and gas related activities) in the expanded sanctuary boundaries, yielding direct, long-term, localized, minor adverse impacts (see Table 5.3, Row 23). These impacts are common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. They are less than significant under any of the alternatives due to their low level of intensity in the context of the total ongoing marine area uses, recreation, and socioeconomic activity occurring in the north central Gulf of Mexico.

The same prohibitions yield indirect, long-term benefits to marine area use, recreation, and socioeconomics both inside and beyond the proposed boundaries as a result of increased biological production that results from reduced fishing pressure or habitat protections inside the proposed sanctuary boundaries (see Table 5.3, Rows 21 and 22). This impact is also common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative, and it is also less than significant under any of the alternatives due to its low level of intensity in the context of the total biological production in the north central Gulf of Mexico.

At the same time, extending sanctuary management into these areas will enhance passive economic use value, yielding direct, long-term, major benefits beyond the proposed boundaries (see Table 5.3, Row 20). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives despite its magnitude given the context of the total U. S. economy to which this benefit accrues. Extending sanctuary management into the proposed expansion areas will also enhance opportunities for research, education, tourism and recreation (e.g., recreational fishing and diving), yielding direct, long-term, localized benefits to marine area use, recreation, and socioeconomics (see Table 5.3, Row 19). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the total research, education, and tourism enterprises in the north central Gulf of Mexico region. For example, sanctuary management activities such as mooring buoy installations will improve safe access and serve to protect the important coral communities of the sanctuary. Increased visitation to the sanctuary for recreation or tourism could in turn result in positive long-term regional economic impacts due to increased visitor spending in coastal communities from which the sanctuary is accessed. The largest beneficial impact would be increasing the passive economic use value to the nation by expanding protections. For a more detailed analysis of potential socioeconomic impacts see Leeworthy et al. (2016, also described further in Section 4.5 and below) for commercial fishing (the study concludes impacts to this sector are small and potentially offset by spatial substitution), recreational fishing (the study concludes impacts to this sector are also small and potentially offset by spatial substitution) and passive economic use value (the study concludes this beneficial impact far exceeds the cost of

sanctuary expansion and is a net benefit to the nation). For the oil and gas industry, see Wolfe (2010, also described in Section 4.5 and below) and Leeworthy et al. (2016); these studies conclude the costs to this industry are minor.

The following subsections identify adverse and beneficial impacts anticipated for specific user groups.

5.3.2.8.1 Commercial Fishing

The proposed sanctuary expansion would restrict certain types of fishing on a small fraction of the hard bottom fish habitat areas targeted by the commercial fishing industry (see Table 5.3, Row 23). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the total commercial fishing industry activity in the north central Gulf of Mexico and considering the mitigating factors identified below (i.e., potential for spatial substitution). As described in Chapter 4, approximately 2,532 square miles of hard substrate exists in the north central Gulf of Mexico (Jenkins 2011).

Table 5.4. Hard bottom areas affected under each alternative.

Alternative	Study Area Total (sq. miles)	Study area hard bottom estimate (sq. miles)	Alternative total area (sq. miles)	Hard bottom affected by alternative (sq. miles)	Hard bottom area as % of alternative total area	Alternative hard bottom area as % of total study area hard bottom	Existing Coral HAPCs Intersected	Hard bottom in Coral HAPC & Alternative (sq. miles)	Other Existing HAPCs Intersected
1	122820	2532	56.2	14.85	26.42%	0.59%	3	14.85	0
2	122820	2532	281.15	74.14	26.37%	2.93%	4	20.88	5
3	122820	2532	383.19	101.56	26.50%	4.01%	4	21.52	7
4	122820	2532	633.75	145.59	22.97%	5.75%	4	21.52	7
5	122820	2532	935.18	181.13	19.37%	7.15%	4	21.52	9

The percentage of hard bottom incorporated in each alternative is variable among the alternatives, as shown in Table 5.4. Under the range of alternatives included in this DEIS, between 14.85 and 181.13 square miles of hard bottom, or 0.59% and 7.15% of the 2,532 square miles in the north central Gulf of Mexico would be protected by an expanded sanctuary designation (Gardner et al. 2002, Gardner and Beaudoin 2005, BOEM 2015e). NOAA's 2015 staff recommendation (Alternative 3) would protect 101.56 square miles of hard bottom, comprising 26.5% of the total area encompassed by this alternative, and 4.01% of the 2,532 square miles of hard bottom in the north central Gulf of Mexico. This estimate disregards artificial hard bottoms, which are heavily targeted by commercial fishers, and the fact that under the various sanctuary expansion alternatives, potential expansion areas overlap existing coral HAPCs (NOAA 2015a, NOAA 2015b), as indicated in Table 5.4. This overlap reduces any potential socioeconomic impact that

sanctuary designation would impose related to commercial fishing since anchoring and fishing with bottom-tending gear is already prohibited on 100% of the hard bottom area affected by Alternative 1, approximately 28% of the hard bottom area affected by Alternative 2, approximately 21% of the hard bottom area affected by Alterative 3, approximately 15% of the hard bottom area affected by Alternative 4, and approximately 12 % of the hard bottom area affected by Alternative 5.

Sanctuary regulations would not preclude commercial fishing within the expanded sanctuary boundaries, but would prohibit fishing with bottom-tending gear types that are damaging to benthic communities, and may make other types of fishing less tenable (see Table 5.3, Row 23). This impact is also common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative, and it is also less than significant under any of the alternatives due to its low level of intensity in the context of the total commercial fishing industry activity in the north central Gulf of Mexico and considering the mitigating factors identified below (i.e., potential for gear substitution, mooring buoy installations made possible by sanctuary designation). For example, though fishing for reef fish using bandit reel would be allowed, prohibitions on anchoring may make this activity more difficult due to the requirement to live-boat to target fish aggregations. Fishing from mooring buoys would also continue to be allowed. As described in Chapter 4, on average ~37 vessels carrying bottom longline gear operated annually in the entire study area of the north central Gulf of Mexico. Of those ~37 vessels, ~11 spent some part of their time inside the area proposed for inclusion in NOAA's 2015 staff recommendation (Alternative 3) boundary for sanctuary expansion. Of the 28 vessels operating in the study area with VMS and permits to fish for shrimp, 3 vessels spent some part of their time inside the area proposed for inclusion in NOAA's 2015 staff recommendation (Alternative 3) boundary for sanctuary expansion. ELB data for the shrimp fishery covers a larger portion of the vessels in the fishery, and shows similarly low numbers of vessels entering proposed alternative areas. Of the 238 vessels operating in the study area with permits to fish for reef fish, 38 vessels spent some part of their time inside the area proposed for inclusion in NOAA's 2015 staff recommendation (Alternative 3) boundary for sanctuary expansion. Of the 128 vessels operating in the study area with VMS and permits to fish for king mackerel (an indication of the coastal migratory pelagic species fishery), 23 vessels spent some part of their time inside the area proposed for inclusion in NOAA's 2015 staff recommendation (Alternative 3) boundary for sanctuary expansion. Of the 155 vessels operating in the study area with permits to fish for highly migratory species, 34 vessels spent some part of their time inside the area proposed for inclusion in NOAA's 2015 staff recommendation (Alternative 3) boundary for sanctuary expansion. Effort by boats fishing with bandit reel or hand gear would be affected to a lesser degree than effort by bottom longliners or shrimp trawlers; the impact to their effort would come as a result of anchoring restrictions (not technically fishing regulations). As described in Chapter 4, many boats carry multiple permit types, so the numbers of vessels identified in this paragraph and in Table 5.5 are not necessarily distinct sets. Sanctuary management actions in proposed expansion areas, such as the installation of mooring buoys, would reduce the impacts of this activity.

Commercial fishers may realize a minor benefit from sanctuary expansion in areas both in and outside of the proposed expansion areas as a result of increased production that results from reduced fishing pressure or habitat protections inside the proposed sanctuary boundaries (see Table 5.3, Rows 21 and 22). These impacts are common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. They are less than significant under any of the alternatives due to their low level of intensity in the context of total fish production supporting this sector throughout the north central Gulf of Mexico.

Table 5.5. Annual average numbers of commercial fishing vessels present in proposed sanctuary expansion areas under each alternative.

Alternative	Commercial Reef Fishing Vessels Accessing Alternative Areas	Estimate of Commercial King Mackerel Fishing Vessels Accessing Alternative Areas (only those w/VMS)	Commercial Highly Migratory Species Fishing Vessels Accessing Alternative Areas	Estimate of Commercial Shrimp Fishing Vessels Accessing Alternative Areas (only those w/VMS)	Bottom-Longline Gear Users
Alt 1 Total	20	12	10	0	5
Alt 2 Total	36	22	22	2	10
Alt 3 Total	38	24	34	3	11
Alt 4 Total	113	61	112	9	25
Alt 5 Total	120	65	118	10	26
Study Area	238	128	155	29	37

5.3.2.8.2 Recreational Fishing

Sanctuary regulations would not preclude recreational fishing within the expanded sanctuary boundaries, and recreational fisheries in the proposed sanctuary expansion areas generally do not employ fishing techniques that would be prohibited under sanctuary regulations. Spearfishing would be prohibited in proposed expansion areas, but this use is very limited and targets artificial structure to a greater degree than natural hard bottoms. To the extent that access to natural hard bottoms is restricted for this fishery, the above analysis of the small fraction of hard bottom in the region to be affected by the alternatives applies (see Table 5.3, Row 23). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the total recreational fishing activity in the north central Gulf of Mexico.

Recreational fishers may realize a minor benefit from sanctuary expansion in areas both in and outside of the proposed expansion areas as a result of increased production that results from fishing restrictions or habitat protections inside the proposed sanctuary boundaries (see Table 5.3, Rows 21 and 22). These impacts are common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. They

are less than significant under any of the alternatives due to their low level of intensity in the context of the total fish production supporting this activity in the north central Gulf of Mexico.

Impacts from the anchoring of smaller vessels (< 100 feet long) for recreational fishing do occur in proposed expansion areas, and sanctuary management actions in those areas such as the installation of mooring buoys would benefit this activity and reduce the its associated impacts (see Table 5.3, Row 19). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of all anchoring activity performed by recreational fishers in the north central Gulf of Mexico.

Table 5.6 Annual average numbers of charter fishing headboats present in proposed sanctuary expansion areas under each alternative.

Alternative	Estimate of Charter Reef Fishing Vessels Accessing Alternative Areas (only those w/VMS)	Estimate of Charter Coastal Migratory Pelagic Fishing Vessels Accessing Alternative Areas (only those w/VMS)
Alt 1 Total	4	4
Alt 2 Total	5	5
Alt 3 Total	5	5
Alt 4 Total	25	25
Alt 5 Total	28	28
Study Area	64	60

5.3.2.8.3 Recreational Scuba Diving

Current FGBNMS regulations prohibit anchoring and management provides mooring buoy installations to support vessels up to 100 feet in length. Implementation of sanctuary expansion will enhance the access to diving areas through mooring buoy installation and will prevent impacts to live bottom habitats (see Table 5.3, Row 19). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of all diving activity in the north central Gulf of Mexico.

Additional potential impacts could result from disturbance recreational divers could generate by:

- accidentally or intentionally damaging or altering the corals, sponges, or other components of the habitats present in the sanctuary (e.g., with fins);
- increased interaction with protected and key species;
- lack of proper buoyancy control;
- collecting souvenirs; and
- fish feeding

The recreational diving impacts identified above may have a greater impact on protected corals due to their threatened status. Sanctuary regulations advance recovery plan strategies for these species, for example, FGBNMS regulations applied to the expanded sanctuary area prohibit injury and removal (or attempt to remove), or possession (regardless of where collected, caught, harvested or removed) of any coral or other bottom formation, coralline algae or other plant, marine invertebrate, brine-seep biota or carbonate rock, or fish (except for fish caught by use of conventional hook and line gear) within the sanctuary. These regulations mitigate impacts from collection of souvenirs by scuba divers. Fish feeding is prohibited because it is believed to significantly alter the behavior of fish by disrupting normal feeding patterns. This type of impact could be especially acute without sanctuary management activities including the promotion of best practices for divers within the sanctuary or rotation of mooring buoys among preferred dive sites on a regular basis to avoid major degradation on a limited area. Once any potential expansion is finalized, FGBNMS intends to promote best diving practices and to install mooring buoys in proposed sanctuary expansion areas as part of its management activities for the protection of the resources at these sites, particularly in areas accessible to recreational divers.

5.3.2.8.4 Oil and Gas Exploration and Production

While sanctuary regulations would not preclude new leasing or oil and gas production within the expanded sanctuary boundaries, they may impose requirements making such oil and gas production more difficult or costly in these areas (see Table 5.3, Row 23). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the extensive oil and gas industry activity in the north central Gulf of Mexico and the factors that mitigate and minimize it as identified below.

Specifically, two additional requirements are imposed on oil and gas activities pursuant to sanctuary designation: 1) shunting requirements inside sanctuary boundaries and outside NAZs and buffer zones; and 2) extension of NPDES permit prohibitions on discharges within national marine sanctuaries (not technically a NMS regulation, but triggered by NMS designation under EPA regulations). Of the platforms currently in place inside the proposed boundaries under Alternatives 2 and 3, none are outside NAZs and buffer zones. Of the platforms currently in place inside the proposed boundaries under Alternatives 4 and 5, four are outside NAZs and buffer zones (see Table 5.6 and Appendix B).

The proposed expansion boundary alternatives intersect oil and gas lease blocks associated with between ~0.1% (5.3MMbbl) and ~1.9% (98.9MMbbl) of the oil and gas reserves in the Gulf of Mexico (5,283MMbbl). NOAA's 2015 staff recommendation (Alternative 3) intersects lease blocks associated with ~0.25% (13MMbbl) of the reserves in the Gulf of Mexico (Kazanis et al. 2015; see Table 5.7). The intersection of proposed boundaries with lease blocks associated with reserve fields is used as a means of estimating an upper bound on reserves that could be more difficult to access under the various expansion scenarios and is likely a significant overestimate given that the affected reserve fields can (in most, if not all cases) be accessed from outside the

proposed boundaries (e.g., by vertically drilling into the same formation from a location outside the proposed boundaries or by directionally drilling from wellheads outside the proposed boundaries into locations below the surface of the sanctuary). The proposed alternatives do not impose additional shunting requirements on existing platforms. The cost of shunting requirements for new platforms inside sanctuary boundaries and outside NAZs and buffer zones has been analyzed to be minimal. Average one time incremental costs imposed by shunting requirements of just over $220,000 per platform were shown by Wolfe (2010) to be recoverable from the profit of a single well within 4 days of operation at 2010 prices (as noted in Chapter 4, multiple wells are typically drilled from individual platforms); given 2015-2016 oil prices, that recovery period is likely closer to 10 days. Should a potential oil or gas development interest seek to recover the small fraction of the Gulf of Mexico reserves to which access is made more difficult or costly by sanctuary expansion, sanctuary regulation would not preclude that possibility.

Table 5.7 Oil and gas industry resources intersected by each alternative (BOEM 2015b).

Alternative	Lease Blocks Intersected	Associated Reserves (BOE MMbbl)	Active Leased Blocks	Lease-holders	Active Platforms	Active Platforms Outside NAZs and Buffer Zones	Platforms Reefed or Wrecked Onsite	Pipeline Miles	All Incidents 1964 to 2012
1	19	5.3	4	2	1	0	0	0.68	0
2	91	10.1	19	8	4	0	0	33.64	0
3	108	13	25	11	5	0	2	73.23	0
4	192	55.2	51	24	8	3	2	157.47	0
5	256	98.9	76	30	11	3	3	270.07	2

One direct, long term, minor adverse socioeconomic impact would occur as a result of NPDES General Permit requirements triggered by sanctuary expansion (see Table 5.3, Row 23). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the extensive oil and gas industry activity in the north central Gulf of Mexico and the factors that minimize and mitigate it as identified below.

The current NPDES General Permits for oil and gas extraction in the Gulf of Mexico do not allow discharges from oil and gas activity within “areas of biological concern” or within national marine sanctuaries. An exception to this prohibition indicates that facilities located within a national marine sanctuary boundary are authorized to discharge in accordance with these permits if all of the following conditions are met: (1) the platform was installed prior to the designation of the national marine sanctuary; (2) the platform is located outside of the NAZ defined by BOEM; (3) all materials are discharged through a shunt pipe that terminates within 10 meters (33 feet) of

the sea floor; (4) sanitary waste is treated with an approved marine sanitation device that complies with pollution control standards and regulations under section 312 of the Clean Water Act; and (5) the materials discharged are associated with and incidental to oil and gas exploration, development or production and originate from wells located within the boundaries of the national marine sanctuary and outside the NAZ. The language of the current NPDES General Permits would thus "grandfather" existing oil and gas platforms if they are in place prior to designation, resulting in continuation of discharges within new sanctuary boundaries, but would preclude discharges from new infrastructure built in any expanded sanctuary boundaries after designation. Though benefits to the water quality and living marine resources in proposed expansion areas will result from the regulation of discharges from oil and gas infrastructure in the expanded sanctuary, this regulation may impose additional costs on the oil and gas industry (e.g., by requiring individual permit applications be made or by requiring "zero discharge" operations within sanctuary boundaries).

Under the various sanctuary expansion alternatives, potential expansion areas overlap existing oil and gas lease blocks, infrastructure (platforms and pipelines) and reserve fields, as indicated in Table 5.7 and Appendix B.

5.3.2.8.5 Shipping

The greatest impact to coral (hard and soft), sponges and other live bottom within 150 feet (46 meters) deep results from anchoring and mooring of large vessels (>100 feet long) (Wilkinson 2002, Dustan and Halas 1987, Davis 1977). The regeneration of the reef after anchor damage may never occur or, even if optimal conditions for regeneration exist, could still take hundreds and perhaps thousands of years for the reef to return to its pre-damage condition (Rogers and Garrison 2001). Anchoring prohibitions in proposed sanctuary expansion areas would prevent such damage but may affect shipping operations by limiting anchoring on shallow features near fairways at the edge of the continental shelf, producing a direct, long-term, localized, minor adverse impact on this user group (see Table 5.3, Row 23). Shipping fairways running close to, and in six instances through, the proposed expansion areas, funnel thousands of ships to ports on the Gulf of Mexico coast annually (see Table 5.7). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity relative to the geographic context across which such anchoring activity can occur along the edge of the continental shelf in the north central Gulf of Mexico.

Table 5.8 Shipping fairways intersected by each alternative (BOEM 2015b).

Alternative	**1**	**2**	**3**	**4**	**5**
Fairway Intersections	0	2	3	5	6

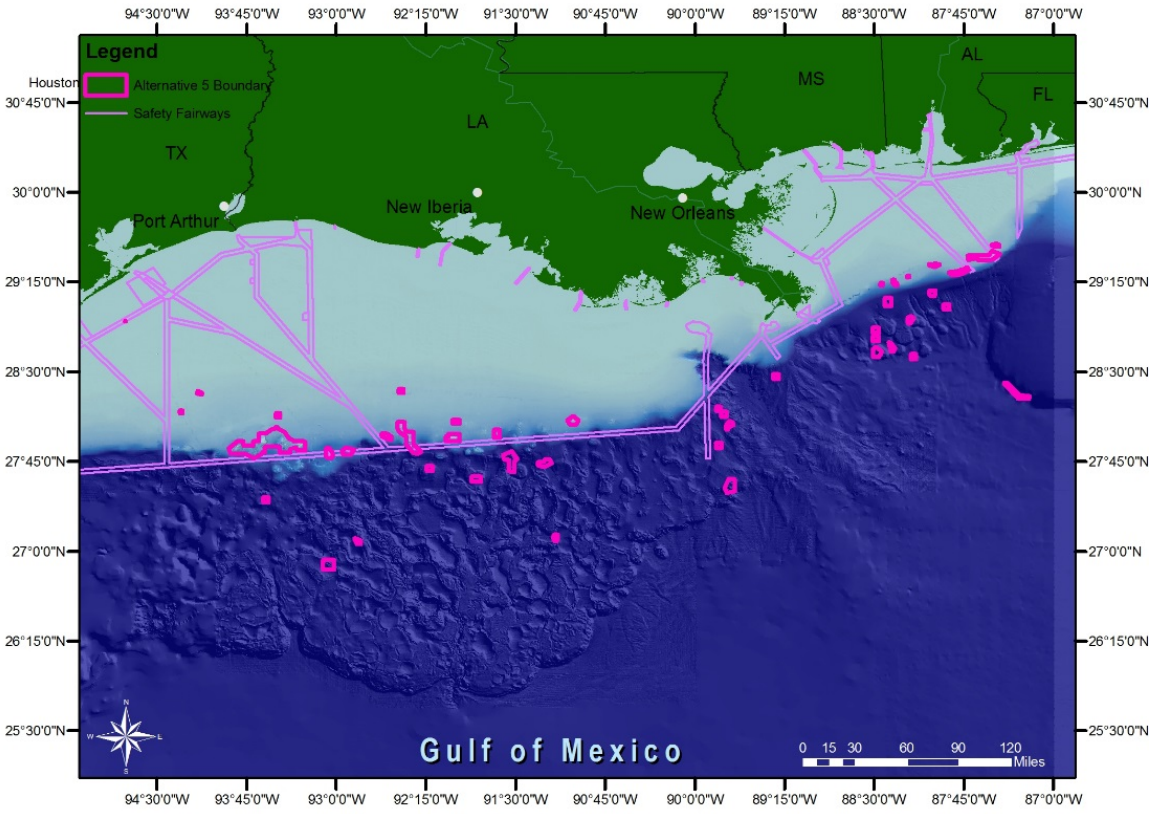

Figure 5.3. Shipping safety fairways in relation to the most comprehensive alternative evaluated in this DEIS (Alternative 5).

Though benefits to the water quality and living marine resources in proposed expansion areas will result from the regulation of discharges from ships passing through the expanded sanctuary (e.g., by precluding the discharge of untreated sewage from holding tanks), this regulation may also impose additional costs on the shipping industry (see Table 5.3, Row 23). This impact is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the geography across which maritime transportation activity occurs in the north central Gulf of Mexico and the limited time ships in transit would be subject to sanctuary regulations due to the discrete nature of the proposed boundaries around protected features. Sanctuary management activities necessary to realize these benefits include coordination with the International Maritime Organization to include new sanctuary boundaries on international nautical charts.

5.3.2.8.6 Passive Economic Use

The added protections provided to proposed expansion areas will significantly increase the benefits to passive economic use for the entire nation. For the additional nine banks in the original FGBNMS Advisory Council alternative alone, passive economic use benefits range from

$16.4 to $18.3 billion over a five-year period using lower bound estimates (Stefanski and Shimshack 2016). These benefits would far exceed both the costs of implementing any of the proposed boundary alternatives, while underestimating the benefits for alternatives 3, 4 and 5, which include resources of greater magnitude than the nine additional banks for which the estimates apply. This direct, long-term, major, beneficial impact extends beyond the proposed boundaries (see Table 5.3, Row 20) and is common to expansion Alternatives 2, 3, 4 and 5 and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives despite its magnitude given the context of the much larger economy of the U. S. to which this benefit accrues.

5.3.3 Cultural and Historic Resources

5.3.3.1 Alternatives 2, 3 and 4

No impacts to cultural or historic resources are anticipated under Alternatives 2, 3 and 4, because no known cultural or historic resources exist within the boundaries proposed for these alternatives (see Table 5.3, Row 24). Should any such resources be discovered within those boundaries in the future, the comprehensive management approach afforded by the NMSA would provide important protections and research capacities allowing for their appropriate conservation and documentation.

5.3.3.2 Alternative 5

Direct, long-term, localized, major beneficial impacts to cultural and historic resources would be generated (see Table 5.3, Row 25) by the resource protection and management activities directed at nationally significant shipwreck sites under Alternative 5 (the USS *Hatteras*, the "Monterrey" wrecks, the *Gulfoil*, the *Gulfpenn*, the S.S. *Robert E. Lee*, the *U-166*, the *Deepwater Horizon*, the "Mardi Gras" wreck and the *Anona*). This impact is unique to expansion Alternative 5, and it is less than significant in the context of the dozens of known and suspected important cultural and historic resource sites in the north central Gulf of Mexico.

These protections would prohibit drilling, dredging, altering, constructing, placing or abandoning any structure material or matter on or in the submerged lands within the proposed expansion area. Any of these activities could potentially disturb, injure or damage submerged historical resources. The NMSA mandates the management and protection of submerged archaeological sites within sanctuary boundaries, but implementing Alternative 5 would likely require a change to sanctuary regulations to specify FGBNMS authority to protect historical resources by prohibiting the possession, moving, removing, injuring, or attempting to possess, move, remove or injure a sanctuary historical resource. With these provisions in place, any potential adverse impacts on historical resources would be negligible. NOAA preservation mandates for maritime archaeological resources derive directly from elements of the Federal Archaeology Program, including the National Historic Preservation Act (NHPA). Section 110 of the NHPA states that each federal agency shall establish a preservation program for the protection of historic

properties. ONMS has conducted research to identify nationally significant submerged cultural resources in the north central Gulf of Mexico.

It is important to note that sunken vessels may contain hazardous cargo, abandoned fuel and unexploded ordnance. The sunken vessels included in this alternative are slowly deteriorating in a corrosive marine environment. For instance, the *Gulfpenn* and *Gulfoil* shipwrecks were both carrying petrochemical loads when they were sunk during WWII, and the *U-166* was armed with 22 torpedoes, among other armaments.

5.3.4 Cumulative Impacts

The CEQ regulations (40 CFR 1508.7) for implementing the provisions of NEPA define cumulative impacts as "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" (CEQ 1997). The regulations further define cumulative impacts as those that can result from individually minor but collectively significant actions that take place over a period of time. The CEQ guidance for considering cumulative effects states that NEPA documents "should compare the cumulative effects of multiple actions with appropriate national, regional, state, or community goals to determine whether the total effect is significant" (CEQ 1997). Under the no action alternative, NOAA would continue to implement sanctuary protections and management activities in the existing sanctuary boundaries. Under Alternatives 2, 3, 4 and 5, NOAA would expand the boundaries of FGBNMS substantially and implement sanctuary protections and management activities in those expanded areas. To date, designations and boundary expansions in the National Marine Sanctuary System have included 14 sites spread throughout the U.S. Exclusive Economic Zone. None of the proposed alternatives would result in an addition of more than 0.5% of the area encompassed by the current National Marine Sanctuary System.

The federal actions considered below are similar to the proposed action, large enough to have far-reaching effects, or are in proximity to the proposed action with similar types of impacts.

5.3.4.1 Cumulative Impact Assessment Methods

CEQ's cumulative effects guidance sets out several different methods for assessment such as checklists, modeling, forecasting and economic impact assessment, where changes in employment, income and population are evaluated (CEQ 1997). This DEIS uses a variety of methods, depending on the resource area, to determine cumulative effects. In general, past, present and future foreseeable actions are assessed by topic area. Cumulative effects may arise from single or multiple actions and may result in additive or interactive effects. Interactive effects may be countervailing, where the adverse cumulative effect is less than the sum of the individual effects, or synergistic, where the net adverse effect is greater than the sum of the individual effects (CEQ 1997). The actions in Table 5.9 are anticipated to occur in the reasonably foreseeable future within the study area. NOAA has considered the effects of these actions in

combination with the impacts of the proposed action to determine the overall cumulative impact on the resources in the study area.

Table 5.9 Actions with Potential to Contribute to Cumulative Impacts

Action	Action Location	Action Agency	Action Description	Projected Completion
BOEM Lease Sales	Gulf-wide	BOEM	BOEM is responsible for all OCS leasing policy and program development issues for oil, gas and other marine minerals, including development of the 5-year plan for permitting geologic and geophysical activities.	Ongoing
EFH and HAPC Designations	Gulf-wide	NMFS/GMFMC	GMFMC is mandated to identify, describe, map and protect EFH. Deep coral HAPCs are currently being evaluated.	Ongoing
NPDES Permit Reviews	Gulf-wide	EPA	5-year review cycle for general permit re-issuance	Ongoing
DWH NRDA, RESTORE, NFWF-GEBF projects	Gulf-wide	NRDA Trustees, RESTORE Council, NFWF, Gulf states, NGO partners	Comprehensive ecosystem restoration for the Gulf of Mexico region.	Ongoing
Other sanctuary nominations, designations, expansions and management activities	Nationwide	ONMS	Proposed designations of NMS in Lake Michigan and Mallows Bay	Ongoing

5.3.4.2 Past, Present and Reasonably Foreseeable Future Actions

The numerous actions that could contribute to cumulative impacts are listed in Table 5.9. This list was compiled based on internal NOAA and partner agency input. Only those actions with potential to contribute to cumulative impacts are listed. These actions are similar in scope to the proposed action, relate to marine activities, have similar types of impacts within the study area, affect similar resources or are large enough to have far-reaching effects on a resource. This approach was taken to include both actions for which detailed descriptions and expected impacts are known, as well as actions that have less defined impacts but may contribute to regional impacts.

As the proposed expansion of the sanctuaries is a regulatory and management action rather than a specific development action, the cumulative effects are related primarily to area-wide management of ocean resources. Several of the projects listed in Table 5.9 are regulatory as well. For purposes of this cumulative analysis, it is assumed that the actions in Table 5.9 would be approved and implemented.

The combination of the alternatives and actions listed in Table 5.9 would result in cumulative beneficial effects in physical, biological and cultural and historic resources. The cumulative actions identified in Table 5.9 would not cause adverse impacts on these resource categories. In other issues, as described below, the proposed alternatives' contribution to any adverse cumulative effects would be minor.

5.3.4.3 Physical and Biological Resources

The proposed sanctuary expansion would not contribute to any substantive adverse impacts on air quality and climate, the noise environment, scenic and visual resources, geology and substrates, water, living marine resources, protected species or cultural and historic resources, as identified above. The proposed alternatives, combined with ongoing BOEM lease sales, EFH and HAPC designations, NPDES permit reviews, DWH NRDA restoration, RESTORE Act projects, NFWF-GEBF projects and other ONMS designations, expansions and management activities would have an overall beneficial cumulative effect on physical and biological resources in the region. The combined resource protections and restoration provided by these actions would result in positive influences on marine habitats and resources (i.e., long-term, moderate beneficial impacts both localized and beyond the proposed boundaries). These cumulative impacts are common to all of the alternatives and proportional to the number of features and areal extent encompassed under each alternative. They are less than significant under any of the alternatives due to their low level of intensity in the context of the wide array of ongoing activities and human uses affecting the physical and biological resources in the Gulf of Mexico region.

5.3.4.4 Marine Area Use, Recreation and Socioeconomics

As identified above, the proposed alternatives would result in beneficial impacts on tourism, recreation, local economics, research, education, and passive economic use. Minor adverse impacts on marine area use, recreation, and socioeconomics may occur as a result of the proposed alternatives due to prohibitions on bottom-disturbing activities, discharges, and certain types of fishing. The actions listed in Table 5.9 are analyzed for significant impacts individually and are not anticipated to cause adverse impacts on socioeconomic resources or human uses in the study area. Their cumulative impacts in combination with any of the alternatives evaluated individually above would not be greater than what was identified for the proposed alternatives. These impacts are less than significant under any of the alternatives due to their low level of intensity in the context of the total marine are use, recreation, and socioeconomic activity in the north central Gulf of Mexico. None of the alternatives or the cumulative actions would contribute to adverse effects on environmental justice (see Executive Order 12898 below).

5.3.4.4.1 Commercial Fishing

The proposed alternatives limit some types of commercial fishing, but would not establish regional closures of fishing grounds or impact other fishery management activities arising from the review process by the GMFMC. The proposed FGBNMS expansion would have beneficial impacts on commercial fisheries and minor adverse impacts on commercial fishing operations, as a result of the proposed fishing, anchoring and discharge regulations. NOAA considered existing HAPCs in developing the alternatives presented in this DEIS. The combination of proposed sanctuary expansion alternatives and proposed HAPC designations may have some adverse cumulative impacts on commercial fishing operators.

The combined expansion of the sanctuary and the HAPC designations would result in a larger area where commercial fishing vessels would be prohibited from using bottom-tending gear or anchoring. However, the overlap between proposed sanctuary expansion boundaries and proposed HAPC area would partially mitigate or minimize this effect. The impacts on commercial fishing from the regulations were identified as minor in Section 5.3.2.8.1. The cumulative effect would also be minor because the proposed FGBNMS expansion area and proposed HAPC areas are relatively small and predominantly overlapping. The nature of this cumulative impact is common to all of the alternatives and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of total commercial fishing activity in the north central Gulf of Mexico and the factors that minimize and mitigate the impact as identified in this paragraph and in the individual impact analysis above.

5.3.4.4.2 Oil and Gas Exploration and Production

The proposed alternatives would not result in the prohibition of offshore oil and gas development in the expansion area, but could make oil and gas exploration more difficult or costly in these areas. This effect was identified as minor in section 5.3.2.8.4. The potential additional burden associated with accessing the small fraction of oil and gas reserves in the proposed expansion areas would have a minor impact on offshore energy development in the context of all Gulf of Mexico OCS oil and gas industry operations. The overall cumulative impact on oil and gas development is minor due to the fact that BOEM lease sales and the associated leasing stipulations and mitigations attached to permits protect topographic features, PSBFs, live bottoms, etc., in the region and will continue for the foreseeable future. The nature of this cumulative impact is common to all of the alternatives and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of total oil and gas exploration and production activity in the north central Gulf of Mexico.

5.3.4.4.3 Shipping

There is the potential for some minor adverse impacts on marine transportation from the combination of the anchoring and discharge regulations in the proposed expansion areas and anchoring restrictions that could derive from proposed deep coral HAPC designations currently

under review by the GMFMC (http://gulfcouncil.org/). The proposed alternatives' impacts on marine transportation were identified as minor in Section 5.3.2.8.5. The incremental increase in impact associated with the cumulative scenario is also considered minor because of the extensive overlap in the areas under consideration for each action and because the discontiguous nature of the areas affected does not preclude ship traffic from anchoring safely or discharging sewage as needed in areas not protected by ONMS or HAPC designations. The nature of this cumulative impact is common to all of the alternatives and proportional to the number of features and areal extent encompassed under each alternative. It is less than significant under any of the alternatives due to its low level of intensity in the context of the extensive geography over which the maritime transportation industry operates in the north central Gulf of Mexico.

5.3.5 Relationship of Short-Term Uses and Long-Term Productivity

NEPA requires consideration of the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity. The short-term uses of the environment relating to each of the alternatives would improve the health and quality of the marine environment by protecting living marine resources and habitats through (1) regulations prohibiting bottom-disturbing activities, discharges into sanctuary waters, certain types of fishing and other regulations; (2) providing a mechanism through the NMSA to respond to groundings and hazardous spills and the introduction and spread of invasive species; and (3) monitoring human activities through regulations and non-regulatory programs that incorporate community involvement in the stewardship of sanctuary resources. Long-term productivity derived from the alternatives is based on the goals of the sanctuary and the suite of Action Plans structured to achieve these goals as identified in the 2012 FGBNMS Management Plan. These include action plans related to the proposed sanctuary expansion, education and outreach, research and monitoring, resource protection, visitor use and operations and administration. Benefits to both short-term uses and long-term productivity based on implementation of sanctuary protections and management actions are proportional to the number of features and areal extent encompassed under each alternative.

5.3.6 Irreversible and Irretrievable Commitments of Resources

NEPA requires an analysis of the extent to which the proposed project's primary and secondary effects would commit nonrenewable resources to uses that future generations would be unable to reverse. The alternatives presented in this DEIS would require minor commitments of both renewable and nonrenewable energy and material resources for the management and research activities associated with the sanctuary. The sanctuary would also commit substantial resources, staff time and funds for conservation and management activities. Nonrenewable resources that would be used during management and research activities include fuel, water, power and other resources necessary to maintain and operate the sanctuary's research vessel and the sanctuary office.

5.3.7 Compliance with All Applicable Environmental Laws and Regulations

The following is a list of general, federal environmental regulations that apply to the proposed action, as well as a description of compliance by NOAA with applicable regulations. NOAA considers and complies with all applicable regulations.

- **National Aquatic Nuisance Prevention and Control Act of 1990, reauthorized by the National Invasive Species Act in 1996:** Establishes the Aquatic Nuisance Species Task Force (ANSTF), which is an intergovernmental organization dedicated to preventing and controlling aquatic invasive species and coordinating government efforts in this regard with those of the private sector and other North American interests. The Undersecretary of Commerce for Oceans and Atmosphere and the Director of the U.S. Fish and Wildlife Service are the ANSTF chairpersons. The proposed sanctuary expansion furthers the objectives of this law by allowing for sanctuary management activities such as the monitoring and removal of invasive lionfish and orange cup coral at and from proposed expansion areas.

- **Clean Water Act, 33 U.S.C. 1251, et seq.**: As described in section 4.6.1.3, above, Congress passed the Water Pollution Prevention and Control Act (Clean Water Act or CWA) in 1972 to protect the quality of the nation's waterways including oceans, lakes, rivers and streams, aquifers, coastal areas, and wetlands, setting out broad rules for protecting the waters of the United States. These guidelines are intended to prevent degradation of the marine environment and require an assessment of the effect of the proposed discharges on sensitive biological communities and aesthetic, recreation and economic values, both directly and as a result of biological, physical and chemical processes altering the discharges. Though some ongoing discharges will continue under current regulations and exemptions to sanctuary prohibitions, none of the alternatives propose to discharge any material into federal waters, and each alternative would reduce potential discharges into federal waters. As such, NOAA has determined that the proposed action furthers the objectives of the CWA and does not require permitting under the CWA.

- **Endangered Species Act:** The ESA requires all federal agencies, in consultation with the Departments of the Interior (USFWS) and Commerce (NMFS), to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or result in the destruction or adverse modification of the critical habitat of such species. For any action with a potential for impacts to federally protected species, NOAA's Office of National Marine Sanctuaries evaluates the potential impacts and, if needed, prepares a biological assessment to inform the biological opinion produced by NOAA's National Marine Fisheries Service. This consultation informs the analysis of impacts on federally listed species to determine their significance. Potential impacts to threatened and endangered species are described in Section 5.2.2.4 above. Based on this evaluation, NOAA believes implementation of the proposed alternatives identified in this

DEIS is not likely to adversely affect any species listed as threatened or endangered, or habitats critical to such species, under the ESA. The proposed alternatives may result in minor benefits to listed species as described in section 5.2.2.4 above. ONMS will confer with NMFS concurrent with public review of this DEIS to ensure that the selected alternative will be compliant with the ESA.

- **Executive Order 13045, Protection of Children from Environmental Health and Safety Risks:** In April 1997, President Clinton signed Executive Order (EO) 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. The EO requires federal agencies to identify, assess and address disproportionate environmental health and safety risks to children from federal actions. The proposed action and alternatives would not result in disproportionate negative impacts on children. Children may benefit from increased education opportunities offered by the sanctuary and from the passive economic use value (bequeath value) to future generations through the protections provided by sanctuary designation.

- **Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations:** Executive Order 12898 directs that the programs of federal agencies identify and avoid disproportionately high and adverse effects on human health and the environment of minority or low-income populations. The designation of national marine sanctuaries by NOAA helps to ensure the enhancement of environmental quality for all populations in the United States. The proposed action and alternatives described in this document would not result in any disproportionate negative impacts on any minority or low-income population, and would result in long-term or permanent beneficial impacts by protecting marine habitats, which provides employment opportunities and results in improved ecosystem services to coastal inhabitants. Minority and low-income populations may benefit from place-based planning efforts that seek to integrate communities into sanctuary management planning.

- **Executive Order 13089, Coral Reef Protection:** Requires that all federal agencies whose actions may affect U.S. coral reef ecosystems in federal, state, territorial or commonwealth waters shall: subject to the availability of appropriations, provide for implementation of measures needed to research, monitor, manage and restore affected ecosystems, including, but not limited to, measures reducing impacts from pollution, sedimentation and fishing. To the extent not inconsistent with statutory responsibilities and procedures, these measures shall be developed in cooperation with the U.S. Coral Reef Task Force and fishery management councils and in consultation with affected states, territorial, commonwealth, tribal and local government agencies, nongovernmental organizations, the scientific community and commercial interests. The proposed sanctuary expansion furthers the goals of this order.

- **Executive Order 13112, Invasive Species:** Directs federal agencies to take actions to enhance prevention and control of invasive species. Specifically the Order states that

each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them. Finally, E.O. 13112 states that federal agencies have an affirmative duty to not authorize, fund or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species. The proposed sanctuary expansion furthers the objectives of this Executive Order by allowing for sanctuary management activities such as the monitoring and removal of invasive lionfish and orange cup coral at and from proposed expansion areas.

- **Executive Order 13186, Migratory Birds:** On January 10, 2001, President Clinton signed Executive Order (EO) 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds." One of the requirements of E.O. 13186 is that each federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations is directed to develop and implement a Memorandum of Understanding (MOU) with USFWS that shall promote the conservation of migratory bird populations (E.O. 13186 Section 3(a)). On July 17, 2012, NMFS and USFWS finalized this MOU to conserve migratory bird populations as prescribed by E.O. 13186. This MOU went into effect on the date it was signed. This NMFS-USFWS MOU encompasses all relevant seabird-related NMFS activities and identifies specific areas of collaboration and cooperation with USFWS, including seabird bycatch reduction, information sharing and coordination, international policy and diplomacy and habitat conservation. The MOU also provides for strengthening migratory bird conservation by identifying strategies that promote conservation and reduce adverse impacts on migratory birds through enhanced collaboration between NMFS and USFWS. In addition, this MOU identifies specific activities where cooperation between NMFS and USFWS will contribute to the conservation of migratory birds and their habitat. These activities are intended to complement and support existing efforts and to facilitate new collaborative conservation efforts for migratory birds. Potential impacts to seabirds have been considered by ONMS as have all protected species impacts, and the proposed alternatives are not anticipated to impact migratory birds.

- **Executive Order 13653, Preparing the United States for the Impacts of Climate Change:** Executive Order 13653 requires each agency to "undertake actions to enhance climate preparedness and resilience." The proposed alternatives provide opportunities to conduct research investigating the impacts of climate change in the marine environment

(e.g., ocean acidification or the ability of corals to survive in low aragonite concentrations), and improves productivity in marine habitats that may increase carbon sequestration.

- **Fish and Wildlife Coordination Act, as amended in 1964:** Requires that all federal agencies consult with NMFS, USFWS and state wildlife agencies when proposed actions might result in modification of a natural stream or body of water. Federal agencies must consider effects that these projects would have on fish and wildlife development and provide for improvement of these resources. The Fish and Wildlife Coordination Act allows NMFS to provide comments to the USACE during review of projects under §404 of the Clean Water Act (concerning the discharge of dredged materials into navigable waters) and §10 of the Rivers and Harbors Act of 1899 (obstructions in navigable waterways). NMFS comments provided under the Fish and Wildlife Coordination Act are intended to reduce environmental impacts to migratory, estuarine, and marine fisheries and their habitats. The proposed alternatives benefit these resources.

- **Magnuson-Stevens Fishery Conservation and Management Act (MSA), Reauthorized by the Sustainable Fisheries Act of 1996:** Congress enacted the MSA to provide the Secretary of Commerce, by and through NMFS, authority to regulate domestic marine fisheries in need of conservation and management. Federal fisheries management is accomplished through Fishery Management Plans (FMPs) developed and prepared by regional Fishery Management Councils (or the Secretary through NMFS where appropriate) and approved, implemented and enforced by NMFS. Each FMP must identify EFH for the fishery and minimize adverse fishing impacts to the extent practicable. In addition, Federal agencies must consult with NMFS on any action that may adversely impact EFH. Sanctuary designation by NOAA supports the goals of this legislation by protecting EFH and contributing to the conservation and management of these species. Fishing regulations promulgated in furtherance of sanctuary designations are required to be considered for implementation by the relevant regional fishery management council. In the case of FGBNMS expansion, the GMFMC will be given the opportunity to adopt such regulation. If the GMFMC fails to act, NOAA may enact such regulation pursuant to the NMSA.

- **Marine Mammal Protection Act of 1972:** 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. Take is defined under the Marine Mammal Protection Act (MMPA) as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 U.S.C. 1362) and is further defined by regulation (50 CFR 216.3) as "to harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. The Secretary of Commerce is responsible for the conservation and management of pinnipeds (other than walruses) and cetaceans. The Secretary of

Commerce delegated MMPA authority to NOAA's NMFS. The Secretary of the Interior (through USFWS) is responsible for walruses, sea and marine otters, polar bears, manatees and dugongs. Title II of the MMPA established an independent Marine Mammal Commission (and its Advisory Committee), which provides independent oversight of the marine mammal conservation policies and programs being carried out by federal regulatory agencies. The Commission is charged with developing, reviewing and making recommendations on domestic and international actions and policies of all federal agencies with respect to marine mammal protection and conservation and with carrying out a research program. The MMPA provides for several exceptions to the moratorium on taking and importation of marine mammals and marine mammal products. NOAA does not believe that the proposed alternatives have the potential to result in the take, injury or harassment of any species protected under the MMPA, and minor benefits to marine mammals may result from the alternatives as described in Section 5.3.2.4.

- **Memorandum on Modification of the Withdrawal of Areas of the United States Outer Continental Shelf from Leasing Disposition (July 14, 2008):** This presidential memorandum withdraws areas of the OCS designated as national marine sanctuaries as of July 14, 2008 from disposition by leasing. The proposed expansion areas evaluated in this DEIS would not receive national marine sanctuary designation prior to July 14, 2008 and would thus not be affected by this withdrawal. The potential for any similar future withdrawals is not proposed and evaluating the potential impact of such an unforeseeable action is not within the scope of the present analysis.

- **Migratory Bird Treaty Act of 1918:** The Migratory Bird Treaty Act authorized federal protection for migratory birds in the United States, and makes it unlawful without a permit from USFWS to pursue, hunt, take, capture, kill or sell birds listed therein ("migratory birds"). The statute does not discriminate between live or dead birds, and gives full protection to any bird parts including feathers, eggs and nests. Over 800 bird species are protected on the list. Expansion of FGBNMS by NOAA will have no impacts on migratory birds.

- **National Historic Preservation Act of 1966:** The NHPA, amended in 1992, requires that responsible agencies taking action that potentially affects any property with historic, architectural, archeological or cultural value that is listed on or eligible for listing on the National Register of Historic Places comply with the procedures for consultation and comment issued by the Advisory Council on Historic Preservation (ACHP). The responsible agency also must identify properties affected by the action that are listed on or potentially eligible for listing on the National Register of Historic Places, usually through consultation with the State Historic Preservation Officer. Section 106 of the NHPA defines requirements and policy for the preservation, restoration and maintenance of the historic and cultural environment of the United States. NOAA complies with Section 106 of NHPA by conducting consultations with the relevant authorities on

historic preservation; since the alternatives evaluated in this DEIS affect only federal waters, NOAA will consult with the ACHP and BOEM regarding the proposed expansion. No adverse impacts to historic or cultural resources are anticipated as a result of any of the alternatives presented in this DEIS.

- **Rivers and Harbors Act of 1899:** The Rivers and Harbors Act of 1899 regulates the following: (1) construction of bridges, causeways, dams or dikes; (2) obstruction of excavations and filling of navigable waters (in offshore areas of the Gulf of Mexico these activities primarily relate to oil and gas industry infrastructure); (3) establishment of harbor lines and conditions related to grants for the extension of piers; and (4) penalties related to the regulated actions, and to the removal of existing structures. No activities regulated under the Rivers and Harbors Act of 1899 are part of the proposed action or any of the alternatives, and the proposed expansion of the existing sanctuary regulatory regime into new areas complements the oversight of dredge and fill activities by the USACE.

5.4 Comparison of Alternatives

Alternative 1, the "No Action" alternative, would not fulfill the purpose described in Section 2.1 or the need described in Section 2.2. Alternatives 2 and 3 would limit the area of expansion to fit within the sanctuary's current operational range and capacity (i.e., using existing staff, facilities, and vessels to conduct management activities), and Alternative 3 would provide the greatest environmental benefit within that range and capacity. Additional resources beyond the current capacity of the FGBNMS would be required to support the more comprehensive Alternatives 4 and 5 described in this DEIS. NOAA's preferred alternative (Alternative 3) consists of modifying the existing Stetson Bank boundary and incorporating East and West Flower Garden Banks in a single new habitat complex area inclusive of Horseshoe Bank. The preferred alternative would also establish seven new discontiguous boundaries encompassing seven individual banks (McGrail, Geyer, Sonnier, Alderdice, MacNeil, Elvers and Parker) and two additional habitat complexes inclusive of multiple reefs and banks (the Bright-Rankin-28 Fathom complex and the Bouma-Bryant-Rezak-Sidner complex). NOAA's preferred alternative would result in a 383.13-square-mile sanctuary (including the existing sanctuary) encompassing 18 significant reef and bank features.

No significant adverse impacts to resources and the human environment are expected under any alternative evaluated to accomplish the proposed action either individually or cumulatively when added to other past, present and reasonably foreseeable future actions. The boundaries proposed under each of the expansion alternatives encompass progressively greater numbers of nationally significant biological and geological features and progressively greater areal extent. Environmental consequences are proportional to the number of features and areal extent encompassed under each alternative. As such, Alternative 5 represents the environmentally preferable alternative under this analysis. However, ONMS has identified Alternative 3 as the agency's preferred alternative (i.e., the alternative that the agency believes would fulfill its

statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors). Alternative 3 provides the greatest environmental benefit that can be managed with current FGBNMS operational capacity and budgetary resources (i.e., using existing staff, facilities, and vessels to conduct management activities in a funding-neutral, or only slightly funding positive, scenario). Long-term beneficial impacts are anticipated if the proposed action is implemented.

Ensuring effective and well-planned operations, human resources and adequate physical infrastructure to support effective management of the sanctuary requires a strong operational foundation to support management goals throughout the areas included in the sanctuary boundaries and the Gulf coast communities with which sanctuary staff engage. Support of on-site management and day-to-day operations requires that highly trained and experienced staff are recruited and supported to implement the activities described in the 2012 FGBNMS Management Plan throughout the current sanctuary and any expanded boundaries. In addition, the appropriate physical infrastructure must be in place to support operations. The sanctuary has offices and facilities, including the sanctuary's research vessel, R/V *Manta*, in Galveston, Texas. The function of these facilities is to provide an effective means to coordinate and communicate with communities, partners and other stakeholders. Adequate staff and infrastructure are critical to successful sanctuary management, providing for research and monitoring, resource protection and education and outreach programs.

While FGBNMS recognizes the significant additional benefits that could be realized under Alternatives 4 and 5, those alternatives cannot be selected as preferred under the relatively funding-neutral scenario that is anticipated. Should additional resources beyond the current capacity of the FGBNMS be made available, further consideration for the inclusion of additional resources included in Alternatives 4 and 5 may be warranted. Specifically, the management and protection of important and vulnerable mesophotic and deep benthic habitat sites and cultural resources across the north central Gulf of Mexico would likely require a sanctuary presence across a larger coastal geography (e.g., additional offices in Louisiana, Mississippi, Alabama or Florida). This would entail additional support for vessel operations, research and monitoring equipment and lab space; additional staff support for sanctuary education and outreach programs; additional support for enforcement of sanctuary regulations, resource protections, management of visitor use across a much larger geographic range and additional operations and administrative support. In short, each of the action plans identified in the 2012 FGBNMS Management Plan would have to be scaled up proportionally to the increased geography included under those alternatives.

In order to maximize resources, NOAA will continue to coordinate and collaborate with partners at the local, state and federal government levels and with academic and non-governmental organizations, utilizing existing infrastructure within each organization to facilitate effective operations. Successful site operations and programs are achieved through a synergy of personnel and available resources. Realizing the progressively greater environmental benefits anticipated from each alternative, proportional to the areas and resources encompassed by the various

expansion alternatives, depends upon sustaining the effective partnership-based management approach FGBNMS has implemented in the existing sanctuary. ONMS has identified Alternative 3 as the preferred alternative based on the determination that the protection of the areas included under that alternative represents the greatest environmental benefit that can be managed in a funding-neutral, or only slightly funding positive, scenario with current or slightly increased levels of support and resource provision from ONMS and partner entities. This matches the purpose for the proposed action described in Chapter 2 of this DEIS to limit the area of expansion to fit within the sanctuary's current operational range and resources (i.e., using existing staff, facilities and vessels to conduct management activities).

Chapter 6

ACKNOWLEDGEMENTS AND LITERATURE CITED

6.1 Acknowledgements

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6.2 Literature Cited

Anderson, L.C. and McBride, R.A. (1996) *Taphonomic and paleoenvironmental evidence of Holocene shell-bed genesis and history of the northeastern Gulf of Mexico shelf*. Palaois (11), 253-63

Badan, A., Candela, J., Sheinbaum, J., and Ochoa, J. (2005) *Upper-layer circulation in the approaches to Yucatan Channel*. Circulation in the Gulf of Mexico: Observations and Models (Geophysical Monograph series), AGU, 161, 57–69

Baillon, S., Hamel, J., Wareham, V.E., and Mercier, A. (2012) *Deep Cold-Water Corals As Nurseries For Fish Larvae*, Frontiers in Ecology and the Environment 10(7), 51–356

Bayer, F. M. (1954) *Anthozoa: Alcyonaria*. In Galtso, P.S. (Ed.), *Gulf of Mexico: its origin, waters, and marine life.* Fishery Bulletin. U.S. Fish and Wildlife Service, 89, 279–284

Boland, G., Current, C., Gravois, M., Metcalf, M. and Peuler, E. (2004) *Fate and Effects of a Spill of Synthetic-Based Drilling Fluid at Mississippi Canyon Block 778, OCS Report MMS 2004-039*. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

Bright, T.J. (1977) *Coral reefs, nepheloid layers, gas seeps, and brine flows on hard banks in the northwestern Gulf of Mexic*o. Proceedings 3rd International Coral Reef Symposium, 1, 40-46

Bright, T.J., McGrail, D.W., Rezak, R., Boland, G.S., and Trippet, A.R. (1985) *The Flower Gardens: A compendium of information.* OCS Study MMS 85-0024. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

Brody, S. D., Grover, H., Bernhardt, S., Tang, Z., Whitaker, B., and Spence, C. (2006) *Identifying potential conflict associated with oil and gas exploration in Texas state coastal waters: a multicriteria spatial analysis*. Environmental Management 38:597-617

Brooke, S., and Schroeder, W.W. (2007) *Chapter 7: State of deep coral ecosystems in the Gulf of Mexico region: Texas to the Florida Straits*. In Lumsden, S.E., Hourigan, T.F., and Bruckner, A.W. (Eds.), *The State of Deep Coral Ecosystems of the United States.* NOAA Technical Memorandum NOS-CRCP-3, Silver Spring, MD

Brooks, J. M., Fisher, C., Roberts, H., Bernard, B., McDonald, I., Carney, R., Joyce, S., Cordes, E., Wolff, G., and Goehring, E. (2014) *Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico.* OCS Study BOEM 2014-650 (Volume 1: Final Report) and BOEM 2014-651 (Volume II: Appendices). U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA

Brooks, J.M., Fisher, C., Roberts, H., Cordes, E., Baums, I., Bernard, B., Church, R., Etnoyer, P., German, C., Goehring, E., McDonald, I., Shank, T., Warren, D., Welsh, S., and Wolff, G. (In Review) *Exploration and research of northern Gulf of Mexico deepwater natural and artificial hard-bottom habitats with emphasis on coral communities: Reefs, rigs, and wrecks - "Lophelia II" Final report.* BOEM Contract M08PC20028. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA

Brown, C., Andrews, K., Brenner, J., Tunnell, J.W., Canfield, C., Dorsett, C., Driscoll, M., Johnson, E., and Kaderka, S. (2011) *Strategy for restoring the Gulf of Mexico (A cooperative NGO report)*. The Nature Conservancy. Arlington, VA

Buhl-Mortensen, L., Vanreusel, A., Gooday, A.J., Levin, L.A., Priede, I.G., Buhl-Mortensen, P., Gheerardyn, H., King, N.J., and Raes, M. (2010) *Biological structures as a source of habitat heterogeneity and biodiversity on the deep ocean margins*. Marine Ecology - An Evolutionary Perspective, 31: 21–50

Bureau of Ocean Energy Management (2015a) *Deep-Water Reconnaissance of Potentially Sensitive Biological Features (PSBF's) Surrounding Shelf-Edge Topographic Banks in the Northern Gulf of Mexico.* OCS Study GM-11-01b. Gulf of Mexico OCS Region, New Orleans, LA

Bureau of Ocean Energy Management (2015b) *Geographic Mapping Data in Digital Format*. Retrieved from http://www.data.boem.gov/homepg/data_center/mapping/geographic_mapping.asp

Bureau of Ocean Energy Management (2015c) *OCS Operations Field Directory*. Gulf of Mexico OCS Region, U. S. Department of Interior.

Bureau of Ocean Energy Management (2015d) *Offshore Statistics by Water Depth*. Retrieved from http://www.data.boem.gov/homepg/data_center/leasing/WaterDepth/wdmaster.asp and http://www.data.boem.gov/homepg/data_center/leasing/WaterDepth/WaterDepth.asp

Bureau of Ocean Energy Management (2015e) *Seismic Water Bottom Anomalies Map Gallery*. Retrieved from http://www.boem.gov/Seismic-Water-Bottom-Anomalies-Map-Gallery/

Cairns, S. D. (1978) *A checklist of the ahermatypic scleractinia of the Gulf of Mexico, with the description of a new species*. Gulf Research Reports, 6(1), 9-15

Cairns, S. D. and Bayer, F.M. (2002) *Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa)*. Proceedings of the Biological Society of Washington, 115, 840–867

Council on Environmental Quality. (1997) *Considering Cumulative Effects Under the National Environmental Policy Act*. Washington, DC

Chowdhury, A.H. and Turco, M.J. (2006) *Geology of the Gulf Coast Aquifer, Texas*. In *Texas Water Development Board Report 365: Aquifers of the Gulf Coast of Texas.* Mace, R.E., Davidson, S.C., Angle, E.S., and Millican, III, W.F. (Eds.) Texas Water Development Board, Austin, TX

Church, R., Warren, D., Cullimore, R., Johnston, L., Schroeder, W., Patterson, W., Shirley, T., Kilgour, M., Morris, N., and Moore, J. (2007) *Archaeological and Biological Analysis of World War II Shipwrecks in the Gulf of Mexico: Artificial Reef Effect in Deep Water*. OCS Study MMS 2007-015. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

Copeland, C. (2008) *Cruise Ship Pollution: Background, Laws and Regulations, and Key Issues.* Report #RL32450. Congressional Research Service. Washington, DC

Cordes, E.E., Bergquist, D.C., Predmore, B.L., Dienes P., Jones, C., Telesnicki, G., and Fisher C.R. (2006) *Alternate unstable states: convergent paths of succession in hydrocarbon-seep tubeworm-associated communities.* Journal of Experimental Marine Biology and Ecology 339, 159-176. doi:10.1016/j.jembe.2006.07.017

Cordes, E.E., McGinley, M.P., Podowski, E.L., Becker, E.L., Lessard-Pilon, S., Viada, S.T., and Fisher, C.R. (2008) *Coral community of the deep Gulf of Mexico*. Deep Sea Research Part I: Oceanographic Research Papers, 55, 777-797

Covington, J. C., Jones, A., and Kaplan, M. (2000) *Economic Analysis of Final Effluent Limitations Guidelines and Standards for Synthetic-Based Drilling Fluids and other Non-Aqueous Drilling Fluids in the Oil and Gas Extraction Point Source Category.* U.S. Environmental Protection Agency Office of Water. Washington, DC

Cox, T. M., Ragen, T. J., Read, A. J., Vos, E., Baird, R. W., Balcomb, K., Barlow, J., Caldwell, J., Cranford, T. W., Crum, L., D'Amico, A., D'Spain, G., Fernández, A., Finneran, J., Gentry, R., Gerth, W., Gulland, F. M. D., Hildebrand, J., Houser, D., Hullar, T., Jepson, P. D., Ketten, D., MacLeod, C. D., Miller, P., Moore, S., Mountain, D. C., Palka, D., Pontganis, P., Rommel, S., Rowles, T., Taylor, B., Tyack, P., Warzok, D., Gisiner, R., Mead, J., and Benner, L. (2006) *Understanding the impacts of anthropogenic sound on beaked whales*. Journal of Cetacean Research & Management 7:177-187

CSA International, Inc. (2007) *Characterization of northern Gulf of Mexico deepwater hard bottom communities with emphasis on Lophelia coral.* OCS Study MMS 2007-044. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

Davis, G.E. (1977) *Anchor damage to a coral reef on the coast of Florida*. Biological Conservation, 11, 29-34

Deepwater Horizon Natural Resource Damage Assessment Trustees. (2016) *Deepwater Horizon oil spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement.* Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

Ditton, R.B. and Baker, T.L. (1999) *Demographics, Attitudes, Management Preferences, and Economic Impact of Sport Divers Using Artificial Reefs in Offshore Texas Waters.* Department of Wildlife and Fisheries Sciences, Texas A&M University. College Station, TX

Doughty C.L., Quattrini A.M., and Cordes E.E. (2014) *Insights into the population dynamics of the deep-sea coral genus Paramuricea in the Gulf of Mexico*. Deep Sea Research Part II: Topical Studies in Oceanography, 99, 71-82

Dustan P. and Halas J.C. (1987) *Changes in the reef-coral community of Carysfort Reef, Key Largo, Florida: 1974 to 1982*. Coral Reefs, 6, 91-106

Edgar, G.J., Banks, S.A., Bessudo, S., Cortés, J., Guzmán, H.M., Henderson, S., Martinez, C., Rivera, F., Soler, G., Ruiz, D., and Zapata, F.A. (2011) *Variation in reef fish and invertebrate communities with level of protection from fishing across the Eastern Tropical Pacific seascape*. Global Ecology and Biogeography, 20(5), 730-743. doi:10.1111/j.1466-8238.2010.00642.x

Energy Information Administration (2014) *Production lookback 2013*. Retrieved from https://www.eia.gov/naturalgas/review/production/2013/

Energy Information Administration (2015a) *Gulf of Mexico Fact Sheet*. Retrieved from http://www.eia.gov/special/gulf_of_mexico/

Energy Information Administration (2015b) *Reduced offshore share in U.S. oil and natural gas production lowers risk from hurricanes*. Retrieved from http://www.eia.gov/todayinenergy/detail.cfm?id=22712

Energy Information Administration (2015c) *Sales of Fossil Fuels Produced from Federal and Indian Lands, FY 2003 through FY 2014*. U. S. Department of Energy, Washington, DC. Retrieved from http://www.eia.gov/analysis/requests/federallands/pdf/eia-federallandsales.pdf

Evans, A. M., Keith, M. E., Voisin, E. E., Hesp, P., Cook, G., Allison, M., da Silva, G., and Swanson, E. (2013) *Archaeological analysis of submerged sites on the Gulf of Mexico Outer Continental Shelf*. OCS Study BOEM 2013-01110. U. S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA

Federal Register. Vol. 66, No. 225, Wednesday, November 21, 2001. *Rules and Regulations*. pp. 58370-58371

Fisher, C.R., Demopoulos A.W.J, Cordes, E.E., Baums, I.B., White, H.K. and Bourque, J.R. (2014a) *Coral Communities as Indicators of Ecosystem-Level Impacts of the Deepwater Horizon Spill*. BioScience, 64(9), 796-807

Fisher, C.R., Hsing, P.-Y., Kaiser, C., Yoerger, D.R., Roberts. H.H., Shedd, W.W., Cordes, E.E., Shank, T.M., Berlet, S.P., Saunders, M.G., Larcom, E.A. (2014b) *Footprint of Deepwater Horizon blowout impact to deep-water coral communities*. Proceedings of the National Academy of Sciences, 111, 11744-11749

Ford, B., Borgens, A., Bryant, W., Marshall, D., Hitchcock, P., Arias, C., and Hamilton, D. (2008) *Archaeological excavation of the Mardi Gras Shipwreck (16GM01), Gulf of Mexico continental slope*. OCS Report MMS 2008-037. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

Formolo, M.J., Lyons, T.W., Zhang, C., Kelley, C., Sassen, R., Horita, J., and Cole, D.R. (2004) *Quantifying carbon sources in the formation of authigenic carbonates at gas hydrate sites in the Gulf of Mexico*. Chemical Geology, 205, 253-264

Frantzis, A. (1998) *Does acoustic testing strand whales?* Nature 392:29

Frederiksen, R., Jensen, A., and Westerberg, H. (1992) *The distribution of the Scleractinian coral* Lophelia pertusa *around the Faroe Islands and the relation to internal tidal mixing*. Sarsia, 77, 157-171

Freiwald, A., Henrich, R., and Pätzold, J. (1997) *Anatomy of a deep-water coral reef mound from the Stjernsund, West Finnmark, Northern Norway*. – In: James, N.P., and Clarke, A.D. (Eds.), *Cool-water carbonates*, SEPM special publication, *56*, 141-162

Fristrup, K. M., Hatch, L. T., and Clark, C. W. (2003) *Variation in humpback whale (*Megaptera novaengliae*) song length in relation to low-frequency sound broadcasts*. Journal of the Acoustical Society of America 113:3411-3424

Gardner, J. V., Dartnell, P., and Sulak, K. J. (2002) *Multi-beam mapping of the Pinnacles Region, Gulf of Mexico*. Open File Report 02-006. U. S. Geological Survey. Retrieved from http://pubs.usgs.gov/of/2002/0006/site/index.html

Gardner, J.V. and Beadoin, J. (2005) *High-Resolution multi-beam bathymetry and acoustic backscatter of selected northwestern Gulf of Mexico outer shelf breaks, Gulf of Mexico*. Science, 23, 5-29

Gass S.E., and Roberts, J.M. (2006) *The occurrence of the cold-water coral* Lophelia pertusa *(Scleractinia) on oil and gas platforms in the North Sea: colony growth, recruitment and environmental controls on distribution*. Marine Pollution Bulletin, 52, 549-559

Gittings, S.R., Bright, T.J., Schroeder, W.W., Sager, W.W., Laswell,J.S., and Rezak, R. (1992) *Invertebrate assemblages and ecological controls on topographic features in the Northeast Gulf of Mexico*. Bulletin of Marine Science, 50(3), 435-455

Guinotte J.M., Orr, J., Cairns, S., Freiwald, A., Morgan, L., and George, R. (2006) *Will human-induced changes in seawater chemistry alter the distribution of scleractinian bioherms?* Frontiers in Ecology and the Environment, 4(3), 141-146

Gulf Coast Ecosystem Restoration Council (2013) *Draft Initial Comprehensive Plan: Restoring the Gulf Coast's Ecosystem and Economy*. Retrieved from http://www.restorethegulf.gov/sites/default/files/Initial%20Comprehensive%20Plan%20Aug%202013.pdf

Gulf Coast Ecosystem Restoration Task Force (2011) Gulf of Mexico Ecosystem Restoration Strategy. Retrieved from http://www.gulfofmexicoalliance.org/pdfs/GulfCoastReport_Full_12-04_508-1_final.pdf

Gulf of Mexico Alliance (2006) *Governors' Action Plan for Healthy and Resilient Coasts*. Retrieved from: http://www.gulfofmexicoalliance.org/pdfs/gap_final2.pdf

Gulf of Mexico Alliance (2009) *Governors' Action Plan II: For Healthy and Resilient Coasts*. Retrieved from: http://www.gulfofmexicoalliance.org/pdfs/ap2_final2.pdf#view=Fit&toolbar=1

Gulf of Mexico Fishery Management Council (1998) *Generic Amendment for Addressing Essential Fish Habitat Requirements in the following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, United States Waters; Red Drum Fishery of the Gulf of Mexico; Reef Fish Fishery of the Gulf of Mexico; Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic; Stone Crab Fishery of the Gulf of Mexico; Spiny Lobster in the Gulf of Mexico and South Atlantic; Coral and Coral Reefs of the Gulf of Mexico*. GMFMC. Tampa, FL

Gulf of Mexico Fishery Management Council (2005) *Final Generic Amendment Number 3 for Addressing Essential Fish Habitat Requirements, Habitat Areas of Particular Concern, and Adverse Effects of Fishing in the following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery of the Gulf of Mexico, United States Waters; Red Drum Fishery of the Gulf of Mexico; Reef Fish Fishery of the Gulf of Mexico; Coastal Migratory Pelagic Resources (Mackerels) in the Gulf of Mexico and South Atlantic; Stone Crab Fishery of the Gulf of Mexico; Spiny Lobster in the Gulf of Mexico and South Atlantic; Coral and Coral Reefs of the Gulf of Mexico*. GMFMC. Tampa, FL

Harborne, A.R., Mumby, P.J., Kappel, C.V., Dahlgren, C.P., Micheli, F., Holmes, K.E., Sanchirico, J.N., Broad, K., Elliott, I.A., and Brumbaugh, D.R. (2008) *Reserve effects and natural variation in coral reef communities*. Journal of Applied Ecology, 45(4), 1010-1018. doi:10.1111/j.13652664.2008.01490.x

Heifetz J., Stone R.P., and Shotwell S.K. (2009) *Damage and disturbance to coral and sponge habitat of the Aleutian Archipelago*. Marine Ecology Progress Series, 397, 295-303.

Hildebrand, J. A. 2004. *Sources of anthropogenic sound in the marine environment*. International Policy Workshop on Sound and Marine Mammals. London, UK

Hourigan, T. F., Etnoyer, P.J., McGuinn, R.P., Whitmire, C., Dorfman, D.S., Dornback, M., Cross, S., and Sallis, D. (2015) *An Introduction to NOAA's National Database for Deep-Sea Corals and Sponges*. NOAA Technical Memorandum NOS NCCOS 191. Silver Spring, MD

Hourigan, T. F., Lumsden, S.E., Dorr, G., Bruckner, A.W., Brooke, S., and Stone, R.P. (2007) *Deep coral ecosystems of the United States: Introduction and national overview*. In Lumsden, S.E., Hourigan, T.F., Bruckner, A.W., and Dorr, G. (Eds.), *The State of Deep Coral Ecosystems of the United States*, U.S. Department of Commerce, NOAA Technical Memorandum CRCP-3, 1-65. Silver Spring, MD

Jeffrey, C.F.G., Leeworthy, V.R., Monaco, M.E., Piniak, G., and Fonseca, M. (2012) *An integrated biogeographic assessment of reef fish populations and fisheries in Dry Tortugas: Effects of No-take Reserves*. NOAA Technical Memorandum NOS NCCOS 111. Silver Spring, MD

Jenkins C. (2011) *Dominant Bottom Types and Habitats*. In *Gulf of Mexico Data Atlas*. National Centers for Environmental Information. Stennis Space Center, MS. Retrieved from: http://gulfatlas.noaa.gov/

Jepson, P. D., Arbelo, M., Deaville, R., Patterson, I. A. P., Castro, P., Baker, J. R., Degollada, E., Ross, H. M., Herráez, P., Pocknell, A. M., Rodríguez, F., Howie, F. E., Espinosa, A., Rieid, R. J., Jaber, J. R., Martín, V., Cunningham, A. A. and Fernández, A. (2003) *Gas-bubble lesions in stranded cetaceans*. Nature 425:575

Ji, Z.-G., Johnson, W. R., Marshall, C. F., and Lear, E. M. (2004) *Oil Spill Risk Analysis: Contingency Planning Statistics for Gulf of Mexico OCS Activities*. OCS Report 2004-026. U. S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Division, Herndon, VA

Ji, Z.-G., Johnson, W. R., Li, Z., Green, R. E., O'Reilly, S. E., and Gravois, M. P. (2012) *Gulf of Mexico Outer Continental Shelf (OCS) Lease Sales, Central and Western Planning Areas, 2012-2017, and Gulfwide OCS Program 2012-2051, OCS Report BOEM 2012-066*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Division, Herndon, VA

Ji, Z.-G., Johnson, W. R., Li, Z., Green, R. E., O'Reilly, S. E., Gravois, M. P., and Murphy, C. (2013) *Gulf of Mexico Outer Continental Shelf (OCS) Lease Sales, Eastern Planning Area, 2012-2017, and Eastern Planning Area OCS Program, 2012-2051, OCS Report BOEM 2013-0110, Revised July 2013*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Environmental Division, Herndon, VA

Johnston, M.A., Nuttall, M.F., Eckert, R.J., Embesi, J.A., Slowey, N.C., Hickerson, E.L. and Schmahl, G.P. (2015) *Long-term monitoring at East and West Flower Garden Banks National Marine Sanctuary, 2011–2012, Volume 1: Technical Report*. OCS Study BOEM 2015-027. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA

Kahng S.E., Garcia-Sais, J.R., Spalding, H.L., Brokovich, E., Wagner, D., Weil, E., Hinderstein, L. and Toonen, R.J. (2010) *Community ecology of mesophotic coral reef ecosystems*. Coral Reefs, 29, 255-275

Kazanis, E. G., Maclay, D.M., and Shepard, N.K. (2015) *Outer Continental Shelf Estimated Oil and Gas Reserves, Gulf of Mexico OCS Region, December 31, 2013. OCS Report BOEM 2015-036*. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region Office of Resource Evaluation, Reserves Section, New Orleans, LA

Kennicutt, M.C., II, (Ed.) (1995) *Gulf of Mexico Offshore Operations Monitoring Experiment, Phase I: Sublethal Responses to Contaminant Exposure. Final Report. OCS Study MMS 95-0045*. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

Kinlan, B., Poti, M., Etnoyer, P., Siceloff, L., Dorfman, J.C.D., and Caldow, C. (2013) *Digital data: Predictive models of deep-sea coral habitat suitability in the U.S. Gulf of Mexico*. Retrieved from: http://coastalscience.noaa.gov/projects/detail?key=35

Kramer, K.L. and Heck, K.L. (2007) *Top-down trophic shifts in Florida Keys patch reef marine protected areas*. Marine Ecology Progress Series, 349, 111-123

Leeworthy, V.R. (2009) *Flower Garden Banks National Marine Sanctuary: Socioeconomic Impacts of Boundary Expansion and Research Area Alternatives, Overview of Some Available Data sources*. Presentation to the Sanctuary Advisory Council, Galveston, TX

Leeworthy, V. R., Schwarzmann, D. and Hernandez, N. (2016) *Socioeconomic Impact Analysis of Boundary Expansion in the Flower Garden Banks National Marine Sanctuary*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD

Leeworthy, V.R. and Wiley, P.C. (2001) *Current Participation Patterns in Marine Recreation, National Survey on Recreation and the Environment 2000*. National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects, November 2001. Silver Spring, MD. Retrieved from http://marineeconomics.noaa.gov/nsre/nsre_2.pdf

Levesque, J.C. and Richardson, A. (2009) *Fisheries and Marine Protected Area Management: A Case Study of the Flower Garden Banks National Marine Sanctuary*. National Ocean Service, Office of National Marine Sanctuaries, Flower Garden Banks National Marine Sanctuary, Galveston, TX

Levesque, J.C. and Richardson, A. (2011) *Characterization of the Recreational Fisheries Associated with the Flower Garden Banks National Marine Sanctuary (USA)*. Wildlife Biological Practices, June (1), 90-115

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. (1998) *Coast 2050: Toward a Sustainable Coastal Louisiana*. Louisiana Department of Natural Resources. Baton Rouge, LA

Ludwick, J.C and Walton, W.R. (1957) *Shelf-edge calcareous prominences in northeastern Gulf of Mexico*. Bulletin of American Association of Petroleum Geologists, 41, 2054-2101

Lumsden S.E., Hourigan T.F., Bruckner A.W., Dorr G. (Eds.) (2007) *The State of Deep Coral Ecosystems of the United States*. NOAA Technical Memorandum CRCP-3. Silver Spring, MD

MacDonald, I. R., (Ed.) (2002) *Stability and Change in Gulf of Mexico Chemosynthetic Communities. Volume II: Technical Report*. OCS Study MMS 2002-036. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

MacDonald, I. R., Schroeder, W. W., and Brooks, J. M. (1995) *Chemosynthetic ecosystems studies, Final Report*. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

MacDonald, I. R., Garcia-Pineda, O. Beet, A. Asl, S. D., Feng, L., Graettinger, G., French-McCay, D., Holmes, J., Hu, C., Huffner, F., Leifer, I, Muller-Karger, F, Solow, A, Silva, M., and Swayze, G. (2015) *Natural and unnatural oil slicks in the Gulf of Mexico*. AGU: Journal of Geophysical Research: Oceans. Vol. 120, No. 12, 8364-8380. doi: 10.1002/2015JC011062

Martin Associates (2015) *The Local and Regional Economic Impacts of the Port of Houston, 2014*. Port of Houston Authority, Houston, TX. Retrieved from http://www.portofhouston.com/static/gen/about-us/Misc/Regional_Economic_Impact_Report_2015.pdf

Maybaum, H. L. (1993). Responses of humpback whales to sonar sounds. Journal of the Acoustical Society of America 94:1848-1849

Miller, P. J. O., Biassoni, N., Samuels, A., and Tyack, P. L. (2000) *Whale songs lengthen in response to sonar*. Nature 405:903

Minerals Management Service (2009) *Notice To Lessees No. 2009-G39 Biologically-Sensitive Underwater Features and Areas. Effective Date: January 27, 2010 Expiration Date: January 26, 2015*. U.S. Department of Interior Minerals Management Service. Gulf of Mexico OCS Region, New Orleans, LA. Retrieved from http://www.bsee.gov/Regulations-and-Guidance/Notices-to-Lessees/2009/09-G39/

Minnery, G.A. (1984) *Distribution, growth rates and diagenesis of coralline algal structures on the Flower Garden Banks, northwestern Gulf of Mexico*. Ph.D. Dissertation, Texas A&M University, Department of Oceanography, College Station, TX

Mission Blue (2016) *Hope Spots*. Sylvia Earle Alliance, Napa, CA. Retrieved from http://mission-blue.org/hope-spots/

Montgomery, J. C., Jeffs, A., Simpson, S. D., Meekan, M. G., and Tindle, C. (2006) *Sound as an orientation clue for the pelagic larvae of reef fish and crustaceans*. Advances in Marine Biology 51: 143-196

Moore, D. R., and Bullis, H. R., Jr. (1960) *A deep-water coral reef in the Gulf of Mexico*. Bulletin of Marine Science of the Gulf and Caribbean, 10, 125-128

Naehr, T. H., Eichhubl, P., Orphan, V., Hovland, M., Paull, C., Ussler, III, W., Lorenson, T.D., and Greene, H.G. (2007) *Authigenic carbonate formation at hydrocarbon seeps in continental margin sediments: a comparative study*. Deep Sea Research Part II: Topical Studies in Oceanography, 54, 1268-1291. doi: 10.1016/j.dsr2.2007.04.010

Nash, U. A. and Sulak, K. J. (2015) GIS determination of the areal extent of off-reef, reef-derived surficial substrate within the Pinnacles polygon - Based on USGS high resolution multibeam sonar (HRMBS) acoustic backscatter data acquired in 2000. USGS Coastal Ecology and Conservation Research Group, Gainesville, FL. Internal Briefing to NRDA TWG, 15 January 2015, 25 pp. Retrieved from https://pub-dwhdatadiver.orr.noaa.gov/dwh-ar-documents/807/DWH-AR0113057.pdf

Nash, U. A. and Randall, M. (2015) GIS determination of the area of high profile (>2 m elevation) reef-top biotope within the Pinnacles polygon - And within potential oil impact zones - Based on USGS high resolution multibeam sonar (HRMBS) mapping. USGS Coastal Ecology and Conservation Research Group, Gainesville, FL. Internal Briefing to NRDA TWG, 21 April 2015, 23 pp. Retrieved from https://pub-dwhdatadiver.orr.noaa.gov/dwh-ar-documents/807/DWH-AR0113034.pdf

National Oceanic and Atmospheric Administration (1998) *Gulf of Mexico Land-Based Pollution Sources Inventory*. National Ocean Service. Retrieved from http://oceanservice.noaa.gov/websites/retiredsites/98gulfmexico.pdf

National Oceanic and Atmospheric Administration (2009) *Final Amendment 1 to the 2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan, Essential Fish Habitat*. National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division, Silver Spring, MD

National Oceanic and Atmospheric Administration (2010a) *NOAA's Next Generation Strategic Plan*. Silver Spring, MD

National Oceanic and Atmospheric Administration (2010b) *NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation*. NOAA Technical Memorandum CRCP 11. Coral Reef Conservation Program, Silver Spring, MD. Retrieved from http://www.coris.noaa.gov/activities/deepsea_coral/dsc_strategicplan.pdf

National Oceanic and Atmospheric Administration (2011a) *Mesophotic Coral Ecosystems*. Retrieved from https://coastalscience.noaa.gov/research/scem/coral/mce and http://coralreef.noaa.gov/aboutcorals/coral101/mesophotic/

National Oceanic and Atmospheric Administration (2011b) *The Gulf of Mexico at a Glance: A Second Glance*. National Ocean Service. Retrieved from http://sero.nmfs.noaa.gov/outreach_education/gulf_b_wet/applying_for_a_gulf_b_wet_grant/documents/pdfs/noaas_gulf_of_mexico_at_a_glance_report.pdf

National Oceanic and Atmospheric Administration (2012a) *Fisheries Economics of the United States, 2011*. NOAA Tech. Memo. NMFS-F/SPO-118. National Marine Fisheries Service, Silver Spring, MD Retrieved from https://www.st.nmfs.noaa.gov/Assets/economics/documents/feus/2011/FEUS%202011-Revised.pdf

National Oceanic and Atmospheric Administration (2012b) *Flower Garden Banks National Marine Sanctuary Final Management Plan*. Office of National Marine Sanctuaries. U.S. Department of Commerce, Silver Spring, MD

National Oceanic and Atmospheric Administration (2012c) *NOAA, BOEM: Historic, 19th Century Shipwreck Discovered in northern Gulf of Mexico*. Retrieved from www.noaanews.noaa.gov/stories2012/20120516_okeanusexplorer.html

National Oceanic and Atmospheric Administration (2014) *Okeanos Explorer: Exploration of the Gulf of Mexico 2014*. Retrieved from http://oceanexplorer.noaa.gov/okeanos/explorations/ex1402/welcome.html

National Oceanic and Atmospheric Administration (2015a) *Essential Fish Habitat GIS Shapefiles*. National Marine Fisheries Service. Retrieved from http://www.nmfs.noaa.gov/sfa/hms/documents/fmp/am1/shapefiles.html

National Oceanic and Atmospheric Administration (2015b) *GIS Data for Gulf of Mexico EFH and HAPC*. National Marine Fisheries Service. Retrieved from sero.nmfs.noaa.gov/maps_gis_data/habitat_conservation/efh_gom/

National Oceanic and Atmospheric Administration (2015c) *Threats to Deep-Sea Corals*. Retrieved from http://coralreef.noaa.gov/deepseacorals/about/threats/

National Oceanic and Atmospheric Administration (2015d) *U. S. Coastal Relief Model*. National Centers for Environmental Information. Retrieved from http://www.ngdc.noaa.gov/mgg/coastal/crm.html

National Park Service (2015) *Mississippi River Facts*. Retrieved from http://www.nps.gov/miss/riverfacts.htm

Normandeau Associates, Inc. (2012) *Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities.* A Workshop Report for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract #M11PC00031

Nowacek, D. P., Thorne, L.H., Johnston, D.W. and Tyack, P.L. (2007) *Responses of cetaceans to anthropogenic noise*. Mammal Review 37(2):81-115

Peterson, C. H., Coleman F.C., Jackson, J.B.C., Turner, R.E., Rowe, G.T., Barber, R.T., Bjorndal, K.A., Carney, R.S., Cowen, R.K., Hoekstra, J.M., Hollibaugh, J.T., Laska, S.B., Luettich Jr., R.A., Osenberg, C.W., Roady, S.E., Senner, S., Teal, J.M., and Wang, P. (2011) *A Once and Future Gulf of Mexico Ecosystem: Restoration Recommendations of an Expert Working Group*. Pew Environment Group. Washington, DC

Pirotta, E., Milor, R., Quick, N., Moretti, D., Di Marzio, N., Tyack, P., Boyd, I., and Hastie, G. (2012) *Vessel noise affects beaked shale behavior: Results of a dedicated acoustic response study*. PLoS ONE 7:e42535

Port of Galveston (2015) *Statistics*. Retrieved from http://www.portofgalveston.com/index.aspx?nid=122

Port of Houston (2015) *Overview*. Retrieved from http://www.portofhouston.com/about-us/overview/

Port of New Orleans (2015) *Port Statistics*. Retrieved from http://www.portno.com/port-statistics

Prouty, N., Roark, E., Buster, N., and Ross, S. (2011) *Growth rate and age distribution of deep-sea black corals in the Gulf of Mexico*. Marine Ecology Progress Series, 423, 101–115. doi:10.3354/meps08953

Puglise K.A., Hinderstein L.M., Marr J.C.A., Dowgiallo M.J., and Martinez F.A. (2009) *Mesophotic Coral Ecosystems Research Strategy: International Workshop to Prioritize Research and Management Needs for Mesophotic Coral Ecosystems, Jupiter, FL, 12-15 July 2008*. NOAA National Centers for Coastal Ocean Science, Center for Sponsored Coastal Ocean Research, and Office of Ocean Exploration and Research, NOAA Undersea Research Program. NOAA Technical Memorandum NOS NCCOS 98 and OAR OER 2. Silver Spring, MD

Pyle, R.I. (1996) *The twilight zone*. Natural History, 105, 59-62

Ramseur, J. L. (2012) *Controlling Air Emissions from Outer Continental Shelf Sources: A Comparison of Two Programs – EPA and DOI*. Congressional Research Service Report for Congress R42123

Reed, J.K. (2002) *Comparison of Deep-Water Coral Reefs and Lithoherms off southeastern U.S.A.* Hydrobiologia 471, 57-69

Rezak, R. and Bright, T.J. (1981) *Northern Gulf of Mexico Topographic Features Study: Final Report*. BLM, contract No. AA551-CT8-35. Texas A&M Research Foundation and Texas A&M University, Department of Oceanography. College Station, TX

Rezak, R., Bright, T.J., McGrail, D.W. (1983) *Reefs and Banks of the Northwestern Gulf of Mexico: Their Geological, Biological, and Physical Dynamics*. Texas A & M University Department of Oceanography. MMS Technical Report No. 83-1-T. U. S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA

Rezak, R., Bright, T.J., McGrail, D.W. (1985) *Reefs and Banks of the Northwestern Gulf of Mexico: Their Geological, Biological, and Physical Dynamics*. John Wiley and Sons, New York, NY

Rezak, R., Gittings, S.R., and Bright, T.J. (1990) *Biotic assemblages and ecological controls on reefs and banks of the northwest Gulf of Mexico.* American Zoologist, 30, 23-35

Ribes, M., Coma, R., and Gili, J.M. (1999) *Heterogeneous feeding in benthic suspension feeders: the natural diet and grazing rate of the temperate gorgonian* Paramuricea cravat *(Cnidaria: Octocorallia) over a year cycle.* Marine Ecology Progress Series, 183, 125-137

Richardson, W. J., Greene Jr., C. R., Malme, C. I., and Thomson, D. H. (1995) *Marine mammals and noise*. Academic Press, San Diego, CA

Roberts, D. J. and Nguyen, A. H. (2006) *Degradation of Synthetic-Based Drilling Mud Base Fluids by Gulf of Mexico Sediments, Final Report: OCS Study MMS 2006-028*. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA

Roberts J. M., Long D., Wilson J.B., Mortensen P.B., and Gage J.D. (2003) *The cold-water coral* Lophelia pertusa *(Scleractinia) and enigmatic seabed mounds along the north-east Atlantic margin: are they related?* Marine Pollution Bulletin, 46, 7-20

Roberts, J. M., Wheeler, A. J., and Freiwald, A. (2006) *Reefs of the deep: the biology and geology of cold-water coral ecosystems*. Science, 312, 543-547

Rogers C.S. and Garrison, G. (2001) *Ten years after the crime: lasting effects of damage from a cruise ship anchor on a coral reef in St. John*. Bulletin of Marine Science 69: 793-803

Rolland, R. M., Parks, S. E., Hunt, K. E., Castellote, M., Corkeron, P. J., Nowacek, D. P., Wasser, S. K., and Kraus, S. D. (2012) *Evidence that ship noise increases stress in right whales*. Proceedings of the Royal Society B 279:2363-2368

Schmitz, Jr., W. J., Biggs, D.C., Lugo-Fernández, A., Oey, L.-Y, and Sturges, W. (2005) *A synopsis of the circulation in the Gulf of Mexico and on its continental margins*. In Sturges W., and Lugo-Fernández, A. (Eds.), *Circulation in the Gulf of Mexico: Observations and Models*, Geophysical Monograph Series, 161, 11–29, AGU, Washington, DC

Schroeder, W. W., Brooke, S. D., Olson, J.B., Phaneuf, B., McDonough, III, J. J., and Etnoyer, P. (2005) *Occurrence of deep-water* Lophelia pertusa *and* Madrepora oculata *in the Gulf of Mexico*. In Freiwald, A. and Roberts, J. M. (Eds.), Cold-water corals and ecosystems, 297-307. Berlin

Schroeder, W.W. (2002) *Observations of* Lophelia pertusa *and the surficial geology at a deep-water site in the northeastern Gulf of Mexico*. Hydrobiologia, 471, 29-33

Selig, E.R. and Bruno, J.F. (2010) *A global analysis of the effectiveness of marine protected areas in preventing coral loss*. PLoS One, 5(2). doi:10.1371/journal.pone.0009278

Simmonds, M. P. and Lopez-Jurado, L. F. (1991) *Whales and the military*. Nature 351:448

Stefanski, S.F. and Shimshack, J.P. (2016) *Valuing Marine Biodiversity in the Gulf of Mexico: Evidence from the Proposed Boundary Expansion of the Flower Gardens Bank National Marine Sanctuary*. Marine Resource Economics, (31)2

Sturges, W., and Lugo-Fernandez, A. (Eds.) (2005) *Circulation in the Gulf of Mexico: Observations and Models*. Geophysical Monograph Series, 161, AGU, Washington, DC

Sulak, K.J., Brooks, R.A., Luke, K.E., Norem, A.D., Randall, M.T., Quaid, A.J., Yeargin, G.E., Miller, J.M., Harden, W.M., Caruso, J.H. and Ross, S.W. (2008) *Demersal fishes associated with* Lophelia pertusa *coral and associated biotopes on the continental slope, Northern Gulf of Mexico*. In: Sulak, K.J., Randall, M.T., Luke, K.E., Norem, A.D., and Miller, J.M.(Eds.) *Characterization of Northern Gulf of Mexico Deepwater Hard Bottom Communities with Emphasis on Lophelia Coral - Lophelia Reef Megafaunal Community Structure, Biotopes, Genetics, Microbial Ecology, and Geology.* USGS Open-File Report 2008-1148. OCS Study MMS 2008-015. Minerals Management Service, New Orleans, LA

Sulak, K.J. and Dixon, P.M. (2015) *Change in Gulf of Mexico mesophotic reef fish community structure across the time threshold of the Deepwater Horizon oil spill event in 2010: Mesophotic reef fish community impacts of the DWH oil spill*. DWH Deepwater Benthic NRDA Technical Working Group Report

Thiel, V., Peckmann, J., Richnow, H. H., Luth, U., Reitner, J. and Michelis, W. (2001) *Molecular signals for anaerobic methane oxidation in Black Sea seep carbonates and microbial mat*. Marine Chemistry, 73, 97–112

Thresher, R.E., Guinotte, J.M., Matear, R.J., and Hobday. A.J. (2015) *Options for managing impacts of climate change on a deep-sea community*. National Climate Change, 5, 635–639

Thompson, M. J., Schroeder, W. W., Phillips, N. W., and Graham, B. D. (1999) *Ecology of Live Bottom Habitats of the Northeastern Gulf of Mexico: A Community Profile*. USGS Contractor Report 1999-0001 and MMS Study OCS-99-0004. U. S. Department of the Interior, U. S. Geological Survey, Biological Resources Division, and Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA

Turner, R. E.and Cahoon, D.R. (Eds.) (1987) *Causes of Wetland Loss in the Coastal Central Gulf of Mexico. Volume I: Executive Summary.* Final Report, Contract No. 14-12-0001-30252. OCS Study/MNIS 87-0119. Minerals Management Service, New Orleans, LA

Veil, J. A. (2008) *Comparison of Two International Approaches to Controlling Risk from Produced Water Discharges*. Argonne National Laboratory. Presetation to the NEL Produced Water Workshop, Aberdeen, Scotland

Veil, J. A., Puder, M. G., Elcock, D., and Redweik, Jr., R. J. (2004) *A White Paper Describing Produced Water from Production of Crude Oil, Natural Gas, and Coal Bed Methane*. Prepared by Argonne National Laboratory for the U. S. Department of Energy National Energy Technology Laboratory, Contract W-31-109-Eng-38

Vermeij, M. J. A., Marhaver, K. L., Huijbers, C. M., Nagelkerken, I., and Simpson, S. D. (2010) *Coral Larvae Move Toward Reef Sounds*. PLoS ONE 5(5): e10660. Doi: 10.1371/journal.pone.0010660

Weaver, D.C., Dennis, G.D., and Sulak, K.J. (2001) *Northeastern Gulf of Mexico Coastal and Marine Ecosystem Program: Community Structure and Trophic Ecology of Demersal Fishes on Pinnacles Reef Tract; Final Synthesis Report*. OCS Study MMS 2002-034. U.S. Department of Interior, Geological Survey, USGS BSR-2001-0008 and Minerals Management Service Gulf of Mexico OCS Region, New Orleans, LA

White, H. K., Hsing, P.-Y., Cho, W., Shank, T. M., Cordes, E. E., Quattrini, A. M., Nelson, R.K., Cmilli, R., Demopoulos, A.W.J., German, C.R., Brooks, J.M., Roberts, H.H., Shedd, W., Reddy, C.M., and Fisher, C. R. (2012) *Impact of the Deepwater Horizon oil spill on a deep-water coral community in the Gulf of Mexico*. Proceedings of the National Academy of Sciences of the United States of America, 109(50), 20303–20308

Wilkinson, C.R. (Ed.) (2002) *Status of coral reefs of the World: 2002*. Australian Institute of Marine Science, Townsville, Australia

Wilson, D., Billings, R., Oommen, R., Lange, B., Marik, J., McClutchey, S., and Perez, H. (2010) *Year 2008 Gulfwide Emission Inventory Study: Final Report*. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2010-045

Wolfe, K.E. (2010*) Estimation of Shunting Costs Resulting from Buffer Expansion in the Flower Gardens Banks and 28 Fathom Banks National Marine Sanctuary*. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD

Yoskowitz, D., C. Leon, J. Gibeaut, B. Lupher, M. Lopez, C. Santos, G. Sutton, and McKinney, L. (2013) *Gulf 360: State of the Gulf of Mexico*. Harte Research Institute for Gulf of Mexico Studies, Texas A&M University at Corpus Christi. Corpus Christi, TX

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