National Marine Fisheries Service
Endangered Species Act Section 7
Biological Opinion

Title: Biological Opinion on the Federally Regulated Oil and Gas Program Activities in the Gulf of Mexico

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

Action Agencies: Bureau of Ocean Energy Management, Bureau of Safety and Environmental Enforcement, U.S. Environmental Protection Agency, and NMFS' Permits and Conservation Division

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

LIST OF ACRONYMS

ACP	Area Contingency Plan
AHTS	Anchor-Handling Towing Supply
APD	Application for Permit to Drill
BA	Biological Assessment
Bbl	Barrels of Oil
BACT	Best Available Control Technology
BMP	Best Management Practice
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
BOP	Blowout Preventer
BSEE	Bureau of Environmental Safety and Enforcement
CAA	Clean Air Act
CCL	Curved Carapace Length
CER	Categorical Exclusion Review
CFR	Code of Federal Regulations
CIE	Center for Independent Experts
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSEM	Controlled Source Electromagnetic Survey
CPA	Central Planning Area
cSEL	Cumulative Sound Exposure Level
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DOCD	Development Operations and Coordination Document
DOT	Department of Transportation
DPP	Development and Production Plan
DPS	Distinct Population Segment
DWH	Deepwater Horizon
DWOP	Deepwater Operations Plan
DWOP	Deep Water Operations Plan
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EP	Exploration Plan
EPA	Eastern Planning Area
EROS	Explosive Removal of Offshore Structures
ESA	Endangered Species Act
FAZ	Full Azimuth
FPSO	Floating Production and Storage and Off-loading Units
G&G	Geological and Geophysical
HRG	High-resolution Geophysical Survey

ITS	Incidental Take Statement
LAA	Likely to Adversely Affect
LADC	Littoral Acoustic Demonstration Center
MARPOL	International Convention for the Prevention of Pollution from Ships
MAZ	Multi-Azimuth
mDNA	Mitochondrial DNA
MODU	Moble Offshore Drilling Unit
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
nDNA	Nuclear DNA
NEPA	National Environmental Policy Act
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service
NOAA	National Atmospheric and Oceanic Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NTL	Notice to Lessees and Operators
NUT	New or Unusual Technology
OBC	Ocean Bottom Cable
OBF	Oil-Based Fluid
OBN	Ocean Bottom Node
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OPA	Oil Pollution Act
OSRP	Oil Spill Response Plan
OSV	Offshore Supply Vessel
PAH	Poly-cyclic Aromatic Hydrocarbon
PAM	Passive Acoustic Monitoring
PCB	Polychlorobiphenyl
PDARP	Programmatic Damage Assessment and Restoration Plan
PDC	Project Design Criteria
PEIS	Programmatic Environmental Assessment
PINC	Potential Incident of Non-Compliance
PM	Particulate Matter
PSD	Prevention of Significant Deterioration
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
RDX	Royal Demolition Explosive or Cyclonitrite
RMS	Root Mean Square
ROV	Remotely-Operated Vehicle
RPM	Reasonable and Prudent Measure
SCL	Straight Carapace Length
SEL	Sound Exposure Level

SEMS	Safety and Environmental Management Systems
sSEL	Sound Exposure Level from a Single Pile-Driving Strike
TCW	Treatment Completion and Workover
TED	Turtle Excluder Device
TNT	Trinitrotoluene
TTS	Temporary threshold shift
USACE	U.S. Army Corps of Engineers
USDOC	U.S. Department of Commerce
DOI	U.S. Department of the Interior
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UWC	Underwater Calculator
VSP	Vertical Seismic Profile
VOC	Volatile Organic Compound
WAZ	Wide Azimuth
WBF	Water-Based Fluid
WCD	Worst-Case Discharge
WPA	Western Planning Area
ZOI	Zone of Influence

1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 USC §1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitats they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with the National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 CFR §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS concurs with that determination for species under NMFS jurisdiction, consultation concludes informally (50 CFR §402.14(b)). The Federal action agency shall confer with the NMFS for species under NMFS jurisdiction on any action which is likely to jeopardize the continued existence of any species proposed to be listed or result in the destruction or adverse modification of proposed critical habitat (50 CFR §402.10).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize ESA-listed species or destroy or adversely modify critical habitat, NMFS provides a Reasonable and Prudent Alternative (RPA) that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures.

Updates to the regulations governing interagency consultation (50 C.F.R. 402) are effective on October 28, 2019 (84 FR 44976). This consultation was pending at the time the regulations became effective and we are applying the updated regulations to the consultation. As the preamble to the final rule adopting the regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice." We have reviewed the information and analyses relied upon to complete this biological opinion (opinion) in light of the updated regulations and conclude the opinion is fully consistent with the updated regulations.

The action agencies for this consultation are the United States (U.S.) Bureau of Ocean Energy Management (BOEM), the U.S. Bureau of Safety and Environmental Enforcement (BSEE), U.S. Environmental Protection Agency (USEPA), and NMFS' Office of Protected Resources, Permits and Conservation Division. The proposed action for this consultation includes all activities associated with the Outer Continental Shelf (OCS) oil and gas program in the Gulf of Mexico (hereafter referred to as "**Oil and Gas Program**" in this opinion).

Oil and Gas Program activities include actions associated with all past leases operating in the Gulf of Mexico at the time this opinion is issued, regardless of when the lease was awarded, and actions associated with new leases awarded in the Gulf of Mexico in the first ten years following issuance of this opinion (through approximately 2029). Each lease is projected to have a 40-year lifespan. Thus, the proposed action is projected to cover 50 years (through approximately 2069). Oil and Gas Program activities include pre-lease activities related to geological and geophysical (G&G) surveys conducted under permits, prior to leasing, and activities associated with end-of-lease-life structure and equipment removal (decommissioning). This programmatic consultation considers all permitted actions and plans (approved by BOEM and BSEE) under the OCS Lands Act (43 USC §1331 et seq. (2008); OCSLA), and by the U.S. Environmental Protection Agency (USEPA) under the Clean Air Act (CAA), and by USEPA under the Clean Water Act (CWA). This consultation also considers the promulgation of Federal regulations under the Marine Mammal Protection Act (MMPA) for the incidental take of marine mammals due to G&G surveys specific to the proposed Oil and Gas Program activities and subsequent issuance of letters of authorization by NMFS' Permits and Conservation Division.

This consultation, biological opinion (opinion), and incidental take statement (ITS), were completed by NMFS Office of Protected Resources Endangered Species Act Interagency Cooperation Division (hereafter referred to as "we") in accordance with section 7(a)(2) and 7(b) of the statute (16 USC §1536 (a)(2)), associated implementing regulations (50 CFR §402), and agency policy and guidance.

This document represents NMFS' opinion on the effects of the above actions on Gulf of Mexico Bryde's whales (*Balaenoptera edeni*), sperm whales (*Physeter macrocephalus*), Kemp's ridley sea turtles (*Lepidochelys kempii*), loggerhead sea turtles (Northwest Atlantic Distinct Population Segment [DPS], *Caretta caretta*), green sea turtles (North Atlantic DPS and South Atlantic DPS, *Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), leatherback sea turtles (*Dermochelys coriacea*), Gulf sturgeon (*Acipenser oxyrinchus desotoi*), oceanic whitetip shark (*Carcharhinus longimanus*), giant manta ray (*Manta birostris*), and designated critical habitat for Gulf sturgeon and loggerhead sea turtles.

1.1 Background

Collectively, BOEM and BSEE were historically part of a single agency known as the Minerals Management Service (MMS), which was renamed the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) on June 18, 2010. BOEMRE was reorganized, effective October 1, 2011, into the separate agencies of BOEM and BSEE. BOEM and BSEE (through their predecessor agencies) have historically consulted with NMFS under section 7 of the ESA on lease sales and five-year leasing plans in the Gulf of Mexico. Many of the leases associated with those lease sales continue to be active. The most recent consultation with NMFS resulted in a biological opinion issued in June 2007 (NMFS 2007). NMFS also issued a separate opinion for decommissioning activities in 2006, and amended that opinion's ITS to include take of sperm whales in 2008 following issuance of the MMPA take authorization (as noted below in Table 1).

On April 20, 2010, the Deepwater Horizon (DWH) mobile offshore drilling unit, a dynamically positioned semisubmersible exploratory drilling rig owned by Transocean Ltd. and leased to BP Public Liability Company, exploded at approximately 9:48 p.m. CDT and began to burn uncontrollably. The explosion occurred within BP's exploration prospect, Macondo, located on a lease in the Mississippi Canyon Block 252, about 53 miles (85 kilometers) southeast of the nearest land at the end of the Mississippi River's Bird's Foot Delta. The rig burned for 36 hours and, after a final explosion, sank on April 22, 2010, at 10:22 a.m. CDT in 4,992 feet (1,521 meters) of water with approximately 700,000 gallons of diesel fuel on board. Eleven crew members were killed in the explosion. According to the *Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan (PDARP)*, 3.19 million barrels of oil (Mbbl) were released into the ocean (Trustees 2016).

Table 1. Completed biological opinions this consultation and biological opinion supersedes.

BOEM/BSEE ACTION	CONSULTATION DATE
Lease Sale 58	1979
Lease Sale 90	July 5, 1984
Lease Sales 110, 112	November 21, 1986
Lease sales 113, 115, 116	November 2, 1987 NMFS again confirmed concurrence on LS 116 on January 9, 2002.
Lease Sales 118, 122	August 8, 1988
Lease Sales 131, 135, 137	April 9, 1990
Lease Sale 139	February 8, 1991
Lease Sales 142, 143	August 17, 1992
Lease Sales 147, 150	July 30, 1993
Lease Sale 152, 155	October 13, 1994
Reinitiation on Lease sales from 1998-2001	December 10, 1997
Lease Sales 169, 171, 172, 174, 175, 177, 178, 180, 182	January 6, 1998 (replaced the November 2, 1987 opinion) LS 179 added to multi-year plan, NMFS concurred January 15, 1982 NMFS again reviewed LS 174 on March 29, 1996; LS 172 on November 6, 1998; LS 177 on March 30, 2000; and LS 180 on June 14, 2001.
Lease Sale 175	October 27, 1999
Destin Dome	April 13, 2000
Lease Sale 178	November 2, 2000
FPSOS (Floating, Production, Storage, and Off-loading Systems) EIS for the OCS.	November 30, 2000
Lease Sale 181	June 15, 2001
Lease Sale 184	July 11, 2002

BOEM/BSEE ACTION	CONSULTATION DATE
Lease Sales 185, 190, 194, 198, 201, 187, 192, 196, 200	November 29, 2002
Lease Sales 189 and 197	August 30, 2003
Programmatic Decommissioning Activities.	August 28, 2006 (replaced all previous decommissioning and abandonment opinions) ITS amended June 20, 2008
Lease Sales 204, 205, 206, 207, 208, 210, 213, 215, 216, 218, 222	June 29, 2007 BOEM added Lease Sale 224 to the 5-year plan and NMFS reviewed on October 9, 2007.

On June 30, 2010, the Natural Resources Defense Council (NRDC) and other environmental non-governmental organizations (NGOs) (the plaintiffs) filed suit [NRDC v. Salazar, No. 2:10-cv-01882 (E.D. La.)] against the U.S. Department of the Interior (DOI), alleging BOEM (then BOEMRE) was in violation of the National Environmental Policy Act (NEPA) by issuing authorizations for seismic surveys in the Gulf of Mexico. A settlement agreement was entered on June 25, 2013. The agreement stayed the litigation and required that BOEM make its best effort to facilitate completion of Final Action on its MMPA application during the stay. If such final action was issuance of an MMPA take authorization, it would be accompanied by:

- Completion of an Environmental Impact Statement (EIS)/Record of Decision or Environmental Assessment (EA)/Finding of “No Significant Impact” for G&G activities in the Gulf of Mexico in support of MMPA application (i.e., Programmatic EIS or PEIS)
- Conclusion of ESA consultation pursuant to section 7 through either the issuance of an ESA biological opinion or a “not likely to adversely affect” concurrence letter from NMFS.

The duration of the stipulated stay was extended by joint agreement of the parties and approval by the court several times. On September 27, 2017, the court approved the parties motion for approval of the second stipulated amendment of the settlement agreement. This amendment continues the stay of litigation until November 1, 2018, and allowed plaintiffs to amend their lawsuit to include NMFS as a defendant based on a claim of undue delay in making a determination on BOEM’s MMPA permit application. In addition to the continuing obligations on BOEM listed above, the subsequent amendment required that by March 13, 2020, NMFS complete any of the following final actions on BOEM’s permit application: (1) a final decision by NMFS denying BOEM’s MMPA Application; (2) BOEM’s withdrawal of the Pending Application or any revision thereof, unless a revised application that is substantively the same in scope as the Pending Application is submitted to NMFS within 14 days after the Pending Application or any revision thereof is withdrawn; or (3) NMFS’s submission of a final MMPA rule or regulation to the Federal Register in response to BOEM’s MMPA Application, preceded or accompanied by (a) a biological opinion or “not likely to adversely affect” concurrence letter from NMFS concluding consultation pursuant to Section 7(a)(2) of the ESA and (b) an

Environmental Impact Statement (“EIS”)/Record of Decision (“ROD”) or Environmental Assessment (“EA”)/Finding of No Significant Impact (“FONSI”) prepared pursuant to NEPA.

This biological opinion represents NMFS’ final action component (3)(a) of the settlement agreement. The DWH oil spill changed the environmental baseline in the Gulf of Mexico and exceeded the effects to ESA-listed species evaluated in the 2007 opinion to an extent that required BOEM and BSEE to reinitiate consultation on oil and gas activities in the Gulf of Mexico. The changes to the baseline also affected the analyses in biological opinions on five-year lease sale programs issued prior to 2007. Instead of reissuing multiple new opinions, NMFS, BOEM and BSEE determined it made more sense to evaluate all ongoing oil and gas activities, regardless of the year of the lease, in a Gulf-wide programmatic opinion. This programmatic opinion will supersede all prior opinions issued to BOEM, BSEE, or their predecessor agencies for oil and gas activities in the Gulf of Mexico. Further, lease sale plans that will be proposed by BOEM in the future will require consultation under section 7 of the ESA. BOEM has indicated they can reasonably predict the nature and extent of new lease sales likely to be proposed and offered during a ten-year period from the time of issuance of this opinion. Therefore, this opinion analyzes the effects of all on-going and future oil and gas activities related to leases awarded through 2029 on ESA-listed and proposed to be listed species and designated critical habitat in the entire Gulf of Mexico. During consultation we considered the effects of all stages of the leasing program, including G&G survey activities which may be permitted by the action agencies, regardless of whether they occur pre- or post-lease, development, and decommissioning. Given the generally expected 40-year lifetime of each individual lease (through decommissioning), this opinion analyzes effects over approximately the next 50 years.

The settlement agreement is relevant to this document because it requires that a number of mitigation measures be implemented for certain seismic surveys in the Gulf of Mexico during the stay of the litigation. These temporary measures (described in the Environmental Baseline section of this opinion) are analyzed further by BOEM and NMFS under NEPA as part of the on-going PEIS for G&G activities in the Gulf of Mexico. While BOEM’s PEIS describes G&G activities from all three program areas (oil and gas, renewable energy, and marine minerals), this consultation only covers actions regulated by BOEM’s oil and gas program, therefore any other program’s G&G activities that may affect ESA-listed species or critical habitat would need a separate consultation under section 7 of the ESA.

The USEPA administers the CWA for the waters seaward of the CWA’s three-mile territorial sea (seaward from the ordinary low water mark) throughout the entire area of the Outer Continental Shelf (OCS) in the Gulf of Mexico and the CAA east of 87.5°W longitude for oil and gas related activities on the OCS. Historically, the USEPA has issued CWA National Pollutant Discharge Elimination System (NPDES) general permits for discharges to these Gulf of Mexico waters from offshore oil and gas related activities. An OCS lessee or operator, as an individual applicant, submits a notice of intent (NOI) to USEPA if they intend to make any discharges covered under the NPDES general permits. Additionally, the USEPA has issued air quality permits to individual applicants in the area of the Gulf of Mexico OCS under its jurisdiction (i.e., east of 87.5°W longitude). As done for previous section 7 consultations with BOEM and BSEE, this consultation considers the effects of air and water discharges resulting from oil and gas activities that would be permitted by the USEPA as an action resulting from BOEM-approved leases on the OCS of the Gulf of Mexico.

1.2 Consultation History

Below is a brief timeline of pertinent activities as they relate to this consultation. As NMFS has not previously issued MMPA regulations for take of marine mammals incidental to oil and gas G&G surveys, there is no consultation history for this activity.

- May 20, 2010: USEPA Region 4 sent a letter to NMFS' Southeast Regional Office requesting comments on three air quality permits in the eastern Gulf of Mexico resulting from BOEM leases included in the 2007-2012 Lease Plan.
- June 30, 2010: BOEMRE requested reinitiation of consultation for OCS oil and gas activities in the Gulf of Mexico as a result of the DWH explosion and resulting spill.
- September 24, 2010: NMFS responded to BOEMRE's reinitiation request with an outline of major issues that needed to be addressed in the biological assessment (BA).
- December 7-8, 2010: In a meeting on oil spill risk analyses (OSRA) needed for the Gulf of Mexico, NMFS, BOEM, and BSEE discussed the need to not only reinitiate the 2007 opinion, but also to reinitiate all previous lease sale opinions, as well as future lease sales, since consultation only covered lease sales until 2012. Tentative agreement among staff resulted in a recommendation for a programmatic Gulf-wide biological opinion, instead of separate opinions for each five-year lease sale program.
- January 24, 2011: NMFS sent a letter to USEPA Region 4 commenting on air quality permits indicating we would be including USEPA in the programmatic consultation with BOEM and BSEE on air matters.
- November 2011 to April 2012: Following a series of correspondences between BOEM and NMFS in letters dated November 23 and December 21, 2011, and February 3, February 8, and April 4, 2012, NMFS and BOEM agreed to an interim review process under the ESA for BOEM permits pending completion of the reinitiated consultation. NMFS began reviews of permits and plans in March 2012.
- February 14, 2012: NMFS sent a letter to BOEM and BSEE requesting clarification on the roles of each agency for oil and gas leasing consultations with NMFS and began coordination and dialogue on the structure of the programmatic consultation.
- July 12, 2012: BOEM and BSEE responded to NMFS's February 14, 2012, letter indicating that the BOEM's Gulf of Mexico Region will be the lead on ESA consultations in the Gulf of Mexico. BOEM would be the lead agency on all program-wide operations

and G&G surveying activities, and BSEE would be the lead agency on decommissioning activities.

- April 24, 2012: BOEM sent a draft BA for all Gulf of Mexico leasing activities to NMFS for a technical and completeness review.
- May 31, 2012: NMFS sent comments to BOEM on the draft BA and requested additional information.
- November 27, 2012: BOEM sent NMFS an update on progress on the BA and indicated a final BA addressing NMFS's comments would be sent in the near future.
- February 7, 2013: BOEM transmitted the final BA and associated documents to NMFS.
- March 12, 2013: NMFS and BOEM held a teleconference to discuss the BA, outstanding issues and questions, and near- and long-term coordination plans.
- March 29, 2013: NMFS sent a letter to BOEM acknowledging initiation of formal consultation, and provided additional details on consultation and on the information requested in the March 12, 2013 call.
- April 15, 2013: The first regularly scheduled conference call was held among NMFS, BOEM, BSEE, and USEPA to discuss the March 29, 2013, letter and technical details required for the consultation.
- June 20, 2013: NMFS sent a first draft of the proposed action section of the programmatic opinion to BOEM and the USEPA for review, accuracy, and revision as needed.
- July 11, 2013: USEPA Region 6 provided two points of clarification on the draft-proposed action.
- July 18, 2013: BOEM hosted an "extremely large spill" webinar to provide more details on the assumptions, calculations, and scope of their extremely large spill analysis.
- July 22, 2013: NMFS made a verbal request for additional information on oil and gas activity in the sperm whale area off the Mississippi River Delta. NMFS also expressed overall concern with the extremely large spill analysis provided by BOEM.
- July 23, 2013: USEPA Region 4 provided edits and comments on the draft-proposed action.
- August 1, 2013: NMFS provided an email request for additional information equivalent to that provided for the three planning areas for oil and gas activities occurring between the 200 meter and 2,000 meter contours off the Mississippi River Delta.
- August 9, 2013: BOEM sent a letter to NMFS restating their verbal agreement to an extended timeline for a completed opinion in October 2014.
- August 16, 2013: BOEM provided an electronic revision to the draft proposed action section of the document sent to BOEM by NMFS on June 20, 2013.
- September 16, 2013: BOEM provided a letter to NMFS responding to the March 29, and July 29, 2013, information requests.
- October 30, 2013: BOEM provided an electronic response to NMFS's August 1, 2013, request for information specific to the contours off the Mississippi River Delta.

- November 18, 2013: Regional leadership for both BOEM and NMFS directed staff to work towards resolving the extremely large oil spill concerns.
- November 21, 2013: During a conference call with BOEM and BSEE, NMFS verbally requested additional information on the effectiveness of their new drilling safety rules regarding reducing the probability of an extremely large spill.
- December 11, 2013: BOEM verbally agreed to conduct a qualitative analysis describing how the new drilling safety regulations were expected to lower the risk of an extremely large spill occurring. BOEM, BSEE, and NMFS agreed to a 4-month extension for the final opinion due to the time necessary to conduct this requested analysis.
- April 11, 2014: BOEM transmitted the qualitative review of the new drilling safety measures.
- June 23, 2014: NMFS transmitted a draft of the project design criteria (PDCs) to BOEM and BSEE staff for review.
- August 19, 2014: BOEM had a conference call with NMFS to discuss approval options following discussions between the operator and NMFS's Southeast Fisheries Science Center fishery gear expert evaluation and recommended a gear modification to reduce entanglement risks for that particular permit. This is relevant to BOEM as they use some of those gear types for certain oil and gas related activities, such as site clearance trawling.
- September 4, 2014: NMFS sent an electronic message to BSEE indicating that NMFS's review of BSEE's Underwater Calculator for predicting impact zones for explosive structure removal may under-predict impact zones and recommended a peer-review before the calculator revisions are used to alter the current monitoring zones.
- December 4, 2014: BOEM and BSEE provided comments on the PDCs for the proposed action.
- January 7, 2015: BOEM provided additional information and clarifications regarding the number and size of very large spills projected to occur in the future.
- January 30, 2015: BOEM provided updated geological and geophysical survey activity levels anticipated for the years 2015-2023.
- February 25, 2015: NMFS sent a letter to BOEM and BSEE advising that more time was needed to complete the biological opinion.
- April 17, 2015: USEPA sent an email letter requesting informal consultation on the reissuance of the offshore oil and gas National Pollutant Discharge Elimination System (NPDES) general permit 460000 for the eastern portion of the Gulf of Mexico. It was determined that an informal consultation was unnecessary as offshore oil and gas NPDES actions for the Gulf of Mexico are considered under this programmatic consultation.
- September 15, 2016: Center of Independent Experts completed their review of BSEE's Underwater Calcultor Version 2.0. Final reports were provided to NMFS and are available online at https://www.st.nmfs.noaa.gov/science-quality-assurance/cie-peer-reviews/cie-review-2016.

- March 22, 2017: NMFS sent a letter to BOEM requesting information regarding consultation on the effects of their activities on newly proposed and listed species and ensuring consultation consistency following the 2016 release of NMFS“Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing” (referred to as NMFS Marine Mammal Acoustic Guidance).
- May 16, 2017: NMFS met with USEPA Region 4, Region 6 and headquarters representatives to discuss current consultation considerations and timelines.
- July 5, 2017: BOEM sent a letter to NMFS providing supplemental consultation information identifying new species to include in the consultation.
- September 7, 2017: NMFS sent a letter to BOEM, BSEE and USEPA Regions 4 and 6 describing their inclusion in the BOEM consultation and that the consultation lead was transferred from the NMFS Southeast Regional Office in St. Petersburg, Florida to the Office of Protected Resources in Silver Spring, Maryland. Also, the NMFS ESA Interagency Cooperation Division sent a memo to NMFS’ Permits and Conservation Division notifying them of the same.
- January 4, 2018: DOI published a new draft proposed National OCS Leasing Program that would be effective from 2019-2024 and supercede the 2017-2022 program. Adoption of the program as proposed would change the action under consulation. However, the information provided by BOEM and BSEE regarding activity levels and locations, and effects analyses for those activities, to be evaluated in this opinion continues to be based on the 2017-2022 program.
- June 22, 2018: NMFS sent action agencies a full staff-level draft opinion for review and comments.
- September 13, 2018: BOEM/BSEE provided response and comments on the draft biological opinion.
- November 2018: NMFS began facilitating a series of bi-weekly substantive calls with BOEM and BSEE to better understand comments on the opinion and to collaboratively work through each topic.
- January 2019: Extended government shutdown resulted in remaining substantive calls being postponed.
- February 2019: Completed series of substantive calls with BOEM/BSEE.
- Since February 2019: There have been several interactions back and forth with federal action agencies regarding revisions to the opinion prior to final release.
- September 2019: A second complete draft was provided to BOEM and BSEE for review.
- February 24, 2020, and then revised and resent on March 12, 2020: BOEM sent NMFS a revised proposed action that removed a large eastern portion of the Eastern Planning Area and a small portion of the Central Planning Area that are both under a leasing moratorium. In this letter BOEM/BSEE removed previously proposed mitigation protocols jointly developed as appendices to the opinion during consultation for preventing vessel strike; marine debris; and seismic survey measures while leaving in

effect the 2015 and 2016 dated NTL's that were already being implemented. Portions of these appendices have been adopted by NMFS in this opinion in the RPA and Reasonable and Prudent Measures (Terms and Conditions). See Sections 14 and 15. BOEM removed from the proposed action vessel speed and nighttime vessel travel restrictions that BOEM had proposed for a portion of the Bryde's whale area. Such restrictions are incorporated by NMFS into the RPA for the Bryde's whale area. See Chapter 14.

2 THE ASSESSMENT FRAMEWORK

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or destroy or adversely modify their designated critical habitat.

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 CFR §402.02.

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

The final designations of critical habitat for green, leatherback, and loggerhead sea turtles and Gulf sturgeon used the term primary constituent element (PCEs) or essential features. The new critical habitat regulations [81 FR 7414 (Feb. 11, 2016)] replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBFs to mean PCEs or essential features, as appropriate for the specific critical habitat.

Our ESA section 7 assessment involves the following steps:

Programmatic Consultation Requirements and Procedures (Section 2.1) and *Description of the Proposed Action* (Section 2.2): We identify programmatic consultation requirements and procedures and describe the proposed action, identify PDCs. Specific to this opinion, we begin with a description of the geographic region in the Gulf of Mexico, providing the context in which the activities would take place. Next we provide overviews of the regulatory authorities governing oil and gas exploration, development and production, and associated CWA, CAA and MMPA permitting, and a description of the activities that occur during the various OCSLA stages. Then we summarize the implementation of the OCSLA; we describe how the various stages or activities associated with oil and gas exploration, development and production, and decommissioning will be reviewed by BOEM, BSEE, USEPA, or NMFS' Permits and Conservation Division and the requirements they must meet to be permitted or authorized. We also describe unplanned, but reasonably certain to occur incidences of oil spills, and associated regulatory requirements to prevent spills. We describe PDCs expected to avoid or minimize adverse effects to ESA resources for categories of activities, and other effects minimization aspects of the proposed action. We then discuss step-down consultation requirements for specific actions implemented under this programmatic consultation.

Action Area (Section 4): We describe the full spatial extent of the action area, which includes coastal areas and into Mexican waters. This section also incorporates maps and any area restrictions proposed by the action agencies.

Stressors Created by the Activities (Section 5): We cross-walk the activies of the proposed action with the stressors those activies create. This organizes the stressors for our evaluation of potential effects to ESA-listed species and designated critical habitat. For example, the stressor of sound may be created by numerous activities in different phases of the program. However, the effects of sound on ESA-listed animals is independent of the activity. Hence, in our *Effects of the Action* (Section 8) we summarize the effects based on the stressor rather than on the activity that created it.

Status of Endangered Species Act Protected Resources (Section 6): We identify the ESA-listed species, species proposed for listing, and designated or proposed critical habitat that are likely to co-occur with identified stressors in space and time and evaluate the status of those species and habitats. In Section 6.1, we identify ESA-listed species and designated critical habitat not likely to be adversely affected. In Section 6.2, we identify and describe ESA-listed or proposed to be listed species and designated critical habitat that are likely to be adversely affected, and provide relavent information on their status, biology, ecology, and life history.

Environmental Baseline (Section 7): We describe the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

Effects of the Action (Sections 8 and 9): Based on the stressors previously identified, and the ESA-listed or proposed to be listed species that are likely to be affected by those stressors, we describe the effects of those stressors on those species in Section 8. Our analysis is inclusive of any existing or proposed measures that will be taken to mitigate or minimize exposure of proposed or ESA-listed resources to the stressors. We conduct an exposure analysis to identify the ESA-listed species that are likely to co-occur with the actions' effects on the environment in space and time, and identify the nature of that co-occurrence. The exposure analysis also identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions' effects and the population(s) or subpopulation(s) those individuals represent. We evaluate the available evidence to determine how individuals of those proposed or ESA-listed species are likely to respond given their probable exposure. This is our response analyses. We also consider how the action may adversely affect designated critical habitat. In Section 9 we analyze the effects of stressors resulting from the proposed action on the identified essential physical and biological features of designated critical habitat for the Northwest Atlantic DPS of loggerhead sea turtle and Gulf sturgeon.

Cumulative Effects (Section 10): Cumulative effects are the effects to proposed or ESA-listed species and proposed or designated critical habitat of future state or private activities that are reasonably certain to occur within the action area 50 CFR §402.02. Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integration and Synthesis (Sections11 and 12): In this section, we integrate the preceding analyses to summarize the consequences to proposed or ESA-listed species and designated critical habitat under NMFS' jurisdiction. We measure risks to individuals of endangered or threatened species using changes in the individuals' "fitness," which may be indicated by changes in the individuals' growth, survival, annual reproductive success, and lifetime reproductive success. When we do not expect ESA-listed animals exposed to an action's effects to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise. As a result, if we conclude that ESA-listed animals are *not* likely to experience reductions in their fitness, we would conclude our assessment. If, however, we conclude that individual animals are likely to experience reductions in fitness, we would assess the consequences of those fitness reductions on the population(s) those individuals belong to.

Conclusion (Section 13); With full consideration of the status of the species and the designated critical habitat, we consider the effects of the action within the action area on populations or subpopulations and on essential habitat features in the context of the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of proposed or ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

Reasonable and Prudent Alternative (Section 14): If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed or proposed to be listed species or destroy or adversely modify designated critical habitat, then we must identify a RPA(s) to the action, if any, that would allow the action to procede without jeopardizing listed species and/or destroying or adversely modifying critical habitat, or indicate that to the best of our knowledge there are no RPAs. See 50 CFR §402.14.

Incidental Take Statement (Section 15): Here we specify the impact of the take, reasonable and prudent measures to minimize the impact of the take, and terms and conditions to implement the reasonable and prudent measures. ESA section 7 (b)(4); 50 CFR §402.14 (i). We also provide discretionary *Conservation Recommendations* (Section 16) that may be implemented by the action agency. 50 CFR §402.14 (j). Finally, we identify the circumstances in which reinitiation of consultation is required (Section 17). 50 CFR §402.16.

References (Section 18): To comply with our obligation to use the best scientific and commercial data available, we collected information through searches of *Google Scholar, Web of Science*, literature cited sections of peer reviewed articles, species listing documentation, and reports published by government and private entities. This opinion is based on our review and analysis of various information sources, including:

- Information submitted by the BOEM, BSEE, USEPA and NMFS Permits and Conservation Division;
- Government reports (including NMFS biological opinions and stock assessment reports);
- National Oceanic and Atmospheric Administration (NOAA) technical memoranda;
- Peer-reviewed scientific literature; and
- External agency or entity data, as available, to assist in the consideration of secondary effects, such as those associated with vessel traffic.

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species and designated critical habitat under NMFS' jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species.

2.1 Programmatic Consultation Requirements and Procedures

Programmatic consultations typically include six elements to ensure consistency with ESA section 7 and its implementing regulations. In Section 3 (*Description of the Proposed Action*) below, we discuss three of these elements as they pertain to the programmatic consultation procedures and reviews:

- Non-discretionary PDCs that describe aspects of the proposed action required for all projects implemented under the program, to avoid or minimize adverse effects on listed species and designated critical habitat.

- Procedures for streamlined project-specific consultation.
- Periodic comprehensive review of the program.

The following additional elements of programmatic consultations are covered in later sections of this opinion.

- Description of the manner in which projects to be implemented under the programmatic consultation may affect listed species and critical habitat, and evaluation of expected level of effects from covered projects (Sections 8 and 8.8).
- Process for evaluation of the aggregate or net additive effects of all projects expected to be implemented under the programmatic consultation, including any RPA (Sections 8 through 14). The programmatic consultation document must demonstrate that when the PDCs, RPA, Reasonable and Prudent Measures and Terms and Conditions are applied to each project, the aggregate effect of all projects will not jeopardize species or destroy or adversely modify their critical habitat, as applicable.
- Procedures for tracking and monitoring projects and validating effects predictions, are also found in the Incidental Take Statement, including its Reasonable or Prudent Measures (RPMs) and associated Terms and Conditions (Section 15).

Actions outside the scope of this programmatic Opinion will be appropriately evaluated when proposed. If a federal action (as defined in 50 C.F.R. 402.02) may affect listed species or critical habitat and is outside the scope of this Opinion, the action agency would need to initiate a separate ESA consultation, if necessary. Such actions would not be addressed by this Opinion, its RPA, or any associated incidental take exempted by the ITS.

Due to the broad scope and duration of the actions and activities[1] addressed by this Opinion, it is not possible to fully anticipate all of the ways in which such actions and activities may be proposed to be carried out in the future (e.g., through the use of new technologies, operating methods, or mitigation approaches, etc.). NMFS will evaluate such proposals with action agencies when they are proposed. The step-down provisions of Section 2.2 of this Opinion identify specific categories of action or activity anticipated to trigger further review and evaluation by NMFS and action agencies. Those procedures describe how NMFS and the action agencies will evaluate whether such actions are expected to have effects of an extent and nature consistent with those effects already evaluated in this Opinion, or will be consistent with such effects if appropriately modified (e.g. with different mitigation). Such actions and activities would then be determined to be covered by this Opinion and its RPA and ITS.

[1] The term "action" refers to Federal agency actions as defined in 50 C.F.R. 402.02 (any activity authorized, funded, or carried out by a Federal agency). Such "actions" by definition involve specific activities carried out by either Federal agencies or the recipients of a federal authorization (e.g., oil and gas lessees and permittees carrying out oil and gas exploration, development, and mitigation). Because of their close relationship, the terms "activities" and "actions" are sometimes used together or interchangeably in this Opinion. The term "action" is also used to refer to the Description of the Proposed Action in Chapter 3 of this Opinion, which contains the description of all the actions and activities addressed by this Opinion.

Section 3.4 also discusses how step-down review may also lead to a project-specific or site-level ESA consultation for which additional analysis is needed to fully evaluate the effects of actions or activities that are addressed in this Opinion, but that could not be fully evaluated at the programmatic level until more was known about their location, timing, and/or the manner in which they are being carried out. Such actions and activities would be covered by this Opinion, its RPA and ITS, but might also require additional measures such as those required through step-down review. In addition, any time an action agency proposes a new approach, NMFS and the action agency may also consider whether the proposal warrants re-evaluation of any aspects of the programmatic Opinion itself (for example, consideration of a broadly new approach to activities and mitigation that would avoid jeopardy in a manner different from the measures described in the RPA).

2.2 Definition of Take, Harm and Harass

Section 3 of the ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. We categorize two forms of take, lethal and sublethal take. Lethal take is expected to result in immediate, imminent, or delayed but likely mortality. Sublethal take is when effects of the action are below the level expected to cause death, but are still expected to cause injury, harm, or harassment. Harm, as defined by regulation (50 CFR §222.102), includes acts that actually kill or injure wildlife and acts that may cause significant habitat modification or degradation that actually kill or injure fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering. Thus, for sublethal take we are concerned with harm that does not result in mortality but is still likely to injure an animal.

NMFS has not defined "harass" under the ESA by regulation. However, on October 21, 2016, NMFS issued interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering." For this consultation, we rely on this definition of harass when assessing effects to all ESA-listed species except marine mammals.

For marine mammal species, prior to the issuance of the October 21, 2016 guidance, consultations that involved NMFS Permits and Conservation Division's authorization under the MMPA relied on the MMPA definition of harassment. Under the MMPA, harassment is defined as any act of pursuit, torment, or annoyance which:

- has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or
- has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment). Under NMFS

regulation, Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild.

Our October 21, 2016 guidance states that our “interim ESA harass interpretation does not specifically equate to MMPA Level A or Level B harassment, but shares some similarities with both levels in the use of the terms ‘injury/injure’ and a focus on a disruption of behavior patterns. NMFS has not defined ‘injure’ for purposes of interpreting Level A and Level B harassment but in practice has applied a physical test for Level A harassment.” In this opinion, available data and models that provide estimates of MMPA Level B harassment have been used in estimating the number of instances of harassment of ESA-listed marine mammals, whereas available data and models that provide estimates of MMPA Level A harassment have been considered for this opinion to be instances of harm and/or injury under the ESA, depending on the nature of the effects.

As described earlier, this opinion is in part the result of reinitiation of consultation following the 2010 DWH event, well before NMFS’s recently issued guidance on the definition of harassment under ESA. As such, data collection, modeling, and environmental document preparation on marine mammal take was completed utilizing the MMPA definition of harass. Given this timing and the complexity associated with modeling take estimates of marine mammals, consistent with prior consultations that involve authorization under the MMPA, we rely on the MMPA definition of Level B harassment to evaluate whether the proposed action is likely to harass ESA-listed marine mammals and if so, use it to estimate the number of instances of harassment of ESA-listed marine mammals that are likely to occur.

Level B harassment as applied in this consultation may involve a wide range of behavioral responses including but not limited to avoidance, changes in vocalizations or dive patterns, or disruption of feeding, migrating, or reproductive behaviors. BOEM’s modeled Level B harassment take estimates of marine mammals do not differentiate between the types of potential behavioral responses, nor do they provide information regarding the potential fitness or other biological consequences of the responses on the affected individuals. We discuss this in our effects of sound section below (Section 8.5).

3 DESCRIPTION OF THE PROPOSED ACTION

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas.

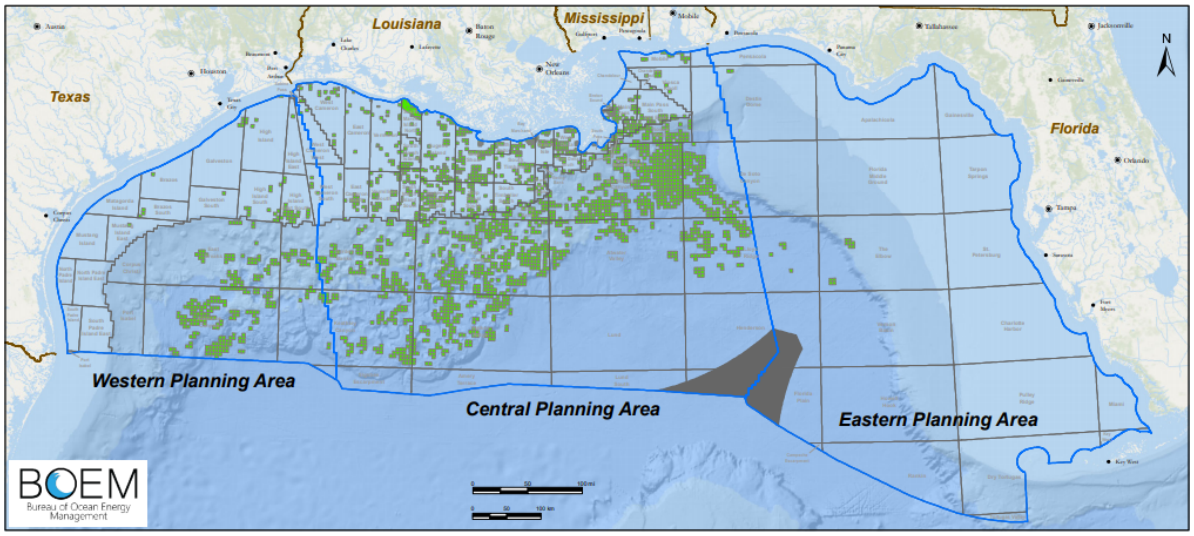
This opinion supersedes all previous section 7 consultations completed under the ESA for any ongoing or future oil and gas-related activity on the OCS in the Gulf of Mexico authorized by either BOEM or BSEE (or their predecessor agencies), and discharges and emissions associated with oil and gas activities permitted by the USEPA under the CWA or CAA in the same area.

The scope of this consultation is DOI’s management and regulation of OCS oil and gas related activities under the OCSLA. Air and water emissions associated with these activities and permitted by the USEPA are interdependent actions, and USEPA is a co-federal action agency for this consultation. Similarly, NMFS Permits and Conservation Division's issuance of an MMPA permit for take of marine mammals by G&G surveys for oil and gas resources is an interdependent action, making NMFS another co-federal action agency for this consultation. Much of the information in the proposed action section comes from documentation created by the action agencies. For BOEM and BSEE, a biological assessment (BA) with appendices, several Programmatic EISs, and other various supplemental supporting information were provided. USEPA provided a biological evaluation, draft copies of general permits and other supplemental information for their portion of the action. Lastly, NMFS' Permits and Conservation Division provided their final rule and supplemental information.

This consultation analyzed all effects to ESA-listed species or species proposed for ESA-listing and designated critical habitat resulting from ongoing and future actions associated with permit issuance and plan approval under the OCSLA in the Gulf of Mexico (Figure 1), Oil and Gas Program permitting under CWA, CAA and MMPA, and from actions associated with all lease sales held in the 10-year period following issuance of this opinion (to approximately 2029) in the Gulf of Mexico. The structure of the OCSLA allows for "incremental step" consultation on each statutorily defined stage of the leasing process for individual leases, and the joint NMFS-Fish and Wildlife Service (FWS) consultation regulations describe the applicable approach to such consultations (50 CFR §402.14(k)). BOEM has not previously, and is not now, requesting incremental step consultation for its Gulf of Mexico activities. The primary reason BOEM has not requested incremental consultations is that the vast number of leases and exploration activities in the Gulf of Mexico, operating simultaneously across all of the OCSLA stages, is not conducive to consultation on discrete OCSLA stages due the time and resources needed. During the consultation, working together BOEM, BSEE, and NMFS determined that a more comprehensive approach would be more effective and efficient. Thus, the agencies determined that conducting a comprehensive, Gulf-wide, programmatic consultation is most suited to the proposed activities and to ensuring that those activities are not likely to jeopardize listed species or destroy or adversely modify designated critical habitat.

For oil and gas leasing purposes, the Gulf of Mexico is divided into three geographic leasing areas: the Western Planning Area (WPA), the Central Planning Area (CPA), and the Eastern Planning Area (EPA) (Figure 1). This consultation considered all areas under federal jurisdiction that include all activities associated with the oil and gas program in the WPA, CPA and a small portion of the EPA that is not under moratorium. The five-year leasing schedules are projected by BOEM for each planning area. BOEM has provided reasonably foreseeable projections for the likely leasing scenarios and activities related to such lease sales for ten years from the date of issuance of this opinion for inclusion in the consultation.

BOEM Gulf of Mexico OCS Region
Blocks and Active Leases by Planning Area
February 3, 2020



Planning Areas	Total Blocks	Total Acres	Number of Leases	Acres Leased
Western	5,240	28,576,813	328	1,869,322
Central	12,409	66,446,351	2,237	11,792,440
Eastern	11,537	64,357,859	18	103,680
Sub-Totals	29,186	159,381,023	2,583	13,765,442
CPA / EPA Shared Blocks*	(86)		0	
Totals	**29,100**	**159,381,023**	**2,583**	**13,765,442**

Active Lease
Exclusive Economic Zone
Northern Portion of the Eastern Gap
Planning Area Boundary

* CPA and EPA contain 86 shared blocks. These blocks are given both a CPA and EPA designation in the data which may account for a higher block total.

Office of Leasing and Plans, Mapping and Automation Section | MAS202000186 | 03 February 2020

Figure 1. Leases currently active in each planning area of the Gulf of Mexico.
Map available at https://www.boem.gov/Gulf-of-Mexico-Region-Lease-Map/.

Projections of activities related to permitting and plan approvals for OCS oil and gas activities, including those resulting from all prior active leases and future lease sales (Table 2), as well as projections for G&G activities (Table 3) are considered in the scope of this opinion. A lease life is typically up to 40 years, and consequently, the proposed action may include lease activities, for example, up to the year 2067 from lease sales held in 2029. In addition, BOEM has the authority to extend the term of a lease if it continues to be actively producing.

Table 2. Summary of total projected activity levels for one lease sale on the Gulf of Mexico outer continental shelf over a 50-year period.

	Offshore Subareas[2]						
	0-60m	**60-200m**	**200-800m**	**800-1,600m**	**1,600-2,400m**	**>2,400m**	**Total OCS[3]**
Wells Drilled							
Exploration and Delineation Wells	4-634	2-300	2-11	3-15	2-8	2-16	17-984
Development and Production Wells	4-326	4-220	4-95	4-35	3-37	3-38	22-767
Producing Oil Wells	0-35	0-23	2-46	1-22	1-19	1-19	5-164
Producing Gas Wells	1-169	0-120	0-46	1-22	1-19	1-19	5-326
Production Structures							
Installed	3-183	2-85	1-4	1-3	1-2	1-3	9-280
Removed Using Explosives	6-130	3-63	0	0	0	0	4-193
Total Removed	3-183	2-85	1-4	1-3	1-2	1-3	9-280
Method of Transportation[4]							
Percent Piped	>99 percent	>99 percent	>99 percent	>99 percent	87->99 percent		92->99 percent
Percent Barged	< 1 percent	0 percent	0 percent	0 percent	0 percent		< 1 percent
Percent Tankered[5]	0 percent	0 percent	0 percent	0 percent	0-13 percent		0-7 percent
Length of Installed Pipelines (km)[6]	20-527	20-417	20-327	24-358	10-275	11-240	105-2,144
Service-Vessel Trips (1,000's round trips)	3-265	2-126	6-51	6-38	6-26	6-36	30-541
Helicopter Operations (1,000·s operations)	17-2,131	17-1,409	8-71	8-53	8-36	8-53	70-3,750

From (2017-2022 Multisale EIS; Table 3-2) (BOEM 2017c) Note that about ten lease sales are typically projected for a five year period.

[2] See Figure 1.
[3] Subareas totals may not add up to the planning area total because of rounding.
[4] 100% of gas is assumed to be piped. (BOEM 2012 multisale)
[5] Tankers are forecasted to occur only in water depths > 1,600 m, otherwise pipelines are used.
[6] Projected lengths of pipelines do not include length in state waters.

Table 3. Projected levels representing upper limits of sound-producing geophysical activities for oil and gas exploration in Federal waters of the Gulf of Mexico over ten years (numbers of surveys in parentheses and survey line distance shown in miles). Table modified from BOEM (2017d).

Year		Western Planning Area							Central Planning Area							Eastern Planning Area					
		HRG	VSP	SWD	2D	3D[7]	WAZ[8]	4D	HRG	VSP	SWD	2D	3D[Error! Bookmark not defined.]	WAZ[Error! Bookmark not defined.]	4D	HRG	VSP	2D	3D[Error! Bookmark not defined.]	WAZ[Error! Bookmark not defined.]	4D
1	Shallow	(3) 400	(3) 93	0	0	(1) 2,620	0	(1) 9,507	(22) 2,000	(17) 496	0	0	(2) 13,605	0	(1) 9,900	(2) 100	(1) 31	0	0	0	0
	Deep	(4) 1,100	(19) 558	3	(0) 3,600	(1) 8,625	(1) 6,728	(3) 29,700	(32) 5,600	(35) 1,054	9	(1) 7,200	(5) 40,686	(6) 52,999	(6) 59,400	0	(2) 62	(1) 180	(1) 1,918	0	0
2	Shallow	(3) 350	(2) 62	0	0	0	0	0	(22) 2,000	(15) 434	0	0	(2) 18,400	(1) 4,897	0	(2) 100	0	0	0	0	0
	Deep	(5) 1,200	(14) 403	1	(1) 1,620	(1) 13,731	(3) 20,043	(3) 29,700	(32) 5,600	(33) 992	8	(1) 1,620	(5) 42,618	(5) 46,347	(6) 59,400	(1) 50	(1) 400	(1) 360	(1) 4,139	0	0
3	Shallow	(3) 350	(3) 93	0	0	0	0	(1) 9,507	(20) 1,950	(14) 403	0	0	(2) 16,538	0	(1) 9,900	(1) 50	(1) 31	0	0	0	0
	Deep	(6) 1,300	(16) 465	2	(1) 540	(1) 8,625	(2) 17,049	(3) 29,700	(35) 5,850	(30) 917	10	(1) 1,620	(4) 33,955	(5) 44,203	(6) 59,400	(2) 100	(2) 62	(1) 18,810	(1) 4,139	0	0
4	Shallow	(3) 325	(2) 62	0	0	(1) 2,620	0	0	(18) 1,900	(15) 434	0	0	(2) 21,433	(1) 6,781	0	0	0	0	0	0	0
	Deep	(6) 1,300	(14) 403	2	(1) 540	(1) 3,786	(3) 20,550	(3) 29,700	(35) 5,850	(33) 992	11	(1) 1,620	(2) 18,658	(2) 21,471	(6) 59,400	(2) 100	(1) 5	(1) 24,210	(1) 10,080	(1) 11,210	0
5	Shallow	(3) 300	(3) 93	0	0	0	0	0	(18) 1,900	(12) 372	0	0	(2) 13,715	0	(1) 9,900	0	0	0	0	0	0
	Deep	(6) 1,400	(16) 465	2	(1) 540	(1) 4,927	(1) 7,287	(3) 29,700	(40) 6,200	(27) 806	7	(1) 1,620	(3) 26,605	(5) 40,507	(6) 59,400	(1) 50	(1) 5	(1) 9,360	(1) 15,120	0	0
6	Shallow	(3) 300	(1) 31	0	0	0	0	0	(17) 1,700	(10) 310	0	0	(2) 17,661	(1) 3,453	0	0	0	0	0	0	0
	Deep	(6) 1,400	(8) 248	1	0	(1) 8,625	(1) 9,205	(3) 29,700	(42) 6,500	(24) 713	8	0	(2) 12,805	(3) 25,872	(6) 59,400	(2) 100	(1) 1	0	(1) 15,120	0	0
7	Shallow	(3) 600	(1) 31	0	0	(1) 2,620	0	(2) 19,013	(15) 1,500	(14) 403	0	0	(1) 12,578	(1) 0	(1) 9,900	0	0	0	0	0	0
	Deep	(7) 1,475	(5) 155	0	(0) 1,800	(1) 9,010	(1) 8,690	(3) 29,700	(45) 7,000	(30) 899	9	(1) 3,600	(2) 13,796	(4) 34,208	(6) 59,400	(3) 150	(1) 0	(1) 810	(1) 10,080	(1) 2,651	0
8	Shallow	(4) 800	(1) 31	0	0	0	0	0	(15) 1,500	(13) 403	0	0	(2) 20,252	(1) 4,514	0	0	0	0	0	0	0
	Deep	(7) 1,475	(5) 155	0	0	(1) 14,162	(1) 8,690	(3) 29,700	(50) 7,500	(29) 868	7	0	(2) 16,253	(3) 30,088	(6) 59,400	(4) 200	(1) 5	(1) 19,350	(1) 10,080	(1) 4,345	0
9	Shallow	(4) 800	(1) 31	0	0	0	0	(2) 19,013	(15) 1,500	(10) 310	0	0	(1) 12,286	0	(1) 9,900	0	0	0	0	0	0
	Deep	(8)	(8)	1	(1)	(1)	(1)	(3)	(50)	(24)	8	(1)	(1)	(3)	(6)	(4)	(1)	(1)	(1)	(1)	0

[7] 3D surveys include ocean bottom cable surveys, nodal surveys, and vertical cable surveys.
[8] WAZ estimates include coil shooting (exclusive to WesternGeco).

Year		Western Planning Area							Central Planning Area							Eastern Planning Area					
		HRG	VSP	SWD	2D	3D[7]	WAZ[8]	4D	HRG	VSP	SWD	2D	3D[Error! Bookmark not defined.]	WAZ[Error! Bookmark not defined.]	4D	HRG	VSP	2D	3D[Error! Bookmark not defined.]	WAZ[Error! Bookmark not defined.]	4D
		1,500	248		540	13,368	8,690	29,700	7,500	713		1,620	7,819	31,056	59,400	200	0	24,660	10,080	4,476	
10	Shallow	(6) 1,000	(1) 31	0	0	0 2,620	0	0	(12) 1,200	(10) 310	0	0	(2) 20,126	(1) 3,066	0	0	0	0	0	0	0
	Deep	(8) 1,500	(5) 155	1	0	(1) 8,516	0	(3) 29,700	(55) 8,000	(24) 713	10	0	(1) 10,002	(3) 26,210	(6) 59,400	(4) 200	(1) 5	(1) 9,000	(1) 10,080	0	0
Totals		(98) 18,875	(128) 3,813	13	(5) 9,180	(14) 103,853	(14) 106,934	(36) 354,040	(590) 82,750	(419) 12,542	87	(6) 18,900	(45) 389,789	(44) 375,674	(65) 643,500	(28) 1,400	(14) 607	(9) 106,740	(10) 90,836	(4) 22,682	0

2D = two-dimensional; 3D = three-dimensional; 4D = three-dimensional time-lapse; ft = foot; HRG = high-resolution geophysical; m = meter; SWD = seismic while drilling; VSP = vertical seismic profile; WAZ = wide azimuth (survey). Shallow = <200-m (656-ft) water depth; Deep = >200-m (656-ft) water depth. Numbers in parentheses represent the number of surveys; numbers without parentheses represent the distance in miles.

This consultation also considered the issuance of USEPA NPDES general permits to authorize discharges into waters of the contiguous zone and ocean in the Gulf of Mexico from oil and gas exploration, development, and production facilities (existing sources or new sources). General permits are issued on five-year schedules for classes of similar dischargers within discrete geographical areas. Within the Gulf of Mexico, two different regional USEPA offices (Regions 4 and 6) administer the USEPA-issued NPDES permits in two discrete geographical areas. Each USEPA region issues an NPDES general permit for offshore oil and gas activities occurring seaward of the three miles CWA "territorial sea" offshore from the states within the boundaries of the respective USEPA's regional jurisdictions. Additionally, USEPA air quality permitting for the eastern Gulf of Mexico and BOEM's air quality oversight for the western Gulf of Mexico are included in this consultation.

Finally, we considered the NMFS Permits and Conservation Division's rulemaking under the MMPA to authorize incidental take of marine mammals from oil and gas related G&G activities and the subsequent issuance of letters of authorization for individual G&G applicants during consultation.

3.1 Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement

This section describes (1) BOEM and BSEE's statutory responsibilities and regulatory authorities, (2) oil and gas program stages, review processes and associated plans and permits approved or issued, (3) implementation of OCSLA stages, and (4) activities authorized under oil and gas plans and permits. In this section we also discuss oil spill prevention, preparedness, containment, and response activities regulated by BOEM, BSEE and other federal agencies. Although not legally permitted discharges, oil spills do regularly result from oil and gas activities in the Gulf of Mexico and their effects, therefore, are considered in this opinion.

3.1.1 Responsibilities and Authorities under the Outer Continental Shelf Lands Act

Under the OCSLA, the Secretary of the DOI has the responsibility to “prepare and periodically revise, and maintain an oil and gas leasing program” in order to “best meet national energy needs” (43 USC §1344(a)). The Act further requires the Secretary to ensure that the U.S. government receives fair market value for acreage made available for leasing, and that offshore conventional (oil and gas) or renewable energy development activities conserve resources, operate safely, and take maximum steps to protect the environment. The Secretary of the DOI has delegated responsibility to implement OCSLA activities relevant to this opinion to BOEM and BSEE.

BOEM is responsible for leasing (including pre- and post-lease activities), exploration, and development plan approval and administration, environmental studies, NEPA analyses, resource evaluation, economic analysis, and the renewable energy program. BOEM reviews and approves plans for OCS oil and gas exploration and development. BOEM’s Office of Strategic Resources, which is responsible for the development of the Five-Year Outer Continental Shelf Oil and Gas Leasing Program, oversees assessments of the oil, gas, and other mineral resource potential of the OCS, inventories oil and gas reserves and develops production projections, and conducts economic evaluations that ensure the receipt of fair market value by United States taxpayers for OCS leases.

BOEM has jurisdiction over OCS air emissions in the Gulf of Mexico west of 87.5° W longitude (off the coasts of Texas, Louisiana, Mississippi, and Alabama). The criteria pollutants include carbon monoxide, nitrogen oxides, sulphur dioxide, suspended particulates, total hydrocarbons, and volatile organic compounds. An overview of BOEM's air regulations is available at https://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of-Mexico-Region/Air-Quality/Overview-of-Air-Quality-Regulations.aspx, and the current National Ambient Air Quality Standards for the six criteria pollutants are available at https://www.epa.gov/criteria-air-pollutants/naaqs-table.

BSEE is responsible for enforcing safety and environmental regulations, offshore regulatory programs, oil-spill response, training and environmental compliance functions. BSEE’s Offshore Regulatory Program develops standards and regulations to enhance operational safety and environmental protection for the exploration and development of offshore oil and natural gas on the OCS. BSEE has oversight over pipeline applications and rights-of-way, and authorizes permits to drill. BSEE’s Oil Spill Response Division is responsible for developing standards and guidelines for offshore operators’ Oil Spill Response Plans (OSRP) through reviews of industry OSRPs to ensure compliance with regulatory requirements and coordination of oil spill drill activities. BSEE’s Environmental Compliance Division provides regulatory oversight that is focused on compliance by operators with all applicable environmental regulations, as well as oversight for lessee and operator obligations under OCS leases. BSEE’s inspectors issue Incidents of Non-Compliance and have the authority to impose sizeable civil penalties for regulatory infractions. In some cases, criminal penalties are also available.

3.1.2 Overview of Oil and Gas Program Stages, Review Processes and Associated Plans and Permits Approved or Issued by the Action Agencies

The OCS leasing process consists of five distinct stages: (1) the five-year planning program, (2) pre-leasing activity and the lease sale, (3) exploration, (4) development and production, and (5) decommissioning.

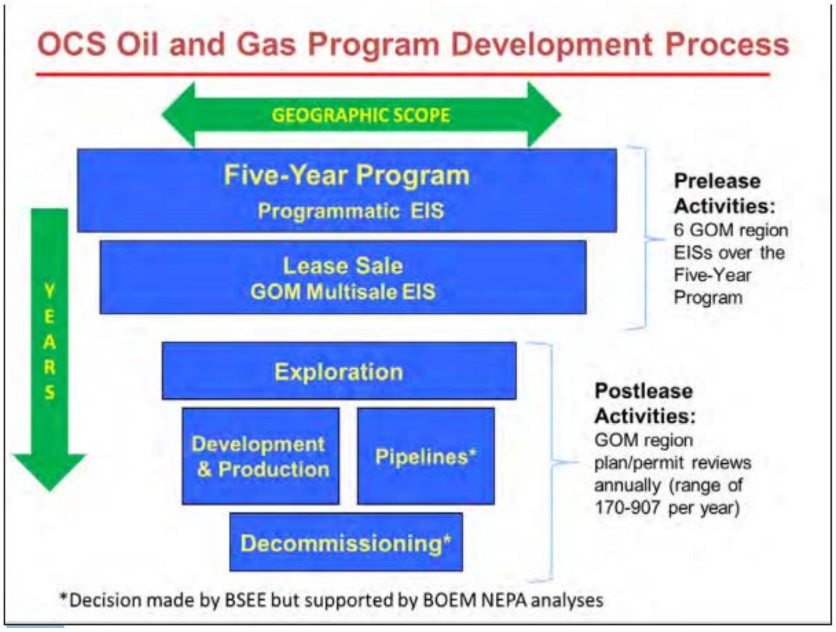


Figure 2. OCS Oil and Gas Program (BOEM 2017b).

3.1.2.1 Five-Year Plans

The Secretary of the DOI is required to prepare a five-year leasing plan, subject to annual revisions, that governs any offshore leasing that takes place during the period of plan coverage. Although no actual plans or permits are approved at this stage, each five-year plan establishes a schedule of proposed lease sales, providing the general timing, size, and location of the leasing activities. The five-year plan is based on multiple considerations, including the Secretary's determination as to what will best meet national energy needs for the five-year period and the extent of potential economic, social, and environmental impacts associated with development. Once a five-year leasing plan is approved, offshore areas included in the plan are made available through scheduled lease sales. Due to the staged decision-making process under OCSLA, BOEM prepares an EIS under the NEPA in conjunction with the plan for each five-year-program.

3.1.2.2 Lease Sales

After a lease sale schedule is finalized in an approved five-year-program, the next stage of OCSLA decision-making takes place when each lease sale is conducted. The lease sale process is governed by a variety of federal laws and regulations; however, Section 8 of the OCSLA and its implementing regulations establish the mechanics of the leasing process. The process begins when the Director of BOEM publishes a call for information and nominations regarding potential lease areas. Pre-lease activities (i.e., off-lease G&G surveys) require permits issued by BOEM. In the Gulf of Mexico, typically the permittees are third-party vendors that acquire data and then sell it to industry. After the permittees have collected data, BOEM may selectively acquire data to update their mineral resources database. Industry uses these data to locate areas having potential for oil and gas production and to prepare bids for lease sales. Although the lease sale in and of itself does not authorize any impact producing activity beyond ancillary[9] activities, due to the staged decision-making process under OCSLA, BOEM often conducts NEPA analyses of all lease sales in a given area or areas under the five-year-program in an EIS (known as a Multi-sale EIS), supplemented as prescribed in NEPA where necessary as later lease sales are prepared. BOEM then makes a decision on whether (and how) to hold a lease sale on an individual basis. If the decision is to hold the lease sale, the Director of BOEM publishes a Final Notice of Sale, which includes, among other things, a list of lease sale block offerings, and a Record of Decision in the Federal Register at least 30 days prior to the date of the sale. The Final Notice of Sale must describe the areas subject to the sale and any stipulations, terms, and conditions applicable to any individual sale.

3.1.2.3 Exploration

Exploration for oil and gas pursuant to an OCSLA lease must comply with an approved exploration plan submitted by lessees. BOEM requires a detailed environmental analysis to accompany submission of an exploration plan. BOEM analyzes the environmental impacts of the proposed exploration activities under NEPA. Extensive environmental review at this stage may be constrained by or rely heavily upon previously prepared NEPA documents. If the regional supervisor disapproves of the proposed exploration plan based on one of the limitations established by OCSLA (e.g., serious harm or damage to the environment; see 43 USC §1351(h)(1)(D)(i)), the lessee may make necessary modifications and resubmit the plan to address the issues raised. Once a plan has been approved, drilling associated with exploration becomes subject to the relevant BSEE regulations governing approval of an application for a permit to drill, which require a detailed analysis of the specific drilling plan.

3.1.2.4 Development and Production

During development and production, the scale of activities significantly increases. Additional regulatory review and environmental analysis are required by the OCSLA before this stage begins. Operators are required to submit a Development and Production Plan (DPP) for areas where significant development has not occurred before or a less extensive Development Operations Coordination Document (DOCD) for those areas, such as certain portions of the Western Gulf of Mexico, where significant activities have already taken place. The information

[9]Ancillary activites, which do not require a permit, are those activities conducted on a lease or unit. If any off-lease data are to be collected, then a permit would be required. BOEM encourages operators to contact BOEM if unsure about need for a permit.

required to accompany submission of these documents to BOEM is similar to that required at the exploration phase, but must address more specific details of planned operations.

3.1.2.5 Decommissioning

Leases typically require removal of obstructions within one year of lease termination, or prior to termination if the operator or DOI deems the structure unsafe, obsolete or no longer useful for operations. Operators must apply for and obtain a BSEE permit approval for safe and adequate removal methods.

The OCSLA authorizes the Secretary of the DOI to promulgate regulations on lease suspension and cancellation. The Secretary's discretion over the use of these authorities is specifically limited to a set number of circumstances established by the Act. A lease may be suspended (1) when it is in the national interest, (2) to facilitate proper development of a lease, (3) to allow for the construction or negotiation for use of transportation facilities, or (4) when there is "a threat of serious, irreparable, or immediate harm or damage to life (including fish and other aquatic life), to property, to any mineral deposits (in areas leased or not leased), or to the marine, coastal, or human environment" OCSLA ((43 USC § 1334(a)). Regulations implementing OCSLA also indicate that BSEE may suspend leases for other reasons, including (1) when necessary to comply with judicial decrees, (2) to allow for the installation of safety or environmental protection equipment, (3) to carry out NEPA or other environmental review requirements, or (4) to allow for "inordinate delays encountered in obtaining required permits or consents." (30 CFR §250.172).

3.1.3 Implementation of Outer Continental Shelf Lands Act Stages

The OCSLA stages are implemented sequentially through various permits, plans, and environmental reviews approved by BOEM or BSEE throughout the life of a lease (Figure 3). However, for purposes of this ESA section 7 consultation, when considering lease blocks, entire planning areas, or the Gulf of Mexico oceanic basin collectively, OCSLA stages will not be evaluated sequentially and activities stemming from individual leases cannot be considered in isolation, because all phases of exploration, development, and production are occurring on many active leases simultaneously.

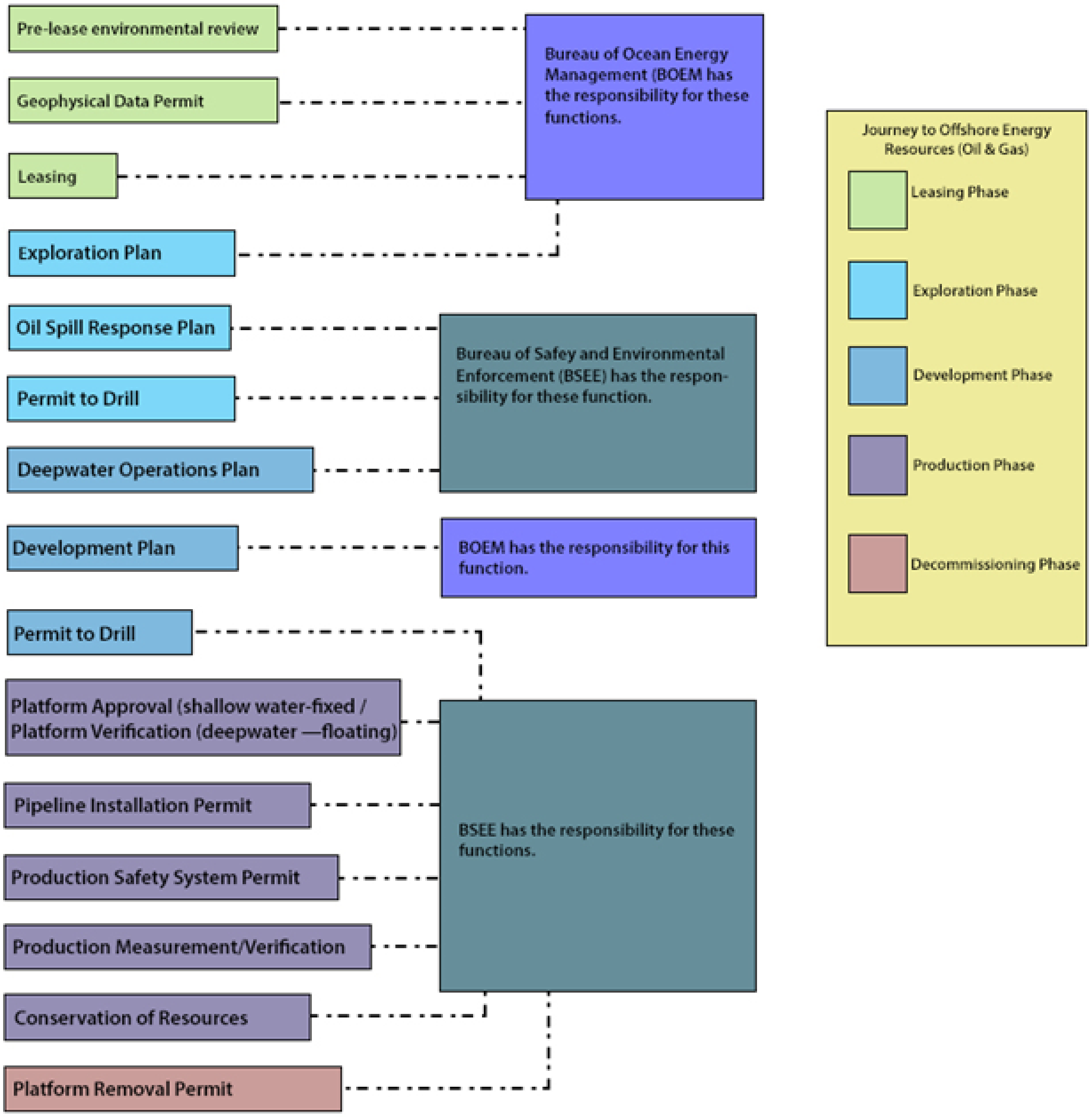


Figure 3. Responsibilities and functions of BOEM and BSEE for permitted activities under OSCLA in the Gulf of Mexico. Figure from BOEM's BA supplemental information.

3.1.3.1 Geological and Geophysical Permits

BOEM is responsible for issuing permits and authorizations for G&G activities in federal waters under the OCSLA (see 30 CFR Parts 550, 551, 580 and 585) as well as under Section 188(a) of the Energy Policy Act of 2005. BSEE is responsible for ensuring compliance with authorization conditions. BOEM issues permits for all types of geological and geophysical activities on the OCS and has permitted over 12,000 seismic surveys (2D and 3D) and more than 400 coring permits in the Gulf of Mexico since the 1953 passage of OCSLA. These G&G surveys generally occur at two different stages of leasing. Off-lease exploratory surveys (e.g., those that occur prior to lease issuance or after lease issuance but outside of the leased block) require a G&G permit (duration of up to one year). Off-lease surveys tend to cover larger oceanographic areas and can last from weeks to months (up to one year). Post-lease issuance G&G activities ("on-lease G&G") are generally localized to the well or lease blocks around an exploratory or development well. On-lease surveys are generally short in duration, lasting hours to a few weeks. On-lease surveys are considered an ancillary activity that require written notification of a revised exploration plan (EP) describing the G&G activity for approval by BOEM (see below description of EPs), but do not require a permit to conduct the activity. Pursuant to regulations at 30 CFR §250.208(a), operators must notify the BOEM Gulf of Mexico OCS Region in writing at least 30 calendar days before conducting any G&G exploration or development activity. Furthermore, the BOEM Gulf of Mexico Region may require a written notice of at least 30 calendar days before conducting any other ancillary activity (30 CFR §250.208(b)). Notice to Lessees (NTL) No. 2009-G34 provides guidance and clarification on the procedures for conducting these activities (http://www.bsee.gov/Regulations-and-Guidance/Notices-to-Lessees/2009/09-G34.aspx).

Geological and geophysical surveys have changed substantially over the last decade. More precise imaging of the subsurface resulted in 3D surveys becoming the standard pre-requisite for oil and gas exploration during the 1990s. Imaging subsalt and complex geologic structures has remained a barrier to data acquisition. In these environments, more advanced acquisition techniques such as multi-component, wide-azimuth (WAZ), full-azimuth (FAZ), multi-azimuth (MAZ), and coil surveys that use multiple sound sources are now being used in the Gulf of Mexico to enhance seismic imaging quality to levels not available in the past. It is reasonable to expect that G&G technologies will continue to change in the future.

Permits for G&G require the following information to be submitted in a permit application: a description of drilling methods or sampling, equipment to be used, estimated bore holes or sample locations, navigation system, method of sampling, description of analyzed or processed data, estimated completion date, a map, plot, or chart showing latitude and longitude, specific block numbers, and total number of borings and samples.

3.1.3.2 Exploration Plans

An Exploration Plan (EP) must be submitted to BOEM for review and approval before any exploration activities can begin on a lease, with the exception of preliminary activities such as hazard surveys or geophysical surveys. The EP describes exploration activities, drilling rigs or vessels, proposed drilling and well-testing operations, environmental monitoring plans, and other relevant information including a proposed schedule of the exploration activities.

An EP may be one of three types. An *Initial Exploration Plan* describes all exploration activities planned by an operator for a specific lease(s), the timing of these activities, information concerning drilling vessels, the location of each well, and an analysis of both offshore and onshore impacts that may occur as a result of the plan's implementation. A *Revised Exploration Plan* describes changes to proposed activities already included in a previously approved Exploration Plan. A *Supplemental Exploration Plan* includes a description of proposed activities on a lease(s) that were not included in an original Exploration Plan for that lease(s). Revised plans often describe additional exploration plans and wells, and ancillary activities such as G&G surveys.

After receiving an EP, BOEM determines if the plan is complete and adequate before technical and environmental reviews. BOEM evaluates the proposed exploration activities for potential impacts relative to geohazards and manmade hazards (including existing pipelines), archaeological resources, endangered species, areas of biological concern, water and air quality, oil-spill response, State Coastal Zone Management Act (CZMA) requirements, and other uses (e.g., military operations) of the OCS.

Currently, a review of EPs and DOCDs (see next section) occurs at the receiving department (e.g., BOEM plans department) as part of their process for deeming an application is complete using a checklist, such as a DP thruster sound review. This department forwards to BOEM biologists those plans that (1) have potential adverse impacts to biological communities, (2) have sound-producing sources such as DP vessels and seismic airgun surveys, or (3) have an entanglement risk such as with some Ocean Bottom Node (OBN) surveys.

BOEM then reviews the EP compliance with all applicable laws and regulations. A NEPA review (e.g., a Categorical Exclusion Review [CER], EA, or EIS as appropriate) is prepared as documentation of the environmental review of the EP. The NEPA review is based on available information, which may include multiple internal reviews of the geophysical report by subject matter experts (e.g., for determining the potential presence of deepwater benthic communities), archaeological report, air emissions data, live-bottom survey and report, biological monitoring plan, and recommendations by the affected state(s), Department of Defense (DOD), FWS, NMFS, and/or BOEM. After an EP is approved, and prior to conducting drilling operations, the operator is required to submit and obtain approval from BSEE for an Application for Permit to Drill (APD).

3.1.3.3 Development Operations Coordination Documents

A Development Operations Coordination Document (DOCD) is a plan submitted to BOEM that describes development and production activities proposed by an operator for a lease or group of leases. The description includes the timing of these activities, information concerning drilling vessels, the location of each proposed well or production platform or other structure, and an analysis of both offshore and onshore impacts that may occur as a result of the plan’s implementation. A Supplemental DOCD describes proposed activities on a lease(s) that were not included in a previously approved DOCD and will require approval of additional permit(s). A revised DOCD describes changes to the proposed activities included in a previously approved DOCD, but will not require the approval of additional permit(s).

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

3.1.3.4 Deepwater Operations Plans

A deepwater operation plan (DWOP) provides information necessary for BSEE to review and approve a deepwater development project, and any other project that uses non-conventional production or completion technology. A DWOP supplements other submittals required by the regulations such as BOEM-approved EPs, Development and Production Plans, and DOCDs. BSEE uses the information in DWOPs to determine whether a project will be developed in an acceptable manner, with respect to operational safety and environmental protection issues involved with non-conventional production or completion technology.

3.1.3.5 Drilling Permit

Before a drilling permit can be approved, many related approvals must be in place: an approved EP or DOCD, and documented compliance with regulations requiring an OSRP, compliance with NEPA, approval of an oil spill financial responsibility document, a geological and geophysical review of all the relevant hydrocarbon bearing zones determination, verification of worst case discharge (WCD) scenarios, and a demonstration that blowout preventer control systems comply with regulations.

When BSEE identifies deficiencies, the drilling permit application is returned to the operator and may be resubmitted with the needed information. To date, BSEE’s Gulf of Mexico Region has not formally denied a permit application; however, there have been numerous situations in which an operator has "withdrawn"/canceled an application or completely revised their originally-proposed activity in response to potential permit conditions and/or proposed environmental standards developed by BOEM and BSEE to ensure adequate resource protection. BSEE and the operator work cooperatively to ensure that all regulatory requirements are met before the application may be approved. Depending on the specific characteristics of the well and the applicable regulatory requirements, this process can take anywhere from a few days to many months. An additional application is required for a permit to modify an approved well. There are no statutory or regulatory deadlines on this stage of the leasing process; within only the applicable limits of the lease term, the operator may take as long as needed to correct the information or gather missing information and resubmit the application.

3.1.3.6 Oil Spill Response Plans

An OSRP must accompany any EP or DOCD. The BSEE's responsibilities include spill prevention, review, and approval of OSRPs (which are required for facilities under the Oil Pollution Act of 1990 [OPA]), inspection of oil-spill containment and cleanup equipment, and ensuring oil-spill financial responsibility for facilities in offshore waters located seaward of the coastline or in any portion of a bay that is connected to the sea either directly or through one or more other bays. The BSEE regulations (30 CFR §254) require that all owners and operators of oil handling, storage, or transportation facilities located seaward of the coastline submit an OSRP for approval before an operator can use a facility. The term "facility" means any structure, group of structures, equipment, or device (other than a vessel), which is used for one or more of the following purposes: exploring for, drilling for, producing, storing, handling, transferring, processing, or transporting oil. A mobile offshore drilling unit (MODU) is classified as a facility when engaged in drilling or down-hole operations. Operators are required to submit a Worst Case Discharge (WCD) analysis for exploratory and development drilling operations according to NTL 2010-N06 (Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS) as part of BOEM's evaluation of EPs and DOCDs, and BSEE's evaluation of APDs (https://www.boem.gov/NTL-2015-N01/). A WCD estimate is required under OPA for oil spill planning purposes. Owners or operators of offshore pipelines are required to submit an OSRP for any pipeline that carries oil, condensate, or gas with condensate; pipelines carrying essentially dry gas do not require an OSRP. Current OSRPs are also required for abandoned facilities until they are physically removed or dismantled.

OSRPs are a requirement of the Clean Water Act, and according to that Act, BSEE must approve OSRPs that contain the following elements:

> (i) be consistent with the requirements of the National Contingency Plan and Area Contingency Plans (ACPs);
> (ii) identify the qualified individual having full authority to implement removal actions, and require immediate communications between that individual and the appropriate Federal official and the persons providing personnel and equipment pursuant to clause;
> (iii) identify, and ensure by contract or other means approved by the U.S. President the availability of, private personnel and equipment necessary to remove to the maximum extent practicable a worst case discharge (including a discharge resulting from fire or explosion), and to mitigate or prevent a substantial threat of such a discharge;

(iv) describe the training, equipment testing, periodic unannounced drills, and response actions of persons on the vessel or at the facility, to be carried out under the plan to ensure the safety of the vessel or facility and to mitigate or prevent the discharge, or the substantial threat of a discharge;
(v) be updated periodically; and
(vi) be resubmitted for approval of each significant change.

Following DWH, BSEE issued NTL 2012-N06, Guidance to Owners and Operators of Offshore Facilities Seaward of the Coast Line Concerning Oil Spill Response Plans, that clarifies, "The response strategy should also consider ….wildlife protection, rescue and rehabilitation strategies and real-time response capability." Specifically, the NTL requires plans to include:

- procedures to rehabilitate wildlife that have become oiled
- a discussion on how the Lessee will obtain authorization to initiate capturing and cleaning of wildlife
- a thorough discussion of wildlife rehabilitation procedures including personnel, equipment, and supplies that will be used to establish and operate a rehabilitation station
- the source of those personnel, equipment, and supplies

The NTL also specifies that in regard to stranded oiled animals, "The term 'remove' is defined at 30 CFR §254.6 as 'containment and cleanup of oil from water and shorelines or the taking of other actions as may be necessary to minimize or mitigate damage to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, public and private property, shorelines, and beaches."

3.1.3.7 Pipeline Permits

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

The responsibility for transportation-related facilities, including pipelines, located landward of the coastline, was re-delegated to the Department of Transportation (DOT) by Executive Order 12777. The DOT retains jurisdiction for deepwater Ports and their associated seaward pipelines pursuant to Executive Order 12777 (Oct. 18, 1991). The term "coastline" is defined in the Submerged Lands Act (43 USC § 1301(c)) to mean "the line of ordinary low water along that portion of the coast which is in direct contract with the open sea and the line marking the seaward limit of inland waters."

3.1.3.8 Platform or other Facility Removal Permits for Decommissioning

During exploration, development, and production operations, temporary and permanent equipment and structures are often required to be embedded into or placed onto the sea floor around activity areas. In compliance with section 22 of the OCS Oil and Gas Lease Form (Form BOEM-2005) and OCSLA regulations (see 43 USC § 1334 and 30 CFR§ 250.1710—Wellheads/Casings and 30 CFR § 250.1725—Platforms and Other Facilities), operators are required to remove all such sea floor obstructions and facilities from their leases within one year of lease termination or after a structure has been deemed obsolete or unusable. These decommissioning regulations also require the operator to sever bottom-founded objects and their related components at least 5 meters (15 feet) below the mudline (30 CFR §250.1716(a)—Wellheads/Casings and 30 CFR §250.1728(a)—Platforms and Other Facilities). Additional requirements establish site-clearance verification procedures (30 CFR §250.1740 to 30 CFR §250.1743) that may include running trawls, remotely-operated vehicles (ROVs), or survey sonars over predetermined radii, depending upon water depth and structure type. There are over 2,000 active production platforms in the Gulf of Mexico (BOEM 2016).

Requirements for decommissioning OCS pipelines are found in 30 CFR §250.1750 through 30 CFR §250.1754. The 30 CFR §250, Subpart Q regulations are further elaborated in NTL No. 2001-G08 that provide lessees and contractors additional information and application/reporting procedures. The severance operations are generally categorized as explosive or non-explosive. The previous NMFS biological opinion concerning impacts on endangered and threatened species associated with explosive severance activities is being superceded by this programmatic opinion. All of the current terms and conditions of structure and well removal activities that are proposed for this formal consultation are outlined in NTL 2018-G03, "Idle Iron Decommissioning Guidance for Wells and Platforms," which BSEE last renewed on December 11, 2018.

3.1.3.9 Air Quality Permits under OCSLA

Air pollutants are commonly emitted from OCS sources. These sources may include equipment that combust fuels, or transport and/or transfer hydrocarbons. The USEPA and BOEM are responsible for administering the CAA and OCSLA, respectively, for air emissions resulting from oil and gas related activities over portions of the OCS. This section addresses BOEM's responsibilities under the OCSLA; Section 3.2 below addresses USEPA responsibilities.

BOEM is responsible for implementing air quality measures on OCS oil and gas activities in Gulf of Mexico waters west of 87.5°W longitude. OCSLA mandates that the Secretary of the DOI prescribe regulations providing for compliance with the National Ambient Air Quality Standards (NAAQS) established pursuant to the CAA, to the extent that the OCS oil and gas activities authorized under OCSLA significantly affect the air quality of any state (43 USC

§1334(a)(8); see also 30 CFR §550). The USEPA has set NAAQS for six principal pollutants called "criteria" pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution[10] (listed as PM2.5 and PM10), and sulfur dioxide. All new or supplemental EPs and DOCDs, and revised DOCDs must include air emissions information sufficient to determine whether an air quality review is required (30 CFR §550.218 and §550.249).

BOEM regulations require a review of air quality emissions during the plan approval process to determine if the projected emissions from a facility result in onshore ambient air concentrations that may require appropriate emissions controls to mitigate potential onshore air quality degradation. A permit applicant performs an initial screening analysis to determine whether "exemption" levels will be exceeded (https://www.boem.gov/Approved-Air-Quality-Models-for-the-GOMR/). If the exemption level will be exceeded, the company performs modeling to determine whether the BOEM "significance" levels will be exceeded onshore. If the modeling shows BOEM's significance levels will be exceeded, best available control technologies (BACTs) must be applied. When modeling demonstrates no impacts according to BOEM's significance levels, then no BACT is needed and a plan is approved.

3.1.4 Descriptions of Activities Authorized under Plans and Permits

The following sections describe in detail the activities implemented under the plans and permits discussed above, including inspection and enforcement activities by the action agencies, and measures required by all operators specifically to avoid or minimize harm to the environment and protected resources. This discussion will facilitate identification of the routes of potential adverse effects to ESA-listed species or designated critical habitats from the proposed action which will be introduced in Section 5 and discussed in detail in Section 99 of this opinion.

Under any of these activities, technologies continue to evolve to meet the technical, environmental, and economic challenges of oil and gas development. New technologies as part of the Oil and Gas Program are discussed in Section 3.1.4.11, below.

3.1.4.1 Geological and Geophysical Surveys

Geophysical surveys routinely occur every day in the Gulf of Mexico. As relevant to the proposed action, G&G surveys are conducted to (1) obtain data for hydrocarbon and mineral exploration and production, (2) aid in siting of oil and gas structures, facilities, and pipelines, (3) identify possible seafloor or shallow-depth geologic hazards, and (4) locate potential archaeological resources and benthic habitats that should be avoided. Data needs and the target of interest drive the selection of a specific technique or suite of techniques.

Specific geophysical surveys may span a single day, weeks, or months. Geophysical surveys would be conducted in federal or state waters of the Gulf of Mexico; however, BOEM and BSEE only have jurisdiction in federal waters. Extensive G&G exploration activity has occurred in the

[10] BOEM has not adopted the revised standards for particulates.

Gulf of Mexico, mainly in the WPA and CPA. BOEM defines two main categories of seismic surveys: (1) deep seismic (Ocean Bottom, Vertical Seismic Profile (VSP) or borehole, 2D, 3D, 4D and wide azimuth surveys (WAZ)), and (2) high resolution surveys, which include airgun and non-airgun equipment (Table 4). Using recent permit application information, BOEM has estimated future seismic activity (Table 4 and Table 5).

Table 4. Summary of all types of geophysical and geological activities over ten years for the Gulf of Mexico Oil and Gas Program (BOEM 2017e).

Survey Type	O&G	REN	MMP	
Deep-Penetration Seismic Surveys				Most, if not all deep-penetration seismic surveys require the use of airguns. Seismic surveys evaluate subsurface geological formations to assess potential hydrocarbon reservoirs and optimally site exploration and development wells. The 2D surveys provide a cross-sectional image of the Earth's structure while 3D provide a volumetric image of underlying geological structures. Repeated 3D surveys result in time lapse, or 4D, surveys that assess the depletion of a reservoir. The VSP surveys provide information about geologic structure, lithology, and fluids.
2D Seismic Surveys	X	--	--	
3D Seismic Surveys	X	--	--	
Ocean-Bottom 2D Seismic Surveys (Cable or Nodes)	X	--	--	
Ocean-Bottom 3D Seismic Surveys (Cable or Nodes)	X	--	--	
Wide-Azimuth and Related Multi-Vessel Surveys	X	--	--	
Borehole Seismic Surveys (2D and 3D VSP Surveys)	X	--	--	
Vertical Cable Surveys	X	--	--	
4D Time-Lapse Surveys	X	--	--	
Airgun High-Resolution Geophysical Surveys				A single airgun used to assess shallow hazards, benthic habitats, renewable energy structure emplacement.
High-Resolution Seismic Surveys	X	X	-	
Non-Airgun Acoustic High-Resolution Geophysical Surveys				Assess shallow hazards, potential sand and gravel resources for coastal restoration, archaeological resources, and benthic habitats. Devices used in subbottom profiling surveys include • Sparkers; • Boomers; • Pingers; and • CHIRP subbottom profilers.
Subbottom Profiling Surveys	X	X	X	
Side-Scan Sonars	X	X	X	
Single-Beam and Multibeam Echosounders	X	X	X	
Non-Acoustic Marine Geophysical Surveys				Electromagnetic signals are used to develop a conductivity/ resistivity profile of the seafloor, helping to identify economic hydrocarbon accumulations and aid with archaeological surveys.
Marine Gravity Surveys	X	--	--	
Marine Magnetic Surveys	X	--	--	
Marine Magnetotelluric Surveys	X	--	--	
Marine Controlled Source Electromagnetic Surveys	X	--	--	
Airborne Remote Surveys				Gravity and magnetic surveys are used to assess structure and sedimentary properties of subsurface horizons. Airborne magnetic surveys evaluate deep crustal structure, salt-related structure, and intra-sedimentary anomalies.
Airborne Gravity Surveys	X	--	--	
Airborne Magnetic Surveys	X	--	--	
Geological and Geotechnical Surveys				Collect surface and near surface sediment samples to assess seafloor properties for siting structures such as platforms, pipelines, or cables. Different types of geologic cores include • gravity corers; • multicorers; • piston corers; • rotary corers; • ROV push cores; and • vibracorers.
Grab and Box Sampling	X	X	X	
Geologic Coring	X	X	X	
Shallow Test Drilling	X	X	--	
COST Wells	X	X	--	
Cone Penetrometer Tests	X	X	--	Geologic coring is also used to assess sediment characteristics for use in coastal restoration projects. Shallow test drilling is conducted to place test equipment into a borehole to evaluate gas hydrates or other properties. The COST wells evaluate stratigraphy and hydrocarbon potential without drilling directly into oil and gas bearing strata.
Other Surveys and Equipment				The devices in this category assist in the execution of surveys, either by providing location or facilitating underwater service tasks. Additionally, water guns are no longer used as a seismic source except in extremely rare instances.
Acoustic Pingers	X	X	--	
Transponders, Transceivers, Responders	X	X	--	
ROVs and AUVs	X	X	--	

2D = two-dimensional; 3D = three-dimensional; 4D = four-dimensional; AUV = autonomous underwater vehicle; CHIRP = compressed high intensity radar pulse; COST = continental offshore stratigraphic test; HRG = high-resolution geophysical; MMP = Marine Minerals Program; O&G = Oil and Gas Program; REN = Renewable Energy Program; ROV = remotely operated vehicle; VSP = vertical seismic profile. All three program areas including oil and gas (O&G), renewable energy (REN) and marine minerals (MMP) were addressed in BOEM's draft PEIS. However, this opinion only covers BOEM's Oil and Gas Program.

Table 5. Summary of projected levels of geological and geophysical activities over ten years for the Gulf of Mexico Oil and Gas Program (BOEM 2016; BOEM 2017e).

Geophysical or Geological Activity	Units	Oil & Gas
HRG Surveys (Airgun and Non-Airgun)	# of Surveys	716
	Line Miles	103,025
VSP Surveys	# of Surveys	561
	Line Miles	16,992
SWD Surveys	# of Surveys	100
	Line Miles	0
2D Surveys	# of Surveys	23
	Line Miles	149,800
3D Surveys	# of Surveys	69
	Line Miles	649,420
WAZ Surveys	# of Surveys	62
	Line Miles	561,432
4D Surveys	# of Surveys	101
	Line Miles	1,108,378
Total 3D, WAZ, 4D Survey	# of Surveys	232
	Line Miles	2,319,230
CSEM	# of Surveys	12
	Line Miles	8,120
CPT	Number	100
Corings	Number	795
Grab Sample	Number	1
Vibracores	Number	0
Jet Probe	Number	0
Bottom Sampling Subtotal	Number	896
Bottom Impacts (10 m^2/sample)	m^2	8,960
Shallow Drill Test Wells	Number	2
COST Wells	Number	1
Bottom Impacts (20,000 m^2/well)	m^2	60,000
Bottom-Founded Monitoring Buoy	Number	0
Bottom Impacts	m^2	0
(Footprint 0.56 m^2/buoy +		
Sweep 34,000 m^2/buoy)		
Total Bottom Impacts	m^2	

2D = two-dimensional; 3D = three-dimensional; 4D = four-dimensional; COST = Continental Offshore Stratigraphic Test; CPT = cone penetrometer test; CSEM = controlled source electromagnetic; HRG = high-resolution geophysical; m^2 = square meters; SWD = seismic while drilling; VSP = vertical seismic profile; WAZ = wide azimuth (survey).

Seismic surveys are performed before lease sales to identify potential areas of hydrocarbons to inform future leasing decisions, including review of seismic data by BOEM to determine fair market value of a lease. Seismic surveys also occur after a lease is issued for a variety of reasons, such as further identifying drilling locations (and thus potentially reducing the number of dry holes); identifying archaeological sites, potential shallow geologic and manmade hazards for engineering; monitoring reservoir levels over time; and site planning for bottom-founded structures.

In general, seismic surveys are deep penetrating and are used to obtain data about geologic formations greater than 300 meters below the sea floor. Typical seismic surveying operations tow a seismic sound source eight to 12 meters below the sea surface. The seismic sound source is generally an airgun array, but it may also be a boomer, sparker, or other technology. One or more streamers (cable(s) with hydrophone signal receivers) are also towed behind the vessel. For towed equipment that has the potential to capture/entrap sea turtles, such as tail bouys, turtle guards are used. An alternative to streamers is the deployment of geophones either connected to ocean-bottom cables (OBC) or ocean-bottom nodes (OBN) placed individually on the sea floor. The airgun array produces underwater sound waves by releasing compressed air into the water column, creating an acoustical energy pulse. The intermittent release of compressed air creates a regular series of strong acoustic impulses separated by silent periods lasting up to 16 seconds (s), depending on survey type and depth to the target formations. The acoustic signals are reflected off subsurface structures and sediments and recorded back near the surface via the hydrophones in the streamer(s) or nodes/geophones. Streamers are often three to 12 kilometers in length. The speed at which the vessels tow them varies depending on the type of survey, but it is typically between three and 4.5 knots (about five to eight kilometers per hour) with gear deployed.

An airgun source can consist of a single device, but most often it is made up of an array or arrays of airguns configured in different ways to produce a desired signal to map certain areas for deep geologic features and oil and gas deposits. Airguns can be towed behind a vessel or suspended into the water from a drilling rig or workboat to survey the area around a well being drilled. The general principal of the airgun is that air is highly pressurized into a cylinder (the airgun), the airgun releases the pressure and discharges a sound pulse toward the sea floor. The pulse travels to the sea bottom and penetrates the subsurface, and the sound signals are reflected by subsurface geologic features (Figure 4 and Figure 5). Signals are recorded by hydrophones towed behind a vessel, geophones deployed down a well, or by receivers (cables or nodes) placed directly on the sea floor.

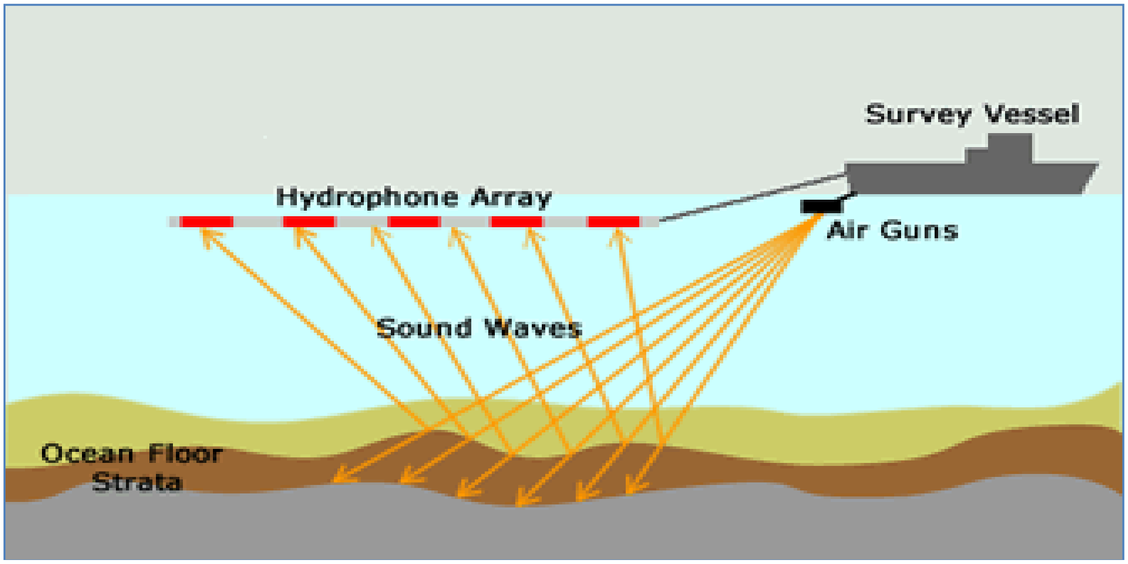


Figure 4. Diagram of a seismic survey vessel towing both an airgun array and hydrophone cables. Figure from BOEM BA supplemental information.

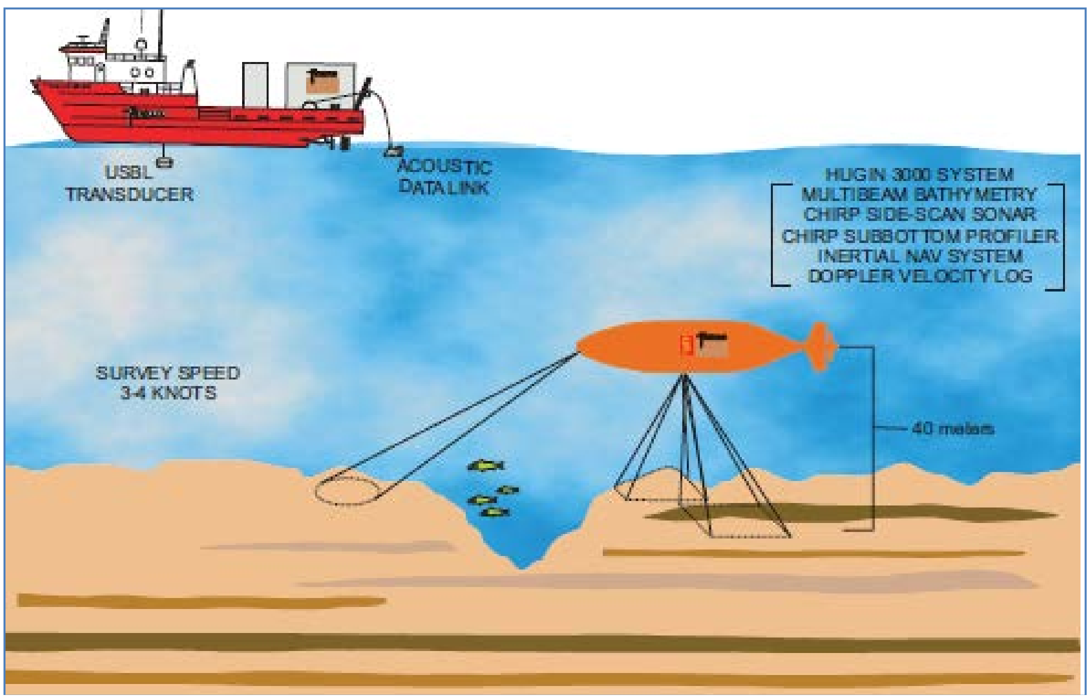


Figure 5. Example of a common high-resolution geophysical survey configuration in the Gulf of Mexico. Figure from BOEM BA supplemental information.

The simultaneous discharge of highly pressurized air from the airguns results in a very loud "bang" several times each minute. The frequency of the bangs depends on the survey and number of source vessels used. Pathways for the transmission of seismic survey sound include direct paths through the water from the airguns, indirect paths that include reflection from the sea surface and bottom, and other pathways depending on the type of bottom sediments. For specific projects, seasonally and spatially variable environmental characteristics such as temperature and salinity can be modeled because they also play a role in determining the frequencies and sound level propagation.

Other G&G sound sources involve various types of sonars that map bottom and subsurface features in greater detail. These HRG surveys are conducted in a similar way, but they use sound sources other than airguns. HRG surveys typically use mid- and high-frequency sound sources attached to the vessel, a towfish (an instrument towed behind a vessel), or an AUV. The largest differences between airgun sound sources and HRG surveys include the frequency of the sound sources (HRG sources are higher frequencies), the source level of the sound sources (HRG source levels are a lower sound level than airguns), and the tow depth of the sound sources (HRG sources are deployed lower in the water column than airguns).

3.1.4.2 Deep Seismic Airgun Surveys

For 2D seismic surveys, a single streamer is towed behind the survey vessel, together with a single source or airgun array. Seismic vessels generally follow a systematic pattern during a survey, typically a simple grid pattern for 2D work, with lines typically no closer than half a kilometer. In simplified terms, 3D surveys collect a very large number of 2D slices, with minimum line separations of only 25-30 meters. A 3D survey may take many months to complete (e.g., three to 18 months) and involves a precise definition of the survey area and transects, including multiple passes to cover a given survey area. For seismic surveys, 3D methods represent a substantial improvement in resolution and useful information relative to 2D methods. Consequently, most areas in the Gulf of Mexico that were surveyed using 2D have been re-surveyed using 3D methods.

The 3D seismic surveying provides the opportunity to create higher resolution subsurface images and to resolve imaging challenges, thereby enabling a more accurate assessment of potential hydrocarbon reservoirs. As a result, the oil and gas industry is able to optimally locate and successfully develop wells, while minimizing the number of exploratory wells required. State-of-the-art interactive computer mapping systems can handle much denser data coverage than the older 2D seismic surveys. Multiple-source and multiple-streamer technologies are used for 3D seismic surveys. A typical 3D survey might employ a dual array of 18 air guns per array. At 10 meters from the source, the resultant pressure is approximately ambient pressure plus one atmosphere. The streamer array might consist of six to eight parallel cables, each 3,000-12,000 meters long, spaced 25-100 meters apart. An 8-streamer array used for deepwater surveys is typically 700 meters wide. A series of 3D surveys collected over time (commonly referred to as four-dimensional or 4D seismic surveying) is used for reservoir monitoring and management (the movement of oil, gas, and water in reservoirs can be observed over time). Increasingly, the data collected in a 3D seismic survey can be processed to provide near surface images adequate for many of the needs previously met by high-resolution surveys.

Wide-azimuth towed-streamer (WAZ) surveys have emerged in the last few years as a step change in marine surveying technology in the Gulf of Mexico. This came about because the risky exploration and development of deepwater subsalt reservoirs required seismic data to have better illumination, higher signal-to-sound ratio, and improved resolution. Wide azimuth acquisition configurations involve multiple vessels operating concurrently in a variety of source vessel-to-acquisition vessel geometries. Several source vessels (usually two to four) are used in coordination with single or dual receiver vessels either in a parallel or rectangular arrangement with a typical 1200-meter vessel spacing to maximize the azimuthal quality of data acquired. It is not uncommon to have sources also deployed from the receiver vessels in addition to source-only vessels. This improves the signal-to-sound ratio and helps to better define the salt and subsalt structures in the deep waters of the Gulf of Mexico. Coiled (spiral) surveys are a further refinement of the wide azimuth acquisition of subsalt data. These surveys can consist of a single source/receiver arrangement or a multi-vessel operation with multiple sources where the vessels navigate in a coiled or spiral pattern over the area of acquisition.

Deep seismic surveying is deeper penetration into the crust layers than other survey types, high energy and low frequency (2D, 3D, 4D or WAZ) and may also be done on leased blocks for more accurate identification of potential reservoirs, thereby aiding in the identification of additional reservoirs in “known” fields. Three-dimensional technology can be used in developed areas to identify bypassed hydrocarbon-bearing zones in currently producing formations and new productive horizons near or below currently producing formations. It can also be used in developed areas for reservoir monitoring and field management. Four-dimensional seismic surveying is predominantly used for on-lease reservoir monitoring and management. Through time-lapse surveys, the movement of oil, gas, and water in reservoirs can be observed over time, and that information is used to adjust production techniques and decisions, leading to more efficient production of the reservoir and the ultimate recovery of a greater portion of the original oil and gas in place. Surveying may occur periodically throughout the productive life of a lease, as frequently as every six months.

3.1.4.3 Ocean-Bottom Airgun Surveys

Ocean-bottom surveys can use either cables or nodes. OBC surveys were originally designed to enable seismic surveys in congested areas (e.g., producing fields) with their many platforms and producing facilities. OBNs are deployed and retrieved by either cable or remotely operated vehicles (ROVs) that are now used as an alternative to cables. OBC surveys have been found to be useful for obtaining multi-component (i.e., seismic pressure, vertical, and the two horizontal motions of the water bottom, or sea floor) information. OBCOBC surveys and nodal acquisition require the use of multiple ships (usually two ships for cable or node layout/pickup, one ship for recording, one ship for shooting, and two utility boats). These ships are generally smaller than those used in streamer operations. Operations are conducted “around the clock” and begin by dropping the cables off the back of the layout boat or by deployment of the nodal receivers by ROVs. Cable length or the number of nodes depend upon the survey demands; cable length is typically 4.2 kilometers but can be up to 12 kilometers. Depending on spacing and survey size, hundreds of nodes can be deployed and re-deployed over the span of the survey. Groups of seismic detectors, usually hydrophones and vertical motion geophones, are attached to the cable in intervals of 25-50 meters. Multiple cables/nodes are laid parallel to each other using this layout method with a 50-meter interval between cables/nodes. Typically, dual airgun arrays are used on a single-source vessel. When the cable/node is in place, a ship towing an airgun array (which is the same airgun array used for streamer work) passes between the cables/nodes, firing every 25 meters. Sometimes a faster source ship speed of six knots, instead of the normal 4.5 knot speed, is used with a decrease in time between gun firings. After a source line is shot, the source ship takes about 10-15 minutes to turn around and pass down between the next two cables or line of nodes. When a cable/node is no longer needed to record seismic data, it is picked up by the cable pickup ship and is moved over to the next position where it is needed. The nodes are retrieved by an ROV. A particular cable/node can lay on the bottom anywhere from two hours to several days, depending upon operation conditions. Normally a cable will be left in place about seven to ten days. However, nodes may remain in place until the survey is completed or recovered and then re-deployed by an ROV.

Location of the cables/nodes on the bottom is done by acoustic pingers located at the detector groups and by using the time of first arrival of the seismic pulse at the detector group. Acoustic pingers use frequencies in the 9-13 kHz range. A detector group is a node or group of nodes that enable the seismic ship to accurately determine node location. To obtain more accurate first arrival times, the seismic data are recorded with less electronic filtering than is normally used. This detailed location is combined with normal navigational data collected on the source ship. In deep-water, the process of accurately locating bottom cables/nodes is more difficult because of the effects of irregular water bottoms and of the thermal layers, which affect travel times and travel paths, thus causing positioning errors.

3.1.4.4 High Resolution Airgun Surveys

High-resolution airgun surveys collect data on surface and near-surface geology used to identify archaeological sites, potential shallow geologic and manmade hazards for engineering, geohazards and soil conditions, site planning for bottom-founded structures , as well as to identify potential benthic biological communities (or habitats) and archaeological resources in support of review and mitigation measures for OCS exploration and development plans. Informationcan also be recovered at much greater depths, so that some surveys are used for exploration purposes. A typical operation consists of a ship towing an airgun or array (about 25 meters behind the ship) and a 600-meter streamer cable with a tail buoy (about 700 meters behind the ship). The ship travels at 3-3.5 knots (5.6-6.5 kilometers per hour), and the airgun is fired every seven to eight seconds (or about every 12.5 meters along a track line). Typical surveys cover one lease block, which is usually 4.8 kilometers on a side. BOEM regulations require information be gathered on a 300- by 900-meter grid, which amounts to about 129 kilometers of trackline data per lease block. For blocks identified by BOEM as having a high probability for the presence of historic archaeological resources (i.e., shipwrecks), grid points must be on a 50-meter spacing (see NTL No. 2011-Joint-G01, http://www.boem.gov/Regulations/Notices-To-Lessees/2011/2011-JOINT-G01-pdf.aspx). Including line turns, the time to survey one block is about 36 hours; however, streamer and airgun deployment and other operations add to the total survey time.

3.1.4.5 Non-airgun, Sound-producing High Resolution Surveys

High-resolution surveys may use airguns but also use other sound sources, such as sub-bottom profilers (at 2.5-7 kilohertz [kHz]), echosounders (single-beam at 12-240 kHz; multibeam at 50-400 kHz), boomers (at 300-3,000 hertz [Hz]), sparkers (at 50-4,000 Hz), compressed high intensity radar pulse (CHIRP) sub-bottom profiler (at 4-24 kHz), pingers (at 2 kHz), and side-scan sonars (16-1,500 kHz). These sound sources are typically powered either mechanically or electromagnetically.

Deep-Tow, Sidescan-Sonar, Single Beam Echosounder, or Multi-beam Echosounder Surveys.

These surveys are conducted primarily for studies associated with the placement of production facilities and pipelines. These surveys typically use a towed autonomous underwater vehicle, and provide information on the presence of sand flows, hydrates, seeps, and bottom topography (e.g., hard bottom). Operations are conducted from ships towing cables up to seven kilometers long, which enable operations in water depths up to 3,000 meters deep. Close to the end of the cable is a 30-45-meter long section of chain to keep the sensor package (fish) tracking at approximately 25-30 meters above the bottom. This requires the chain to be dragged along the sea floor, which cuts a trench in the sea floor approximately 10 centimeters wide by 15 centimeters deep (four inches wide by six inches deep). In situations where the chain could become entangled in shipwrecks, well heads, or other obstructions or where reef colonies live, the chain is removed, and the sensor package is kept above the sea floor by adjusting the length of the tow cable. Maintaining a constant elevation above the sea floor by adjusting the cable length is very difficult, and the elevation above the sea floor is somewhat greater in this case. These sources are often used simultaneously with airguns during deep-penetration seismic surveys.

Subbottom Profiling Surveys.

Sparkers, boomers, pingers and CHIRPs each function differently but all provide similar data for shallower penetration of the subsurface (first few inches to feet). Sparkers use electricity to turn water into a vapor pulse that can penetrate several hundred feet into the subsurface and they are usually towed on one side of the ship opposite the hydrophone array on the other side of the ship. Boomers use electricity to cause two spring-loaded plates to push away from each other. They are usually towed behind the vessel on a towed sled. A pinger creates a weaker sound source which remains at one frequency and CHIRPs sweep through multiple frequencies and receive relatively clear echo returns.

Non-Sound Producing Geophysical Surveys

Marine gravity data can be collected with instruments on the sea floor, in boreholes, ships, helicopters or planes. Data were originally collected on the sea floor, but technology has moved the collection point to ships. Marine gravity meters have, in some cases, been housed in a ship while it is conducting a seismic survey. Another method of collection uses dedicated ships (about 50 meters long) to collect an independent gravity dataset. Global positioning navigation systems and larger, more stable seismic ships make it possible to achieve the same order of accuracy with gravity meters placed in seismic ships as in dedicated ships. Data grids for gravity surveys typically range from 0.8 x 1.6 kilometers or 1.6 x 1.6 kilometers to higher altitude flying 6 x 19 kilometers or 13 x 39 kilometers.

Marine magnetic surveys measure Earth's magnetic field to determine structure and sedimentary properties of subsurface horizons. These surveys are usually conducted in conjunction with a seismic survey, allowing the navigation information to be used for both surveys. The development of low-power digital sensors has allowed the sensor package to be towed behind the seismic source array, which has greatly improved the operational efficiency of magnetic surveys.

Magnetotelluric surveys are passive measurements of Earth's electromagnetic fields. Electromagnetic surveys are used to help delineate potential oil and gas reservoirs. Many geological processes in the crust and upper mantle of the sea floor involve the interaction of fluid phases with surrounding rock. The conductivities of hydrothermal phases are different from those of host rock, and collectively they offer distinct profiles of electrical conductivity/resistivity depending on the specific geological process involved. Controlled source electromagnetic surveys (CSEM) induce very low frequency (typically less than two Hz) electromagnetic signals into the upper layers of the sea floor via a towed dipole. The signals are propagated laterally to an array of receivers kilometers away. The variations in the electromagnetic field relative to the geometry of the receiver arrays and distance provide a conductivity/resistivity profile of the sea floor. From the profile, hydrocarbon reservoirs can be differentiated from water reservoirs and surrounding rock.

Aeromagnetic and Airborne Gravity Surveys are conducted to assess structure and sedimentary properties of the subsurface. Aeromagnetic surveys specifically look for deep crustal structure, salt-related structure, and intra-sedimentary anomalies. They are often flown by twin-engine, fixed-wing aircraft, typically Cessna 404s or 208s, Piper Aerostars, or Navajos. The flight lines are on the order of 400 kilometers long at a height of 75-150 meters above the surface and are flown at speeds of about 220 kilometers per hour.

Geological and Geochemical Sampling

Geochemical sampling is conducted to obtain samples of the sea floor for physical and/or chemical analyses. Sampling results are used to site structures such as platforms and pipelines. Chemical analyses (surface geochemical prospecting) are based on the premise that upward migrated petroleum from deep source rocks and reservoirs can be detected in near-surface sediments and can be used to evaluate exploration potential. Bottom sampling uses devices that penetrate anywhere from a few centimeters to several meters below the sea floor. Samples of near-surface sediments are typically obtained by dropping a piston core or gravity core (dart-essentially a weighted tube) to the ocean floor and recovering it with an attached wire line. Samples can also be obtained using a grab (a device with a jaw-like mechanism) or with a dredge, which is a wire cage dragged along the sea floor. Shallow coring is done by conventional rotary drilling equipment from a drilling barge or boat. Penetration is usually limited to the recovery of several feet of consolidated rock. Usually a program of bottom sampling and shallow coring is conducted simultaneously using a small marine drilling vessel.

Table 6. Projected levels of non-sound producing geological and geophysical activities over a ten year period in survey line distance (miles). Parenthetical numbers represent number of surveys. From (BOEM 2017e).

Year	Western Planning Area			Central Planning Area			Eastern Planning Area		
	Geologic Coring	CSEM	Drilling Test [A]	Geologic Coring	CSEM	Drilling Test [A]	Geologic Coring	CSEM	Drilling Test [A]
Year 1	0	0	0	(2) 20 cores	(1) 760 miles	0	(1) 15 cores	0	0
Year 2	0	(1) 660 miles	0	(3) 80 cores	(2) 1,520 miles	0	(2) 30 cores	0	0
Year 3	(1) 10 cores	0	0	(4) 90 cores	0	0	(2) 30 cores	0	0
Year 4	0	0	0	(2) 20 cores	(1) 760 miles	0	(2) 80 cores	0	0
Year 5	(1) 40 cores	(1) 660 miles	0	(2) 60 cores	0	0	0	(1) 460 miles	0
Year 6	0	(1) 660 miles	0	(2) 20 cores	(1) 760 miles	0	(2) 30 cores	0	0
Year 7	0	0	(1) 1 well	0	0	0	0	0	0
Year 8	0	0	0	(5) 95 cores	0	0	(2) 30 cores	0	0
Year 9	(2) 20 cores	(1) 660 miles	0	0	(1) 760 miles	(1) 1 well	0	(1) 460 miles	0
Year 10	0	0	0	(5) 95 cores	0	0	(2) 30 cores	0	0
Totals	(4) 70 cores	(4) 2,640 miles	(1) 1 well	(25) 480 cores	(6) 4,560 miles	(1) 1 well	(13) 245 cores	(2) 920 miles	0

[A] Penetration <150 meters (500 feet). CSEM = controlled-source electromagnetic. Typically, one OCS block is nine square miles (23.3 square kilometers, 2,331 hectares, or 5,760 acres).

3.1.4.6 Drilling

Oil and gas operators use drilling terms to represent stages in the discovery and exploitation of hydrocarbon resources. "Exploration well" generally refers to the first well drilled on a prospective geologic structure to confirm that a resource exists and to validate how much of the resource can be expected. If the quantities of the discovered resource appear to be economically viable, one or more follow-up "delineation wells" help define the amount of the resource or the extent of the reservoir. Following a discovery, an operator often temporarily plugs and abandons exploration and/or delineation wells to allow time for a development scenario to be generated and for equipment to be built or procured. Table 2 above presents a summary of oil and gas exploration and development as a result of one lease sale. For all new leases issued in the ten-year period following issuance of this opinion (i.e., through about 2029), BOEM and BSEE estimate the following annual activity levels for *exploration and delineation wells*:

- WPA: 30-43 exploration and delineation wells annually
- CPA: 143-203 exploration and delineation wells annually
- EPA: 0-1 exploration and delineation wells annually

For all new leases issued in the ten-year period following issuance of this opinion (i.e., through about 2029), BOEM and BSEE estimate the following activity levels for *development and production wells*:

- WPA: 37-53 development and production wells annually
- CPA: 177-251 development and production wells annually
- EPA: 0-1 development and production wells annually

Exploration and delineation wells are typically drilled with MODUs; for example, jack-up rigs, semi-submersible rigs, submersibles, platform rigs, or drill ships. Non-MODU drilling units, such as inland barges, are also used. The type of rig chosen to drill a prospect depends primarily on water depth. The depth ranges for exploration rigs are shown in Table 7.

Table 7. Drilling rig types typically associated with each corresponding depth range (BOEM 2017b)[11].

MODU or Drilling Rig Type	Water Depth Range (meters)
Jack-up, submersible, and inland barges	≤ 100
Semi-submersible and platform rig	100-3,000
Drillship	≥ 600

An average exploration well requires 30-120 days (mean of 60 days) to drill. The actual time for each well depends on many factors, including the depth of the prospect’s potential target zone, the complexity of the well design, and the directional offset of the wellbore needed to reach a particular zone. A typical scenario assumes that the average exploration or delineation well depth will be approximately 12,055 feet (3,674 meters) below mudline.

Figure 6 shows a generic well schematic for a relatively shallow exploration well in the deepwater Gulf of Mexico. This well design was abstracted from actual well-casing programs from projects in the Mississippi Canyon and De Soto Canyon OCS areas and from internal BOEM data. A generic well configuration cannot capture all of the possible influences that can impact how a well is designed. These influences include (1) unique geologic conditions at a specific well location, (2) directional drilling requirements, (3) potential sidetrack(s), andand (4)

[11] Pages 3-18.

company preferences. For exploratory wells, contingencies (such as anticipated water-flow zones in the formation) must also be considered in the casing program.

Delineation and production wells are sometimes collectively termed “development wells.” A development well is designed to extract resources from a known hydrocarbon reservoir. Sometimes an operator will decide to drill a series of development wells, move off location, and then return with a rig to complete all the wells at one time. If an exploration well is clearly a dry hole, the operator permanently abandons the well without delay. BOEM estimates that 89-90 percent of development wells will become “producing wells.” Development wells may be drilled from movable structures, such as jack-up rigs, fixed bottom-supported structures, floating vertically-moored structures, floating production facilities, and drill ships (either anchored or dynamically positioned drilling vessels). The range of these production systems are shown in Figure 7. The typical process includes setting and cementing the production casing, installing some down-hole production equipment, perforating the casing and surrounding cement, treating the formation, setting a gravel pack (if needed), and installing production tubing. One form of formation treatment is known as *fracking, or hydraulic fracturing,*—pressurizing the well to force chemicals or mechanical agents into the formation. Mechanical agents, such as sand or small microspheres (tiny glass beads), can be used to prop open the created factures which then act as conduits to deliver hydrocarbons to the wellbore. Well treatment chemicals are commonly used to improve well productivity. Well completion techniques and chemicals vary depending on the rock properties of the reservoir. For example, acidizing a reservoir to dissolve cementing agents and improve fluid flow is the most common well treatment in the Gulf of Mexico. BOEM (2017b) describes a typical process after the casing has been cemented, as to perforate the casing and cement, inject water, brine or gelled brine as carrier fluid for a “frac pack”/sand proppant pack and gravel pack; treating/acidizing the reservoir formation near the wellbore; installing production screens; running production tubing; and installing a production tree. More than 65 percent of the well completions may use frac-packs, or fracturing and gravel packing completion (BOEM 2017b). Well stimulation activities are BSEE-regulated by an “Application for Permit to Modify”.

In contrast to onshore fracking in low-permeability shale reservoirs, the majority of fracking offshore are frac-packs, which are small scale by comparison and most commonly used for high-permeability formations to reduce the concentration of sand and silt in the produced fluids and maintain high flow rates. Frac-packs, which use similar chemicals as those onshore, also remain proximally close to the borehole (usually less than about 30 m) (BOEM 2017b).

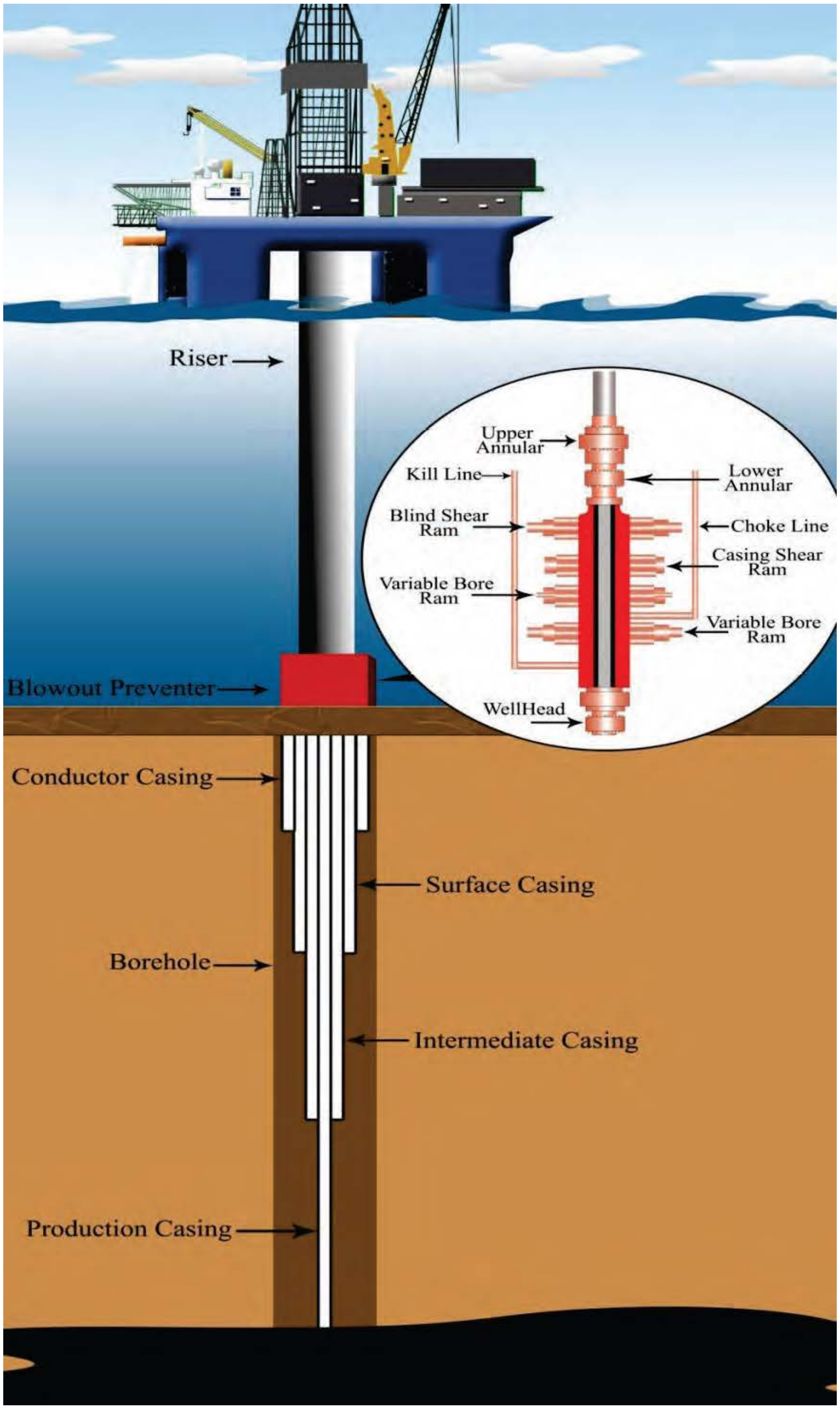


Figure 6. General well schematic (BOEM 2017b).

The type of production structure (Figure 7) installed at a site depends mainly on water depth, but also on the total facility lifecycle, the type and quantity of hydrocarbon production expected, the number of wells to be drilled, and the number of anticipated tie-backs from other fields. All of these factors can influence an operator's procurement decision. The number of wells per structure varies according to the type of production structure used, the prospect size, and the drilling/production strategy deployed for the drilling program and for resource conservation.

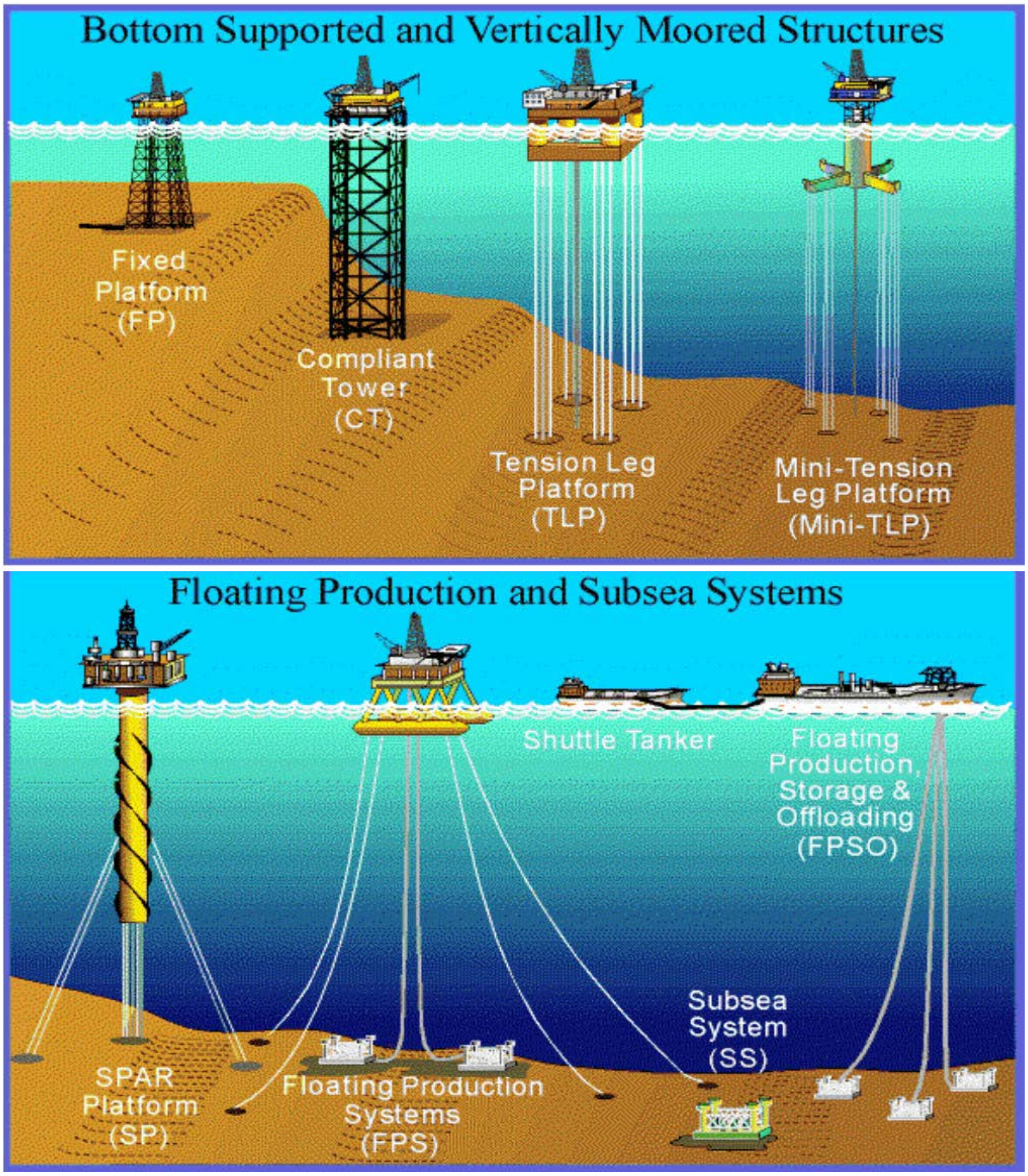


Figure 7. Deepwater development systems (BOEM 2017b).

Production systems can be fixed, floating, or, increasingly in deep water, subsea. BOEM has described and characterized production structures in its deepwater reference document (BOEM 2017b). In water depths of up to 1,312 feet (400 meters), a typical scenario assumes that conventional, fixed platforms that are rigidly attached to the sea floor will be the type of structure preferred by operators. In water depths of less than 656 feet (200 meters), 20 percent of the platforms are expected to be manned (defined as having sleeping quarters on the structure). In depths between 656 and 1,312 feet (200 and 400 meters), all structures are assumed to be manned. It is also assumed that helipads will be located on 66 percent of the structures in water depths less 197 feet (60 meters), on 94 percent of structures in water depths between 197 and 656 feet (60 and 200 meters), and on 100 percent of the structures in water depths greater 656 feet (200 meters). At water depths greater than 1,312 feet (400 meters), platform designs based on rigid attachment to the sea floor are not expected to be used. The 1,312-foot isobath appears to be the current economic limit for this type of structure.

3.1.4.7 Vessel Operations

The Gulf of Mexico Oil and Gas Program involves the operation of a variety of vessels. These include service vessels, barges, tankers, and G&G survey vessels.Vessel specifics are determined by the activity. For example, there may be vessels specific to anchor handling or pipe laying.

Service Vessels

Service vessels are one of the primary modes of transporting personnel and supplies between service bases (Figure 8) and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Cargo carried by service vessels to offshore sites includes fresh water, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food. A trip is considered the transportation from a service base to an offshore site and back; in other words, a round-trip. BOEM anticipates the following levels of vessel traffic over a ten year period (BOEM 2017e):

- WPA: 11,857-44,071 service vessel trips annually.
- CPA/EPA: 43,986-125,543 service vessel trips annually.

For cumulative scenarios over the next 70 years, BOEM estimates between 55,842 and 169,614 services vessel trips annually BOEM (2017b), which based on a comparison to an estimate of the total vessel traffic in the Gulf of Mexico in 2012, represents between six and 19 percent of all vessel traffic in the Gulf of Mexico.

Based on the model provided by Kaiser (2010), there were an average of 4.46 supply vessels needed per week during exploration and development drilling in shallow water and 6.4 supply vessels needed per week in deepwater. Drilling operations in shallow water takes less time (5.9 weeks), on average, when compared with deepwater drilling (10 weeks). A platform in shallow water (less than 800 m) is estimated to require one vessel trip every 3.1 days over the production life. A platform in deepwater (greater than or equal to 800 m) is estimated to require one vessel trip every 1.2 days over the production life. All trips are assumed to originate from the designated service base to an offshore site and back.

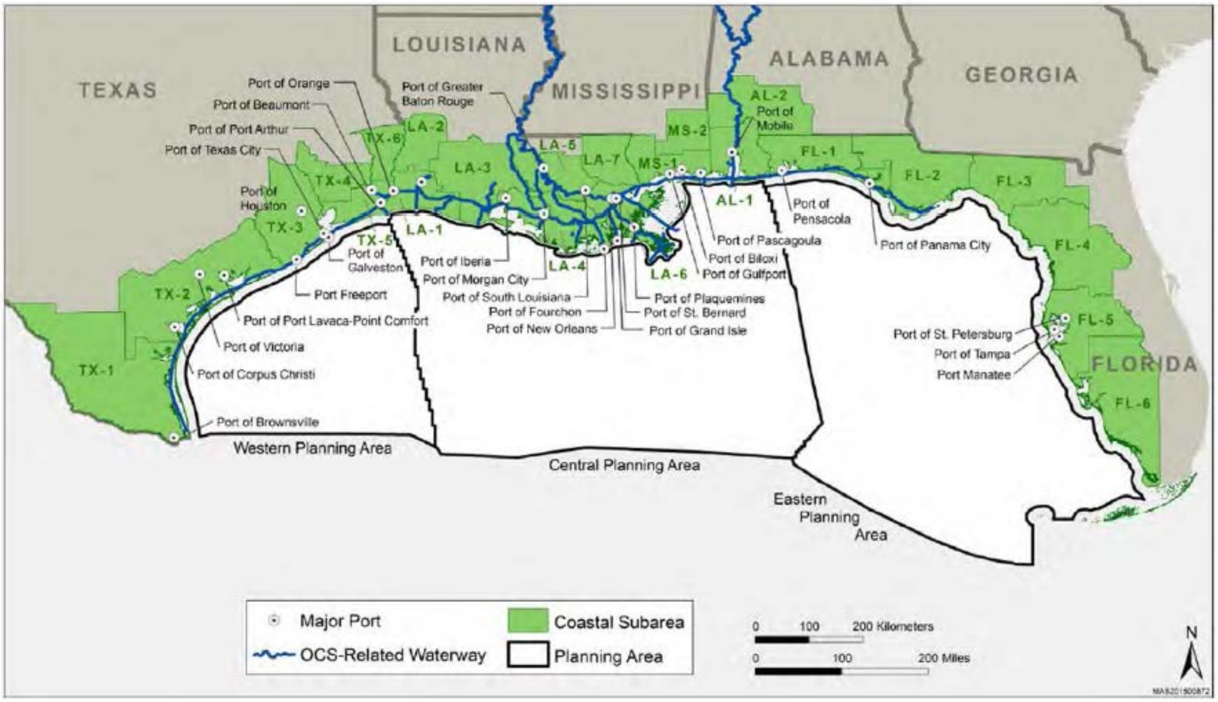


Figure 8. OCS-related service bases in the Gulf of Mexico (BOEM 2017b).

Service vessels primarily used in deep water are offshore supply vessels (OSVs), fast supply vessels, and anchor-handling towing supply/vessels (AHTSs). Other deepwater specialty service vessels are well stimulation vessels. The OSVs and AHTSs carry the same type of cargo (i.e., fresh water, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, food, and miscellaneous supplies) but have different functions. The AHTSs also differ from the supply vessels by their deepwater mooring deployment and towing capabilities.

Barges

Barges may be used offshore to transport oil and gas, supplies such as chemicals or drilling mud, or wastes between shore bases and offshore platforms. Barges are non-self-propelled vessels that must be accompanied by one or more tug boats. Because of this, barge transport is usually constrained to shallow waters, close to the shoreline. Barging of OCS oil from platforms to shore terminals is an option used by the oil industry in lieu of transporting their product to shore via pipeline. A platform operator generally decides at the beginning of a development project whether the production will be barged or piped. Barging is used very infrequently as an interim transport system before the installation of a pipeline system. About one percent of the oil produced in less than 60 meters in both the WPA and the CPA during the proposed action is expected to be barged to shore. Over the 40-year life of the leases, less than one percent of the total oil produced is expected to be barged.

Other types of barging operations may be carried out in connection with OCS operations. Besides barging from platform to shore terminal, some platform operators choose to barge their oil to other platforms where it is then off-loaded to storage tanks and later piped to shore.

Recently there has been some barging of oil from deepwater sites during extended well testing; this activity is likely to increase in the future. Storage and barging of the well stream from extended well tests is an alternative to flaring the gas and burning the liquids produced during well testing. No information is currently available on the number of barge trips associated with these other types of offshore oil barging operations.

Tankers

Tankers are used to transport oil from floating production and storage and off-loading units (FPSOs). FPSOs are floating production systems that store crude oil in tanks located in the hull of the vessel and that periodically off-load the crude to shuttle tankers for transport to shore. FPSOs may be used to develop marginal oil fields or used in areas too distant from the existing OCS pipeline infrastructure. Shuttle tankersvary in size, but they are primarily limited by the 34- to 47-foot water depths of U.S. Gulf Coast refinery ports. Because of these depth limitations, shuttle tankers are likely to have a cargo capacity of between 500,000-550,000 bbl. All shuttle tankers are required to be double hulled.

In the Gulf of Mexico, two FPSO systems, one associated with the Cascade Chinook Project, and another associated with the Shell Stones Project have shuttle tankers currently in operation. These tankers make seven-day round trips to refineries along the Gulf Coast, serving an area from Corpus Christi, Texas, to Pascagoula, Mississippi. As new wells and FPSOs are put in operation, additional shuttle tankers will be put into service and will visit FPSOs every three to five days. BOEM projects that in the next 70 years, at a maximum one new FPSO system would be put in place. For this FPSO, as well as the two currently in operation, BOEM estimates that when operating at maximum capacity, maximum offloading would occur once every 3.3 days, which would equate to 110 shuttle tanker transits across the Gulf of Mexico annually per FPSO (BOEM 2017e).

Vessels associated with Geological and Geophysical Activities

G&G activities are also expected to produce vessel traffic. BOEM estimated those levels, which are displayed in Table 8.

Table 8. Vessel traffic associated with geological and geophysical activities over ten years (BOEM 2017e).

Survey Type	Projected Vessel-Months[A]	Estimated Transits to Shore Base for Survey Vessels	Estimated Transits to Shore Base for Service Vessels
Vessel Based (2D, 3D, 4D, WAZ)	3,446	328	19,368
Platform Based (VSP, SWD)	66	165	19
Vessel Based (Non-Airgun HRG)	72	288	0
Other	17	24	107
Oil and Gas G&G Activities Subtotal		805	19,494
HRG	0.18	5	0
Sampling	0.1	27	0
Bottom-Founded Buoy	0.1	2	0
Renewable Energy G&G Activities Subtotal		34	0
HRG	18	90	0
Sampling	2	4	0
Vibracore/Jet	15	60	0
Marine Minerals G&G Activities Subtotal		154	0
Combined Total Transits		993	19,689

A Vessel months are used as a measure of vessel utilization, or vessel activity, necessary to complete the data acquisition. Vessel months were calculated by multiplying the projected number of survey events times the mean number of vessels used in that survey type times the mean duration of that survey type. 2D = two-dimensional; 3D = three-dimensional; 4D = four-dimensional; G&G = geological and geophysical; HRG = high-resolution geophysical; SWD = seismic while drilling; VSP = vertical seismic profile; WAZ = wide azimuth (survey).

Vessel Operation Conservation Measures

To minimize the potential for vessel strikes to marine animals, BOEM and BSEE issued NTL 2012-JOINT-G01, which clarifies 30 CFR §550.282 and 30 CFR §250.282 and which incorporates NMFS guidelines for monitoring procedures related to vessel strike avoidance measures. BOEM and BSEE monitor for any takes that occur as a result of vessel strikes and also require that any operator immediately report the striking of any marine animal (30 CFR §550.282, 30 CFR §250.282, and NTL 2012-JOINT-G01). These current measures are being proposed for continuation in the future.

3.1.4.8 Helicopter Operations

For all new leases issued in the ten-year period following issuance of this opinion (i.e, through about 2029), BOEM and BSEE estimate the following annual helicopter activity levels (see also Table 9 belowbelow for G&G activity level estimations):

- WPA: 130,500-261,250 helicopter round trips annually.
- CPA: 594,500-1,112,500 helicopter round trips annually.
- EPA: 0-16,000 helicopter round trips annually.

Helicopters are a primary mode of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. Equipment and supplies are sometimes transported via helicopter as well. Protected species surveys during decommissioning activities also utilize helicopters. Helicopter trips are considered a flight segment; that is, from a take-off to a landing, regardless of other stops offshore. In areas of heavy industry activity, helicopter segments can be a matter of minutes, hopping from one structure to the next. To meet the demands of deepwater activities, the offshore helicopter industry is purchasing new helicopters that travel farther and faster, carry more personnel, are all weather capable, and have lower operating costs. The number of helicopters operating in the Gulf of Mexico is expected to decrease in the future as helicopters that operate are expected to be larger and faster.

Table 9. Helicopter traffic associated with geological and geophysical activities over ten years (BOEM 2017e).

Survey Type	Estimated Helicopter Transits Needed to Support Surveys
Vessel Based (2D, 3D, 4D, WAZ)	7,329
Platform Based (VSP, SWD)	168
Vessel Based (Non-Airgun HRG)	0
Other	0
Oil and Gas G&G Activities Total	7,497

2D = two-dimensional; 3D = three-dimensional; 4D = four-dimensional; G&G = geological and geophysical; HRG = high-resolution geophysical; SWD = seismic while drilling; VSP = vertical seismic profile; WAZ = wide azimuth (survey).

3.1.4.9 Offshore Infrastructure/Construction

For all new leases issued in the ten-year period following issuance of this opinion (i.e., through about 2029), BOEM and BSEE estimate the following activity levels for installation of production structures:

- WPA: 7-10 installations of production structures annually.
- CPA: 30-41 installations of production structures annually.
- EPA: 0-1 installations of production structures annually (no more than two structures projected to be installed for the entire BOEM 50-year planning period).

BSEE does a technical review of all proposed OCS oil and gas structure designs and installation procedures. All proposed facilities are reviewed for structural integrity. The lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to assure their structural integrity for the safe conduct of operations at specific locations. Applications for platform and structure approval are filed in accordance with 30 CFR §250.901. Design requirements are presented in detail at 30 CFR §§250.904-250.909. The lessee evaluates characteristic environmental conditions associated with operational functions to be performed. Factors such as waves, wind, currents, tides, temperature, and the potential for marine growth on the structure are considered. In addition, pursuant to 30 CFR §§250.902 and 250.903, BSEE has established a program to assure that new structures meeting the conditions listed under 30 CFR §250.900(c) are designed, fabricated, and installed using standardized procedures to prevent structural failures. After installation, platforms and structures are required to be periodically inspected and maintained under 30 CFR §250.912.

Types of Offshore Structures

Bottom-founded or floating structures may be placed over development wells to support production from a prospect. These structures provide the means to access and control the wells. They are a staging area for processing and treating produced hydrocarbons from the wells, initiating export of the produced hydrocarbons, conducting additional drilling or reservoir stimulation, conducting workover activities, and carrying out eventual abandonment and decommissioning procedures. The variety of offshore infrastructure installed for hydrocarbon production includes fixed and floating platforms, caissons, well protectors, casing, wellheads, and conductors, and pipelines. Subsea wells may also be completed to produce hydrocarbons from the shelf and in the deepwater portions of the Gulf of Mexico. The subsea completions require a host structure to control their flow and to process their well stream. The subsea well is controlled via an umbilical cable from the host.

Fixed, jacketed platforms are the most common surface structures in the Gulf of Mexico and account for about 60 percent of all bottom-founded surface structures on the shallow continental shelf. Fixed platforms are brought on location as complete units or in sections on an installation barge towed by powerful tug boats. If the structure is fabricated in sections, it is generally composed of two segments called the *jacket* (the lower portion) and the *deck* (the portion above the water line). The platform’s tubular-steel jacket is then launched from a barge, upended, and lowered into position by a derrick barge with a large crane. The jacket is anchored to the sea floor by piles driven through the legs. The deck section with one or more levels is then lifted atop the jacket and welded to the foundation. The platform may have a helipad installed on its deck section. Platforms may or may not be manned continuously.

Caissons, the second most numerous structures, account for about 30 percent of bottom-founded, surface structures in the Gulf of Mexico. Caissons are located primarily on the shallow continental shelf. Simpler in design and fabrication than traditional jacketed platforms, most caissons consist of a steel pipe that generally ranges from 36-96 inches (91-244 centimeters) in diameter. The caisson pipe is driven over existing well(s) to a depth that allows for shoring against varying sea states. Though primarily installed for well protection, some caissons may also be used as foundations for equipment and termination or relay points for pipeline operations.

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

Installation of Structures

Structure installation and commissioning activities may take place over a period of a week to a month, typically at the beginning of a platform’s potential 40-year production life. Commissioning activities involve the emplacement, connecting, and testing of the structure's modular components that are assembled on site. The time required to complete the operations to start production at a structure depends on the complexity of its facilities. To keep floating structures on station, a mooring system must be designed and installed. Lines to anchors or piling arrays attach the floating components of the structure. With a tension leg platform (TLP), tendons stem from a base plate on the sea bottom to the floating portion of the structure. Most exploration drilling, platform, and pipeline emplacement operations on the OCS require anchors to hold the rig, topside structures, or support vessels in place. Anchors disturb the sea floor and sediments in the area where dropped or emplaced. Dynamically positioned rigs, production structures, and vessels are held in position by four or more propeller jets and do not cause anchoring impacts. Mooring buoys may be placed near drilling rigs or platforms so that service vessels need not anchor or for when they cannot anchor (in deeper water). The temporarily installed anchors for these buoys are usually smaller and lighter than those used for vessel anchoring and, thus, will have less impact on the sea bottom. Moreover, installing one buoy will preclude the need for numerous individual vessel-anchoring occasions. Service vessel anchoring is assumed not to occur in water depths greater than 150 m (492 ft) and only occasionally in shallower waters (vessels would always tie up to a platform or buoy in water depths greater than 150 m). Barges generally tie up to a production system rather than anchor. Barges and other vessels are also used for both installing and removing structures. Barge vessels use anchors placed away from their location of work.

Pile Driving of Structures

In addition to various pieces of support equipment used in construction, such as vessels and cranes, pile driving is the primary method by which fixed structures are attached to the sea floor and provide stability for other support structures. Classified as either impact hammers or vibratory hammers, the design of the pile driving hammer assembly varies depending upon the medium powering the system; however, most assemblies contain a specialized control unit, piston, ram, and anvil. The impact hammer systems used for OCS-related work predominantly utilize steam, pneumatic, or hydraulic assemblies. Most of the steam and pneumatic systems used in the Gulf of Mexico are limited to surface operations and have energy outputs (torque) ranging from 15,000-60,000 feet/pound (20-82 kilonewton meters). Hydraulic impact hammer systems can be used in both surface and subsea operations and most generally range from 11,000-370,000 feet/pound (15-500 kilonewton). Almost all vibratory hammer systems use hydraulic power and, due to their configuration, they can be used for both surface and subsea operations.

Operators determine the type and size of pile driving equipment they require based upon the dimensions and design of the object being driven, water depths, equipment configuration (surface vs. subsea), sediment/substrate types, and the nature of the operations being conducted. Sediment types are varied in the Gulf of Mexico, but for shallow sea bed activities such as these they are generally classified as consisting of muds (directly off river deltas/outlets), clays (mostly from the Louisiana-Texas border westward), and unconsolidated sands or silt (most of the shelf of the Northern Gulf of Mexico). Each sediment type offers differing levels of friction that must be overcome to allow the pile to penetrate to a sufficient depth. There are two primary pile-driving operations on the OCS: (1) the setting of casing conductors (also known as *drive pipe*) for drilling operations, and (2) pile emplacement for securing oil and gas structures and facilities to the sea bed.

Casing Conductor (Drive Pipe) Installation

Due to the frequency of exploratory and development drilling operations on the OCS, the greatest number of pile-driving operations involve the setting or installation of casing conductors. Most casing conductors range in diameter from 12-36 inches and have wall thicknesses that run from 0.25-0.75 inches. These are generally driven into the substrate until the conductor “meets refusal” or cannot be driven further without damage. Conductor casings can also be jetted into the sea bed; however, the ease of mobilization of hammer drivers coupled with their speed of penetration, minimizes the use of jetting equipment, which requires more time to deploy and is often unviable due to water depth and sediment type. Most casing conductor driving operations occur in water depths less than 200 meters.

Structure/Facility Pile Installation

Pile-driving operations are also conducted during oil and gas structure/facility installations on the Gulf of Mexico OCS. Structure piles are generally forged or rolled-sheet constructed steel pipes that range in diameter from 24-96 inches and have wall thicknesses that run from 0.5-2 inches. The piles are inserted into the legs of the platform jackets, along the inner wall of a caisson, or into sleeves configured into skirt bracings or sea floor templates for structures in certain deepwater/unstable environments. As with conductor casings, piles are generally driven into the substrate until it “meets refusal” or reaches a sufficient depth to ensure stability. Once set to the proper depth/refusal, the pile is then welded or grouted to the jacket leg, caisson, or sleeve to affix the facility to the sea bed.

Deepwater and subsea installations primarily use suction embedding (anchor piles), but some vibratory-hammer pile installation work is still conducted on the shelf to 'pin' the jacket assembly to the sea bed prior to deck installation (Scaggs 2010). Based on the number of shelf facilities installed over the last five years, BOEM/BSEE estimate about 20 structures annually (with an average of approximately four-piles per structure), all of which are projected to be in less than 150-meters water depth. Because BOEM does not require pile-installation reporting under OCSLA regulations, a projection of 80 instances of vibra-hammer use per year is estimated.

Pipelines

Pipelines are the primary means of transporting produced hydrocarbons from offshore oil and gas fields to distribution centers or onshore processing points. Pipelines on the OCS are designated as either gathering lines or trunklines. Gathering lines are typically shorter segments of small-diameter pipelines (generally 4-12 inches [10-30 centimeters]) that transport the well stream from one or more wells to a production facility or from a production facility to a central facility serving one or several leases (e.g., a trunkline or central storage or processing terminal). Trunklines are typically large-diameter pipelines (as large as 36 inches [91 centimeters]) that receive and mix similar production products and transport them from the production fields to shore (Table 10). A trunkline may contain production from many discovery wells drilled on several hydrocarbon fields. The OCS-related pipelines near shore and onshore may merge with pipelines carrying materials produced in state territories for transport to processing facilities or to connections with pipelines located farther inland.

Pipelines are installed by lay barges that are either anchored or dynamically-positioned while the pipeline is laid. Conventional pipe-laying barges use an array of eight anchors that each weigh 9,000 kilograms (19,842 pounds) to position the barge and to move it forward along the pipeline route. These anchors are continually moved as the pipe-laying operation proceeds. The area actually affected by these anchors depends on water depth, wind, currents, chain length, and the size of the anchor and chain. Pipeline sections may be welded together on a conventional lay barge as it moves forward on its route or they may be welded together at a fabrication site onshore and wound onto a large-diameter spool or reel. Once the reel barge is on location, the pipeline is straightened and lowered to the sea floor on its intended route. Both types of lay barge use a stinger to support the pipeline as it enters the water. The stinger helps to prevent undesirable bending or kinking of the pipeline as it is installed. In some cases, pipelines or segments of pipelines are welded together onshore or along a beach front area and then towed offshore to their location for installation.

BSEE is responsible for regulatory oversight of the design, installation, maintenance, and removal of OCS producer-operated oil and gas pipelines. The BSEE's operating regulations for pipelines, at 30 CFR §250 Subpart J, are intended to provide safe and pollution-free transportation of fluids in a manner that does not unduly interfere with other OCS users.

The coast line marks the boundary that determines which agency is responsible for a facility. The BOEM/BSEE of the DOI is responsible for offshore facilities, including pipelines but not deepwater ports, located seaward of the coastline. The USEPA is responsible for non-transportation-related offshore facilities located landward of the coastline. The U.S. Coast Guard (USCG) and the Research and Special Programs Administration of the DOT will handle transportation-related offshore facilities, including pipelines, located landward of the coastline.

For all leases issued in the ten-year period following issuance of this opinion (i.e., through about 2029), BOEM and BSEE estimate the following annual pipeline activity levels:

- WPA: 131-309 kilometers of pipelines annually
- CPA: 631-1,430 kilometers of pipelines annually
- EPA: 0-6 kilometers of pipelines annually

For the OCS Program, which includes proposed lease sales in the WPA, CPA, and EPA, 0-12 new pipeline landfalls are projected from 2020 through 2070 (over the 40-year lease life for leases awarded during the first ten years after this opinion is issued). Most, if not all, of the OCS pipeline installed is expected to tie into the existing infrastructure.

Table 10. Outer continental shelf pipeline landfalls Installed between 1996 and 2009. Figure from BOEM BA supplemental information.

Segment Number	Year Installed	Product Type	Size (inches)	Company	State
10631	1996	Oil	24	Equilon Pipeline Company LLC	Louisiana
12470	1996	Oil	24	Manta Ray Gathering Company LLC	Louisiana
11217	1997	Gas	30	Enbridge Offshore	Louisiana
11496	1997	Oil	12	ExxonMobil Pipeline Company	Louisiana
11952	2000	Oil	18-20	ExxonMobil Pipeline Company	Texas
14470	2004	Oil	10	Chevron USA Inc.	Louisiana
13972	2004	Oil	24	Manta Ray Gathering Company LLC	Texas
13987	2004	Oil	24	Manta Ray Gathering Company LLC	Texas
13534	2005	Oil	30	BP Pipelines (North America)	Louisiana
13534	2005	Oil	30	Mardi Gras Endymion Oil Pipeline Co.	Louisiana
17108	2007	Gas/Condensate	16	Stone Energy Corporation	Louisiana
17691	2009	Gas/Oil	08	Stone Energy Corporation	Louisiana

BSEE evaluates the design, fabrication, installation, and maintenance of all OCS pipelines. BSEE evaluates proposed pipelines for an appropriate cathodic protection system that is required to protect the pipeline from leaks resulting from external corrosion of the pipe, an external pipeline coating system to prolong the service life of the pipeline, measures to protect the inside of the pipeline, proposed operating pressure of the line, and protection of other pipelines crossing the proposed route. BSEE also evaluates protective safety devices such as pressure sensors and remotely-operated valves, the physical arrangement of those devices proposed to be installed by the applicant for the purposes of protecting the pipeline from possible overpressure conditions and for detecting and initiating a response to abnormally low-pressure conditions. Proposed pipeline routes are evaluated for potential impacts on biological communities. Operators are required to periodically inspect pipeline routes and conduct monthly overflights to inspect pipeline routes for leakage.

3.1.4.10 Air Emissions

Several oil and gas industry actions generate emissions which release pollutants to the atmosphere. Air pollutants are generated during exploration and production activities when fuels are combusted to run drilling equipment, power generators, and run engines. Vessel and helicopter operations are an additional source of emissions during supply deliveries, seismic surveys, and personnel transports. Air pollutants are also released during both venting and flaring events to dispose of hydrocarbon vapors or natural gas. Flaring/venting may also be necessary to remove potentially damaging completion fluids from the wellbore and to provide sufficient reservoir data for the operator to evaluate reservoir development options during unloading/testing operations and/or in emergency situations.

The OCSLA (43 USC §1334(a)(8)) requires the Secretary of the DOI to promulgate and administer regulations that comply with NAAQS, pursuant to the CAA (42 USC §7401 et seq.), to the extent that authorized activities significantly affect the air quality of any state. Under provisions of the CAA Amendments of 1990, the USEPA Administrator has jurisdiction in OCS areas in the Gulf of Mexico eastward of 87.5°W longitude (see Section 3.2.2for USEPA's air permitting action). Figure 9 displays the jurisdictional boundaries between BOEM and USEPA. BOEM implementing regulations in 30 CFR §250 Subpart C apply to those air emission sources in the Gulf of Mexico westward of 87.5ºW longitude. BOEM issued NTL 2014-G01 that discusses collecting and reporting information through their online system to provide additional information on its oversight of air emissions on the OCS (https://www.boem.gov/BOEM-NTL-No-2014-G01/). USEPA's OCS Air Regulations at 40 CFR Part 55 implement section 328 of the CAA and establish the air pollution control requirements for OCS sources and the procedures for implementation and enforcement of these requirements.

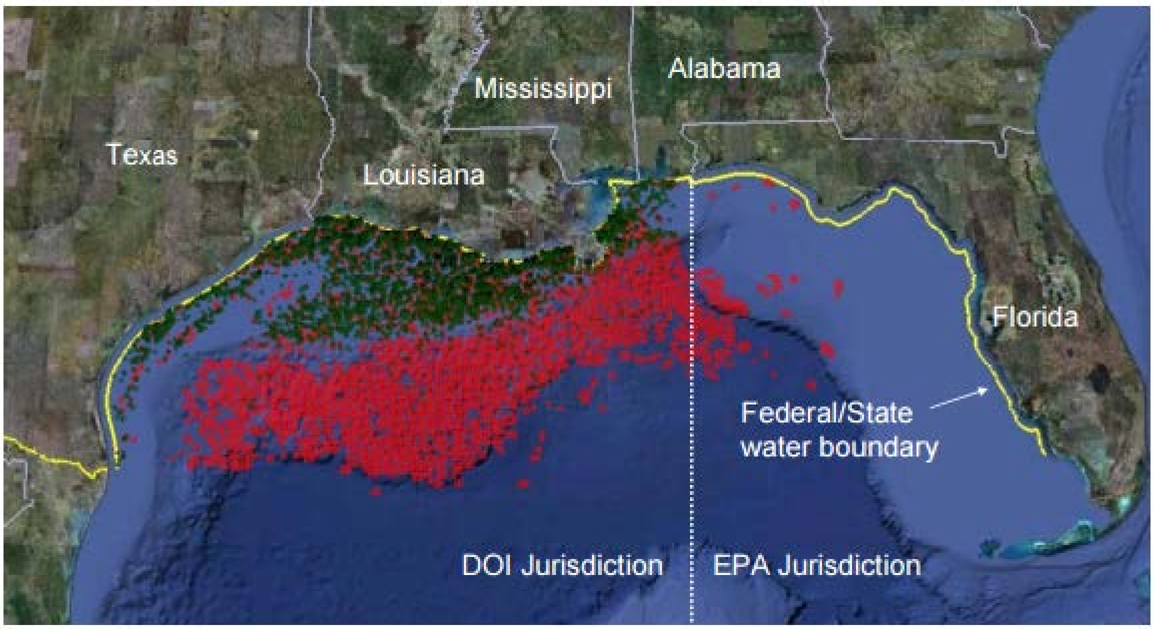


Figure 9. USEPA and BOEM air quality jurisdictional boundaries. Lease blocks that were active in 2012 are shown in red and dark green areas depict platforms (Ramseur 2012).

BOEM Air Quality Review Requirements

All new or supplemental EPs and DOCDs must include air emissions information sufficient to determine whether an air quality review is required (30 CFR §§550.218 and 550.249). The BOEM regulations require a review of air quality emissions to determine if the projected emissions from a facility would be expected to result in onshore ambient air concentrations above BOEM significance levels. The regulated pollutants include carbon monoxide, suspended particulates, sulphur dioxide, nitrogen oxides, total hydrocarbons, and volatile organic compounds.

The BOEM uses a two-level hierarchy of evaluation criteria to evaluate potential impacts of offshore emission sources to onshore areas. The evaluation criteria are the exemption level and the significance level. If the proposed activities exceed the criteria at the first (exemption) level, the evaluation moves to the significance level criteria. The initial evaluation compares the worst-case emissions to the BOEM exemption criteria. If the proposed activity emissions are below the exemption levels, the proposed action is exempt from further air quality review. If exemption levels are exceeded, then the second step requires refined modeling using the Offshore and Coastal Dispersion Model or the CALPUFF Model (https://www.boem.gov/Approved-Air-Quality-Models-for-the-GOMR/). The results from the modeling, the modeled potential onshore impacts, are compared with BOEM significance levels. If the significance levels are exceeded in an attainment area, an area that meets applicable NAAQS, the operator would be required to apply best available control technology to the emissions source. If the affected area is classified as nonattainment, further emission reductions or offsets may be required.

According to BSEE, field compliance verification is conducted for air quality inspections on OCS facilities (BSEE presentation to NMFS, May 19, 2019). These efforts monitor active operations and determine compliance with environmental standards.

3.1.4.11 New or Unusual Technologies

Emergent technologies continue to evolve to meet the technical, environmental, and economic challenges of deepwater development. New or unusual technologies (NUTs) must be identified by the operator in its EP, DPP, DWOP, and DOCD or through BOEM's plan review processes. These technologies are reviewed by BOEM for alternative compliance or departures that may trigger additional environmental review.

Some new technologies differ from established technologies in how they function or interface with the environment. These include equipment or procedures that have not been installed or used in Gulf of Mexico OCS waters. Having no operational history, they have not been assessed by BOEM (or NMFS) through technical and environmental reviews. New technologies may be outside the framework established by BOEM regulations and, thus, their performance (e.g., safety, environmental protection, efficiency) has not been addressed by BOEM. The degree to which these new technologies interface with the environment and the potential impacts that may result are considered in determining the level of NEPA review that would be initiated.

Under any of these proposed activities, NUTs may be identified through BOEM's G&G permit review, by the operator in OCS plan applications, or through BOEM's plan review and authorization processes. If BOEM's review of a permit or plan determines that a NUT is part of the proposed work, the permit or plan cannot be approved until an environmental assessment (EA) is prepared and a review of the plan is completed. BOEM does not designate specific technologies as NUT until industry identifies and brings them to BOEM for approval. Some of the technologies proposed for use by operators are often extended applications of existing technologies and interface with the environment in essentially the same way as well-known or conventional technologies. These technologies are reviewed by BOEM for alternative compliance or departures that may trigger additional environmental review. Some examples of new technologies that do not affect the environment differently and that are being deployed in the Oil and Gas Program are synthetic mooring lines, subsurface safety devices, and multiplex subsea controls. Those that do not have an environmental effect that varies from what is considered in this opinion would not require further review or consultation with NMFS.

The degree to which these new technologies interface with the environment and the potential impacts that may result are considered in determining the level of NEPA review that would be initiated and whether step-down review would be triggered as defined in this opinion.

BOEM has developed a NUT review checklist to help facilitate decisions on the appropriate level of engineering and environmental review needed for a proposed technology. The questions operators must address for a NUT review include:

1. Has the technology or hardware been used previously or extensively in the Gulf of Mexico OCS Region under operating conditions similar to those anticipated for the activities proposed in this plan (therefore technically not considered NUT)?
2. Does the technology function in a manner that potentially causes different impacts to the environment than similar equipment or procedures did in the past?
3. Does the technology have a significantly different interface with the environment than similar equipment or procedures did in the past?
4. Does the technology include operating characteristics that are outside the performance parameters established by 30 CFR §550?

A senior NEPA coordinator conducts the NUT Review with the assistance of the engineers in the BSEE Technical Assessment Section and the senior plan coordinator. Any proposed NUT that is determined to function in a manner that potentially causes different impacts to the environment than similar equipment or procedures did in the past or has a significantly different interface with the environment than similar equipment or procedures did in the past will meet the extraordinary condition at 43 CFR §46.215(d) and will be evaluated in an EA.

The BOEM has developed a NUT matrix to help facilitate decisions on the appropriate level of engineering and environmental review needed for a proposed technology. Technologies will be added to the NUT matrix as they emerge, and technologies will be removed from the matrix as sufficient experience is gained in their implementation. From an environmental perspective, the matrix characterizes new technologies into three categories: technologies that may affect the environment; technologies that do not interact with the environment any differently than “conventional” technologies; and technologies about which BOEM does not have sufficient information to determine their potential impacts to the environment. In this latter case, BOEM will seek to gain the necessary information from operators or manufacturers regarding the technologies to make an appropriate determination on potential effects on the environment.

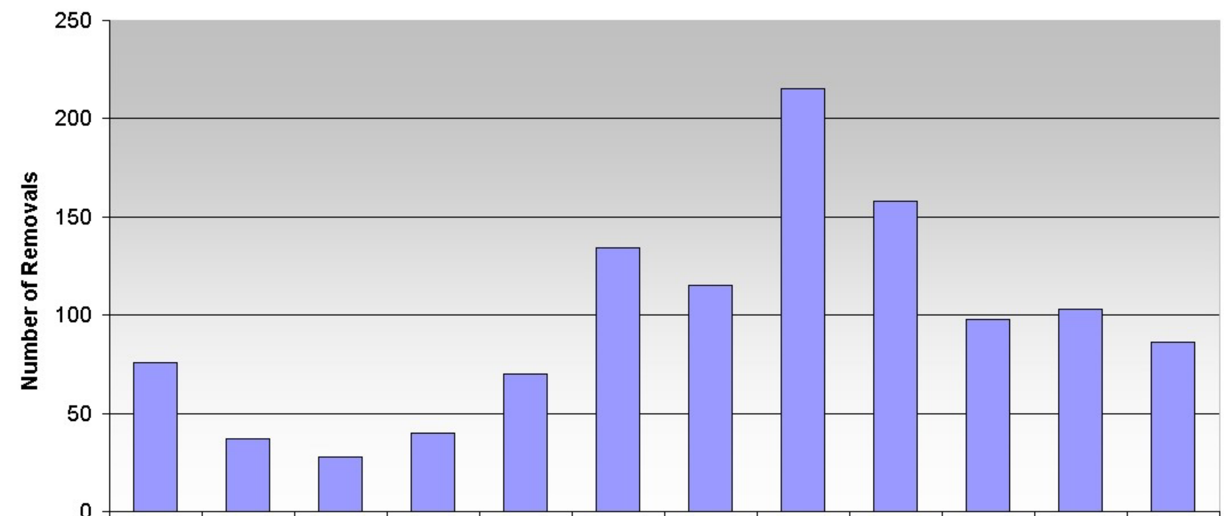
The BSEE project-specific engineering safety review ensures that equipment proposed for use is designed to withstand the operational and environmental conditions in which it would operate. When an OCS operator proposes the use of NUTs or procedures not specifically addressed in established BSEE regulations, the operations are evaluated for alternative compliance or departure determination. Any new technologies or equipment that represent an alternative compliance or departure from existing BSEE regulations must be fully described and justified before they would be approved for use.

3.1.4.12 Decommissioning and Structure Removal

In October 2010, BOEMRE published NTL 2010-G05, "Decommissioning Guidance for Wells and Platforms" (sometimes referred to as the "Idle Iron" policy) to clarify existing regulations that apply when a well or platform is "no longer useful for operations," and needs to be plugged (in the case of a well) or removed (in the case of platforms and other structures). The updated BSEE NTL 2018-G03, "Idle Iron Decommissioning Guidance for Wells and Platforms" clarifies that wells that were not useful (i.e., no longer producing) are required to be plugged by set times implemented by BSEE, or one year after lease termination/expiration. Any well that became "idle" or not useful for lease operations subsequent to the NTL's publication is expected to be plugged no later than three years after the well became "idle." The NTL also clarifies that BSEE will enforce the decommissioning of platforms considered "idle" or no longer useful at the time the NTL was published. Any platform that became "idle" or not useful for lease operations subsequent to the NTL's publication is expected to be decommissioned no later than five years after the platform became "idle." BSEE regulations require the operator to sever bottom-founded objects and their related components at least 4.6 meters (15 feet) below the mudline. Structures that would be severed for removal, referred to as target structures, include the following:

- Wellheads and conductors.
- Subsea wellheads and conductors.
- Subsea production devices (valve assemblies to produce the well, test the system, or shut-in operations).
- Jacketed platforms.
- Caissons.
- Well protectors (small piled jackets with or without a support deck).
- Cables, chains, and mooring lines.
- Suction pile anchors.
- Pipelines.
- Cement structures and foundations.

Structures are usually completely removed, with components being refurbished and reused, sold for scrap, or sent as waste to a landfill. However, approximately ten percent of structures that have been decommissioned have been toppled-in-place within an artificial reef or towed to an approved reef site (Kaiser et al. 2005). Partial removal of structures has occurred in only a handful of cases for large, heavy structures. Operators schedule most of their removal projects from June-December when seas are generally calm (Figure 10).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Removals	76	37	28	40	70	134	115	215	158	98	103	86
% of Total	6%	3%	2%	3%	6%	12%	10%	19%	14%	8%	9%	8%

Removal Month

Figure 10. Seasonal trends of removal operations from 1994-2003 (Source: MMS data)

For each structure-removal operation, a project management team develops a decommissioning plan and schedule. The team could be within the company, an independent third party, or a specialized unit within a decommissioning contractor group. Decommissioning operations may employ a single "turn-key" salvage contractor (offers a complete removal package) or up to three levels of subcontractors. Currently, there are six removal project management companies, seven derrick/lift vessel companies, about 12 non-explosive-severance companies, and two explosive-severance companies. Up to five companies provide turn-key contracts, for either explosive or non-explosive-severance work. Decommissioning options are presented in Figure 11.

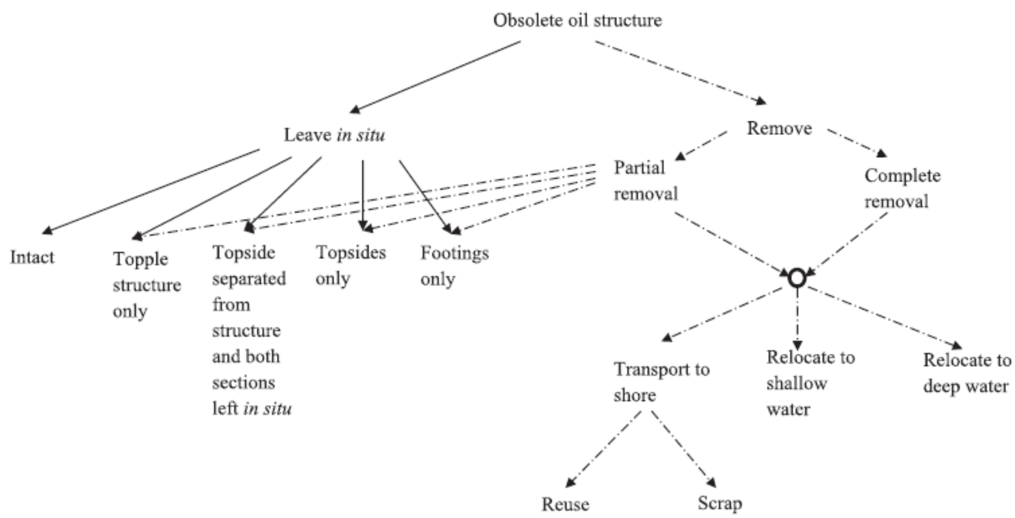


Figure 11. Decommissioning options for an obsolete structure (Fam et al. 2018).

To accomplish these removals, a host of activities are required to (1) mobilize necessary equipment and service vessels, (2) prepare the decommissioning targets (e.g., piles, jackets, conductors, bracings, wells, pipelines), (3) sever the target from the sea bed and/or into manageable components, (4) salvage the severed portion(s), and (5) conduct final site-clearance verification work. Preparatory work could include pipeline flushing and securing, equipment removal, tank/deck cleaning, and survey work. The topside equipment such as living quarters, generators, and processing equipment are removed and taken to shore. The deck section is then detached, lifted from the platform, and transported by barge. Conductors and piles are severed 15 feet below the mudline. The jacket is then disconnected from the sea bed and lifted onto a cargo barge. Depending on the target, a complete removal decommissioning operation may span several days or weeks, and in some cases, even months.

The use of explosives is the preferred method for severance of structures from their foundations. Although mechanical severance techniques are available, such methods can be less reliable and be more costly, particularly as water depth increases. Explosives are generally placed below the mudline, inside or outside of the target members. Occasionally, specialized explosive devices are required to sever targets that are in open water, above the mudline, such as chains, cables, and pipelines (DEMEX Division of TEI Construction Services 2003). In the sections below, we describe decommissioning as four stages: pre-severance, severance, post-severance, and site clearance.

There are currently 2,091 active platforms in the Gulf of Mexico, with 2,021 of these located in water depths of 200 meters (656 feet) or less (July 12, 2017, *Offshore Statistics by Water Depth*, BOEM webpage*)*. In addition, as of January 27, 2017 BSEE data indicate there are 356 platforms that fit the “idle iron” definition and there are an additional 273 platforms that are on expired or terminated leases. Most of these platforms eligible for decommissioning are in water depths of less than 30 meters (100 feet) (Table 11 and Table 12).

Table 11. Structure removal permit applications from 2004 to 2015 (BOEM 2016; BOEM 2017b).

Final Disposition	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Percent
Scrapping/Shore	144	118	164	124	176	237	223	352	282	186	198	115	2,319	83.3
Reuse	2	2	1	19	16	4	3	1	16	13	18	2	97	3.5
Rigs-to-Reefs	8	21	20	34	35	40	53	40	28	36	36	18	369	13.2
Total	154	141	185	177	227	281	279	393	326	235	232	135	2,785	100

Table 12. Actual structure removals from 2004 to 2015 (BOEM 2016; BOEM 2017b).

Structure Type	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	Percent
Caissons	101	41	52	60	59	80	57	113	98	99	84	38	882	38.2
Platforms	64	65	46	82	74	129	142	152	147	105	88	70	1,164	50.4
Mobile Offshore Production Units	0	0	0	1	1	0	0	0	0	0	0	0	2	0.07
Mini-Tension Leg Platforms	0	0	1	0	0	0	0	0	0	0	0	0	1	0.03
Well Protectors	29	17	16	17	19	25	19	28	38	18	29	5	260	11.3
Total	194	123	115	160	153	234	218	298	283	216	201	113	2,309	100

Pre-Severance Operations

The first step in a structure-removal operation is the development of a decommissioning plan and schedule. It is the responsibility of a project management team to assess the nature of the operation, taking into consideration, among other things, the target structure(s), marine conditions, available services (e.g., lift vessels, severing subcontractors), and initial operator preferences.

The first set of these activities to occur on the Gulf of Mexico OCS involve the onsite mobilization of lift and support vessels, specialized equipment, and load barges necessary to receive the salvaged structure. The primary mobilization bases would be Fourchon, Cameron, Morgan City, New Iberia, and Intracoastal City in Louisiana and Galveston, Port Aransas, and Port Arthur in Texas. The primary salvage yards for the scrapping or refurbishment of structures are Morgan City (Amelia) and New Iberia in Louisiana and Port Arthur in Texas.

Any requisite preparatory work commences on and near the structure, which could include pipeline flushing and securing, equipment removal, tank/deck cleaning, and survey work. When set, all of the necessary personnel (e.g., welders, equipment operators, severing technicians), vessels (e.g., derrick/jack-up barge, tugs, load barges), and support equipment (e.g., severing tools, ROVs) are mobilized on station at the structure site. Once the lift vessel is on location and positioned, personnel and equipment are staged to begin preliminary work on the structure. For subsea targets such as casing stubs, divers or ROVs are used to assess the target, conduct any necessary surveys, and assist in either deploying or conducting the below mudline severing methodology.

For surface structures such as caissons and jacketed platforms, a temporary gangway is secured to allow the cutting crews and riggers access to the structure. Depending on the size and design of the platform, modules such as generator shacks and berthing compartments, as well as other large components (e.g., flaring booms, crane assemblies), may need to be cut/disconnected from the topsides and removed. The remaining topsides assembly is then cut from the piles/jacket, lifted, and secured on the load barge. When required, welders connect scaffolds and bracing around the open piles to allow for personnel and equipment access. If internal pile severing will be conducted, crews then install and operate jetting equipment down the pile to washout the existing mud plug (most often sequentially). Once all piles are jetted and gauged (i.e., internal clearance verification) to the proper cut depth, all unneeded equipment is removed from the structure and the severing operations can commence.

To mitigate any potential impacts to biological resources BSEE will require operators to conduct surveys and reporting prior to mobilizing on site and conducting any sea floor disturbing activities. For the biological surveys, operators are to follow NTL No. 2009-G39 (https://www.bsee.gov/notices-to-lessees-ntl/notices-to-lessees/ntl-2009-g39-biologically-sensitive-underwater-features), which requires lessees to avoid or mitigate impacts to topographic features, live bottoms (pinnacle trend features and low relief features such as sea grass communities), and potentially significant biological features. BSEE will also require operators to conduct surveys and report to avoid impacts to potential archaeological resources. The guidelines for these surveys and reporting are detailed in NTL No. 2005-G07.

Severance Operations

As previously mentioned, there are two primary methodologies used in the Gulf of Mexico for cutting decommissioning targets; non-explosive and explosive severance. The choice of severing tool used depends on the target size and type, water depth, economics, environmental concerns, tool availability, and weather conditions. Despite advancements in non-explosive-severance methods and the requisite marine protected species mitigation measures, BSEE expects explosive-severance activities to continue to be used in at least 63 percent of all platform removals for the foreseeable future.

Modeling on structure removal processes done by Kaiser et al. (2005) is presented below, though these data do not reflect the increase in removals since 2010. Since previous studies and environmental reports distinguish explosive severing activities as having the greatest potential to harm marine protected species, the report concentrates on the estimated number of platform removals that may employ explosive cutting. Because an operator’s appraisal of when and how to decommission a specific structure involves several complex factors, the main components of the report consist of “optimistic” and “pessimistic” model sets (platform life expectancy, probabilistic removal, and binary-choice severance selection models) and a section that provides a statistical description of decommissioning operations based upon historical data.

Kaiser et al. (2005) provided projections of removals by modeling structure removal processes until the year 2021 for removals using explosive-severance. For all activities issued in the ten-year period following issuance of this opinion (i.e., through about 2029), BOEM and BSEE estimate the following structuresto be removed with explosives:

- WPA/CPA: 43-81 structure removals annually using explosives. BSEE expects that this annual number will not remain constant and will decline over time.
- No foreseeable structure removals are expected to occur in the EPA.
- No foreseeable structure removals via explosives in waters greater than 200 meters.

Non-explosive methods include abrasive cutters (sand and abrasive-water jets), mechanical cutters (e.g., carbide or rotary), diamond wire cutting devices, and cutting facilitated by commercial divers using arc/gas torches. These methods are relatively slow and potentially harmful to human health and safety (primarily for diver severances) but have little to no impact on the marine environment. For a detailed discussion of these methods, refer to BOEM's Programmatic Environmental Assessment for Decommissioning (2014).

There is a wide range of explosive materials available for use in severing charges in Gulf of Mexico decommissioning activities. Severing contractors are responsible for assessing the type of material needed based upon its characteristics in relation to the target size and design, specific marine conditions, and potential methods of charge deployment. Explosive-severance activities use specialized charges to achieve target severance. Unlike most non-explosive methods, severance charges can be deployed on multiple targets and detonate nearly-simultaneously (i.e., staggered at an interval of 0.9 seconds), effecting rapid severances. These devices can be deployed and operated by divers, ROV, or from the surface.

Explosive-severance activity or "detonation event" for most removal targets lasts for only several seconds. For complex targets or in instances where the initial explosive-severance attempts are unsuccessful, more than one detonation event may be necessary per decommissioning operation. Hours or days would be needed to implement mitigation measures and redeploy new charges.

There are three types of charges used in severing structures in the Gulf of Mexico: bulk charges, shaped charges, and fracturing charges. Bulk charges are used most often. Bulk charges are designed to sever targets using the mechanical distortion and subsequent ripping resulting from the shock wave and expanding gas bubble released during the detonation. The charge may be placed in a section of polyvinylchloride pipe or in layers of steel and/or concrete to confine and focus the detonation. The charges are placed either inside or outside of the target.

Shaped charges are placed in special housings designed to create a void between the explosive material and target wall. Employing a phenomenon known as the Monroe Effect, the shock wave deforms the shaped housing into a high-velocity plasma jet within the void. The formed jet cuts through steel targets. Shaped charges are much more efficient in cutting targets, thereby greatly reducing the net explosive weight needed to sever similar-sized targets. Shaped charges can be deployed internal or external to the target structure.

Fracturing charges are currently the least used explosives cutting tools in the Gulf. Generally available as "plaster" or shock-refraction cutters, fracturing charges sever targets by taking advantage of the reflected shock wave resulting from the initial force developed during detonation (Board and Structures 1996). The focus of the shock wave direction results in fracturing of the target wall opposite of the charge, with the ensuing gas bubble expanding and causing the completion of the cut. Not very effective on wells or grouted piles, fracturing charges are primarily available in the form of an adhesive-backed tape, which has always required divers for deployment (Continental Shelf Associates Inc. 2004). Severing contractors are currently working on improvements to the charges, including charge delivery systems that could negate the need for divers.

Post-Severance Operations

Once the operator completes their severance activities, the structure must be removed from the sea bed and transported to its final destination (e.g., salvage yard, alternative location, reef site). Similar to its pre-severance duties, the on-station lift vessel is responsible for the post-severance hoisting of the cut material out of the water and onto a load barge or comparable vessel. If the lift vessel cannot pull the structure free from the sediment, on-station supervisors will decide whether or not to reattempt the severing method or to revert to a backup cutter.

All of the lifted components are ultimately arranged on the load barge and sea-fastened (i.e., welded and braced) to the deck to facilitate transport to the final destination (e.g., new location, salvage, recycling, or reefing). Though rarely used in the Gulf, a company may also need to employ a process called "progressive transport" or "hopping," which allows for the controlled, surface-accessible dividing of oversized jackets. Following the severance of a structure from its foundation, welders install closure plates atop of all exposed jacket legs or piles. Valve assemblies built into each of the closure plates allow compressed air to evacuate water from the tubulars, deballasting the jacket and making it buoyant (Snyder 2000). After being hoisted by and secured to the stern of a lift vessel, the jacket is then towed to a previously surveyed location in shallower water. The set-down locations are expected to be far enough offshore to allow for backloading onto a barge. At the new site, the jacket is ballasted and set back onto the sea floor, exposing several additional feet of the structure above the water. From this position, welders can return to the jacket and set up scaffolding, which allows them to remove the closure plates and begin cutting all of the necessary legs, piles, and diagonal/vertical bracing. Once complete, the severed jacket section is rigged, lifted, and secured to a load barge. If the lift vessel is still not capable of lifting the remaining jacket assembly, welders reattach the closure plates, and the procedure is repeated until successful.

The use of jacket hopping is expected to be extremely rare. However, in instances when proposed, BSEE will require surveys of the route from the initial structure location to each site that the structure would be set down.

Rigs to Reefs

The Energy Policy Act of 2005 (P.L. 109-58) amended the OCSLA to authorize BSEE to oversee renewable energy and alternative uses of the OCS. Current BSEE regulations allow a waiver (30 CFR §250.1730) to complete structure removal by allowing the appropriate conversion of retired platforms for reefs when such platforms are permitted and designated for use by a state artificial reef program and within areas established for receipt of platforms for the enhancement of habitat for fish and other aquatic life. Although BSEE may grant a waiver from the decommissioning requirements to remove the platform, the actual creation of the artificial reef is an action that drives the issuance of allowable waivers. There is also an opportunity for the abandonment-in-place of certain sea floor obstructions (30 CFR §250.1716(b)(3)—Wellheads/Casings and 30 CFR §250.1728(b)(3)—Platforms and Other Facilities); however, the obstructions are limited to water depths greater than 800 meters (2,625 feet) and are evaluated on a case-by-case basis. Over 470 platforms had been converted to permanent artificial reefs in the Gulf of Mexico. BSEE supports and encourages the reuse of obsolete structures as reefs, however specific requirements must be met for the departure to be granted per 30 CFR §250.1730:

- The structure must become part of a State artificial reef program that complies with the criteria in the National Artificial Reef Plan;
- The responsible State agency requires a permit from the operator and must accept title and liability for the reefed structure once removal/reefing operations are concluded; and
- The lesee/operator must satisfy any USCG navigational requirements for the reefed structure.

Site Clearance

After all decommissioning work is completed and the structure is salvaged, operators are required to perform site-clearance work to ensure that the sea floor of their lease(s) have been restored to prelease conditions. Based upon requirements found in Subpart Q of the OCSLA regulations (30 CFR §§250.1740 to 250.1743), operators have the option of either trawling (with commercial nets, Table 13) or conducting diver, high-resolution sonar, or ROV surveys over specific areas for the structure type.

Table 13. Site clearance requirements with trawl nets. BOEM BA supplemental information.

Structure	Clearance Requirement
Well site	300-foot-radius circle centered on the well location
Subsea well site	600-foot-radius circle centered on the well location
Platform site	1,320-foot-radius circle centered on the location of the platform
Single-well caisson, well protector jacket, template of manifold	600-foot-radius circle centered on the structure location
If trawling occurs near an active pipeline, trawling must occur:	
Buried active pipelines	contact the pipelines owner about the condition of the pipeline

Structure	Clearance Requirement
Unburied active pipelines 8 inches in diameter or larger	no closer than 100 feet to either side
Unburied smaller diameter active pipelines in the area that have obstructions present	remove the pipeline
Unburied active pipelines in the trawl area that are smaller than 8 inches in diameter and have no obstructions present.	parallel to the pipeline

NTL 1998-G26 specifies that platforms and single-well caissons/well protectors located in water depths less than 300 feet must be trawled in two directions. The regulations contain specific trawling requirements that are designed to facilitate the removal of any small objects or obstructions (e.g., tools, containers, batteries) that may have been lost or discarded during the operational life of the structure.

To avoid the occasion where an unknown obstruction (man-made or biological) could be damaged or cause damage to the trawling equipment, operators choose to conduct diver, sonar, and/or ROV surveys of the grid area. A high-frequency sonar system is used to determine geodetic positions for each sea floor obstruction, and a dispatched diver(s) or ROV recovers or investigates the object. Unlike trawling, survey-led recovery activities only disturb the sea floor in a limited area around the obstruction, reducing the potential for additional impacts to the benthic environment.

BOEM currently applies the following conditions of approval to permits for site clearance:

Site-clearance Trawling Reporting: If trawling is used to comply with the site clearance verification requirements under 30 CFR §§ 250.1740-1743, which mandates that turtle excluder devices (TEDs) be removed from the trawl nets to facilitate the collection of seabed debris, you must abide by maximum trawl times of 30 minutes, allowing for the removal of any captured sea turtles. If during your trawling activities, you capture a sea turtle in your nets, you must:

1. Contact BSEE's Office of Environmental Compliance (OEC) at protectedspecies@bsee.gov and NMFS' Southeast Regional Office (SERO) at takereport.miifsser@noaa.gov immediately;

2. Resuscitate and release any captured sea turtles as per NMFS' guidelines found online at https://www.sefsc.noaa.gov/turtles/TM NMFS SEFSC 580 2010.pdf (see page 3-6; Plate 3-1) or **Appendix J** to this opinion; and

3. Photograph the turtle, and complete a sea turtle stranding form for each sea turtle caught in your nets. The form can be found at: https://www.sefsc.noaa.gov/species/turtles/strandings.htm and submit to NMFS and BSEE (to the email addresses noted above).

Post Approval Notificaiton (Structure Removal): Per 30 CFR § 250.194(c) and clarified in NTL No. 2005-G07, if during site clearance operations you discover any object of potential archaeological significance you are required to immediately halt operations. In addition, you must immediately report this discovery to BSEE Office of Environmental Compliance (Env-

Compliance-Arc@bsee.gov) and contact Dr. Christopher Horrell at (504) 736-2796. Additional guidance will be provided to the operator as to what steps will be needed to protect any potential submerged archaeological resources. Additionally, as specified under 30 CFR § 250.1743:

- You are required to provide the trawling logs for both heavy-duty nets and verification nets with descriptions of each item recovered. Should you only pull site clearance verification nets, please clearly state this within the body of the Site Clearance Report. In addition, provide ALL vessel logs related to vessels that were used to recover items during site clearance operations (e.g. anchor handling vessels, lift boats, dive support vessels, tug boats, etc.). Ifyou did not use any vessels to recover items, please clearly state this within the body ofthe Site Clearance Report.

- With your Site Clearance Report you are also required to provide a CD or DVD of all digital photographs ofthe items recovered during the use ofthe heavy-duty trawl nets, site clearance verification trawl nets, diver recovery, and any other vessels used. Each photograph must be of appropriate scale and size so that individual items can be identified. All photographs of recovered items must also correspond with the items recovered and listed on individual lines within the logs. In addition, when you submit your photographs, you should label each photograph file name so that it represents the individual trawl line from which the items were recovered.

<u>Progressive-Transport Notification:</u> In accordance with OCSLA requirements (30 CFR § 250.1727(g)), if at any point in your decommissioning schedule progressivetransport/" hopping" activities are required to section your jacket assembly or support material barge loading, a prior written request must be submitted and approval must be obtained from the Regional Supervisor/Field Operations. Your request to use progressivetransport must include a detailed procedural narrative and separate location plat for each "set-down" site, showing pipelines, anchor pattems for the derrick barge, and any known archaeological and/or potentially sensitive biological features. The diagram/map of the route to be taken from the initial stmcture location along the transport path to each site must also be submitted with your request. If the block(s) that you intend to use as "setdown" sites have not been surveyed as per NTL No. 2009-G39 and NTL No. 2005-G07, you may be required to conduct the necessary surveys/reporting prior to mobilizing on site and conducting any seafloor-disturbing activities.

3.1.5 Oil Spills

Oil spills are not legally permitted discharges because the Oil Pollution Act prohibits any release of oil to the environment, including accidental discharges. Oil spill prevention, preparedness, containment, and response are regulated by BOEM and other federal agencies, because spills do regularly result from oil and gas activities in the Gulf of Mexico. Accidental discharges from various sources are expected to occur as a result of the proposed action

Table 15, Table 16, source data are from BOEM unless otherwise noted). The number of spills estimated is derived by application of the historical rate of spills per volume of crude oil handled (billion barrels [Bbbl]) (1996-2010) (BOEM et al. 2012) to the projected production from a typical sale. The actual number of spills that may occur in the future could vary from the estimated number (Table 14).

Table 14. Average number and size of spills expected in the Gulf of Mexico over 40 years[A].

Spill Size Group	Spill Rate (spills/Bbbl)[B]	Number of Spills Estimated for a WPA Proposed Action	Number of Spills Estimated for a CPA Proposed Action	Number of Spills Estimated for a EPA Proposed Action	Estimated Median Spill Size (bbl)[C]
0-1.0 bbl	2,020	234-404	929-1,806	<1-143	<0.024
1.1-9.9 bbl	57.4	7-11	26-51	<1-4	3.0
10.0-49.9 bbl	17.4	2-3	8-16	<1-1	3.0
50.0-499.9 bbl	11.3	1-2	5-10	<1-1	130
500.0-999.9 bbl	1.63	< 1	< 1-1	<1	749.9
≥ 1,000-9,999 bbl	1.13	< 1	< 1-1	<1	2,200[C]
≥ 10,000 bbl	0.31	< 1	< 1	<1	---
Extremely large	---	---	---	---	---

[A]As noted above, the number of spills estimated is derived by application of the historical rate of spills per volume (billion barrels [Bbbl]) crude oil handled (1996-2010) to the projected production from a typical sale (15-40 years for life of lease). The actual number of spills that may occur in the future could vary from the estimated number.
[B]Source: (BOEM et al. 2012)and calculations based on data therein. The spill rates presented are a sum of rates for U.S. OCS platforms/rigs and pipelines, and include the DWH spill event.
[C]Median without DWH event

Table 15. Average number and size of spills over 1,000 barrels of oil expected to occur in the Gulf of Mexico over 40 years. Data from BOEM BA supplemental information.

	Volume (Bbbl)	Mean Number of Spills			Mean Number of Spills	Probability (percent chance) of One or More Spills			Probability (percent chance) of One or More Spills
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Proposed Actions (single proposed lease sale)									
WPA (low estimate)	0.114	0.03	0.1	0	0.13	3	10	n	12
CPA (low estimate)	0.46	0.12	0.4	0	0.52	11	33	n	41
EPA (low estimate)	0	0	0	0	0	0	0	0	0
WPA (high estimate)	0.119	0.05	0.17	0	0.22	5	15	n	20
CPA (high estimate)	0.894	0.22	0.74	0.02	0.98	20	52	2	62
EPA (high estimate)	0.071	0.02	0.06	0	0.08	2	6	0	8
Cumulative OCS Program									
WPA (low estimate)	2.51	0.63	2.21	0	2.84	47	89	n	94
CPA (low estimate)	15.831	3.96	13.93	0	17.89	98	**	n	**
EPA (low estimate)	0	0	0	0	0	0	0	0	0
WPA (high estimate)	3.697	0.92	2.77	0.19	3.88	60	94	17	98
CPA (high estimate)	21.734	5.43	18.01	0.43	23.87	**	**	35	**
EPA (high estimate)	0.211	0.05	0.19	0	0.24	5	17	0	21

*Spill rates were calculated based on the assumption that spills occur in direct proportion to the volume of oil handled and are expressed as number of spills per barrels of oil handled. bbl = barrels; Bbbl = billion barrels; n = less than 0.5 percent; ** = greater than 99.5 percent. "Platforms" refers to facilities used in exploration, development, or production.*

Table 16. Average number and size of spills over 10,000 barrels of oil expected in the Gulf of Mexico over 40 years. Data from BOEM BA supplemental information.

	Volume (Bbbl)	Mean Number of Spills			Mean Number of Spills	Probability (percent chance) of One or More Spills			Probability (percent chance) of One or More Spills
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
Proposed Actions (single proposed lease sale)									
WPA (low estimate)	0.114	0.01	0.02	0.00	0.04	1	2	n	3
CPA (low estimate)	0.460	0.06	0.08	0.00	0.14	6	8	n	13
EPA (low estimate)	0	0	0	0	0	0	0	0	0

	Volume (Bbbl)	Mean Number of Spills			Mean Number of Spills	Probability (percent chance) of One or More Spills			Probability (percent chance) of One or More Spills
		Platforms	Pipelines	Tankers	Total	Platforms	Pipelines	Tankers	Total
WPA (high estimate)	0.119	0.03	0.03	0.00	0.06	3	3	n	6
CPA (high estimate)	0.894	0.12	0.15	0.01	0.27	11	14	1	24
EPA (high estimate)	0.071	0.01	0.01	0	0.02	1	1	0	2
Cumulative OCS Program									
WPA (low estimate)	2.510	0.33	0.45	0.00	0.78	28	36	n	54
CPA (low estimate)	15.831	2.06	2.85	0.00	4.91	87	94	n	99
EPA (low estimate)	0	0	0	0	0	0	0	0	0
WPA (high estimate)	3.697	0.48	0.57	0.06	1.11	38	43	6	67
CPA (high estimate)	21.734	2.83	3.68	0.14	6.65	94	97	13	**
EPA (high estimate)	0.211	0.03	0.04	0	0.07	3	4	0	6

*Bbbl = billion barrels; n = less than 0.5 percent; ** = greater than 99.5 percent. “Platforms” refers to facilities used in exploration, development, or production.*

3.1.5.1 Oil Spill Prevention Regulations and Policies

In this subsection we describe oil spill prevention regulations and polices that were in place or have been updated or created since 2010 and are applicable to the proposed action.

Workplace Safety Rule (Safety and Environmental Management System Final Rule)

The National Commission on the DWH Oil Spill and Offshore Drilling (Oil Spill Commission) and the National Academy of Engineering recommended a variety of changes to DOI’s regulatory scheme, such as the expanded use of safety management systems. The BOEMRE promulgated the performance-based Safety and Environmental Management System (SEMS) Rule on October 15, 2010 (30 CFR §250, Subpart S), which requires full implementation for all OCS facilities and operators no later than November 15, 2011. The SEMS Rule establishes a holistic, performance-based management tool that requires offshore operators to establish and implement programs and systems to identify potential safety and environmental hazards when they drill; clear protocols for addressing those hazards; and strong procedures and risk-reduction strategies for all phases of activity, from well design and construction to operation, maintenance, and decommissioning. It also requires operators to have a comprehensive safety and environmental impact program designed to reduce human and organizational errors. The SEMS applies to all OCS oil and gas operations and facilities under BOEM and BSEE jurisdiction, including drilling, production, construction, well workover, well completion, well servicing, and DOI pipeline activities. The SEMS also applies to all OCS oil and gas operations on new and existing facilities under BOEM and BSEE jurisdiction. BSEE published a Final Rule on the Safety and Environmental Management Systems (SEMS II) on April 5, 2013 (78 FR 20423).

The following is a list of BSEE regulations that are related to oil spill prevention:

- 30 CFR §250.130 pertains to site inspections of oil and gas offshore facilities
- 30 CFR §250.168 grants BSEE authority to suspend operations for reasons related to both safety and to compliance issues
- 30 CFR §250.187 requires incident reporting by operators so that all incidents may be tracked and reviewed with the intent of preventing a repeat of the incident, thus strengthening overall safety which can lead to fewer oil spills

- 30 CFR §§250.201, -286 and -400 all relate to the information to be included in plans submitted to BSEE for review and approval, DWOPs and drilling operations requirements such as blowout preventers (BOPs), which all focus specifically on reducing the probability of an oil spill occurrence
- 30 CFR §250, Subpart H pertains to oil and gas production safety systems
- 30 CFR §250, Subparts I and J regulate platforms and structures and pipelines
- 30 CFR §250, Subpart O pertains to well control and production safety training, the goal of which is to ensure a clean and safe OCS
- 30 CFR §250, Subpart S governs SEMS: All operators are required to have a SEMS program, the goal of which is to promote safety and environmental protection by ensuring all personnel aboard a facility are complying with the policies and procedures identified in the SEMS.

BOEM and BSEE have instituted many regulatory reforms in response to many of the recommendations in reports following the DWH event to improve offshore safety and oversight. BOEM provided NMFS a qualitative analysis of oil spill literature, regulatory changes, and improvements issued since DWH. The 2014 Qualitative Review of Safety Measures to Minimize Frequency of Blowouts and Spills and Maximize Containment Capabilities is incorporated by reference and the key points summarized below.

Safety and Environmental Management Systems (SEMS I and SEMS II) Rule

On October 15, 2010, the Safety and Environmental Management System (SEMS) Rule (75 FR 63610, codified at 30 CFR Part 250, Subpart S) was required to be fully implemented by all OCS oil and gas facilities and operators no later than November 15, 2011.

The SEMS Rule:

- Allows stop work authority to any personnel witnessing unsafe practices.
- Identifies safety and environmental information needed for a facility.
- Requires a facility-level hazard risk assessment.
- Requires written procedures and training for safe work practices.

SEMS requires that operators develop and implement provisions to authorize stop-work authority for any offshore industry personnel who witness an imminent risk or dangerous activity, establishes requirements for reporting unsafe working conditions, and requires employee participation in the development and implementation of their SEMS programs.

The SEMS rule was amended by SEMS II which requires the use of independent third parties to perform the audits of the operators' programs. An audit is required every four years, with an initial two-year re-evaluation.

BSEE Final Drilling Safety Rule

BSEE's Final Drilling Safety Rule was published on August 22, 2012 (77 FR 50855) and updated on September 7, 2016 (81 FR 61834). The requirements of the Rule intend to decrease the likelihood of another extremely large spill by increasing effective measures for spill prevention, and ensuring timely containment should such a spill occur.

Some of the changes required by the Final Drilling Safety Rule (30 CFR §250) include new casing and cementing requirements, new testing and verification requirements for safety features such as auto shear rams and BOPs, expansion of BOP requirements in deepwater drilling operations, and new provisions to train personnel in well monitoring, control, and maintenance of equipment. A subsea containment system required by BSEE is shown in Figure 12.

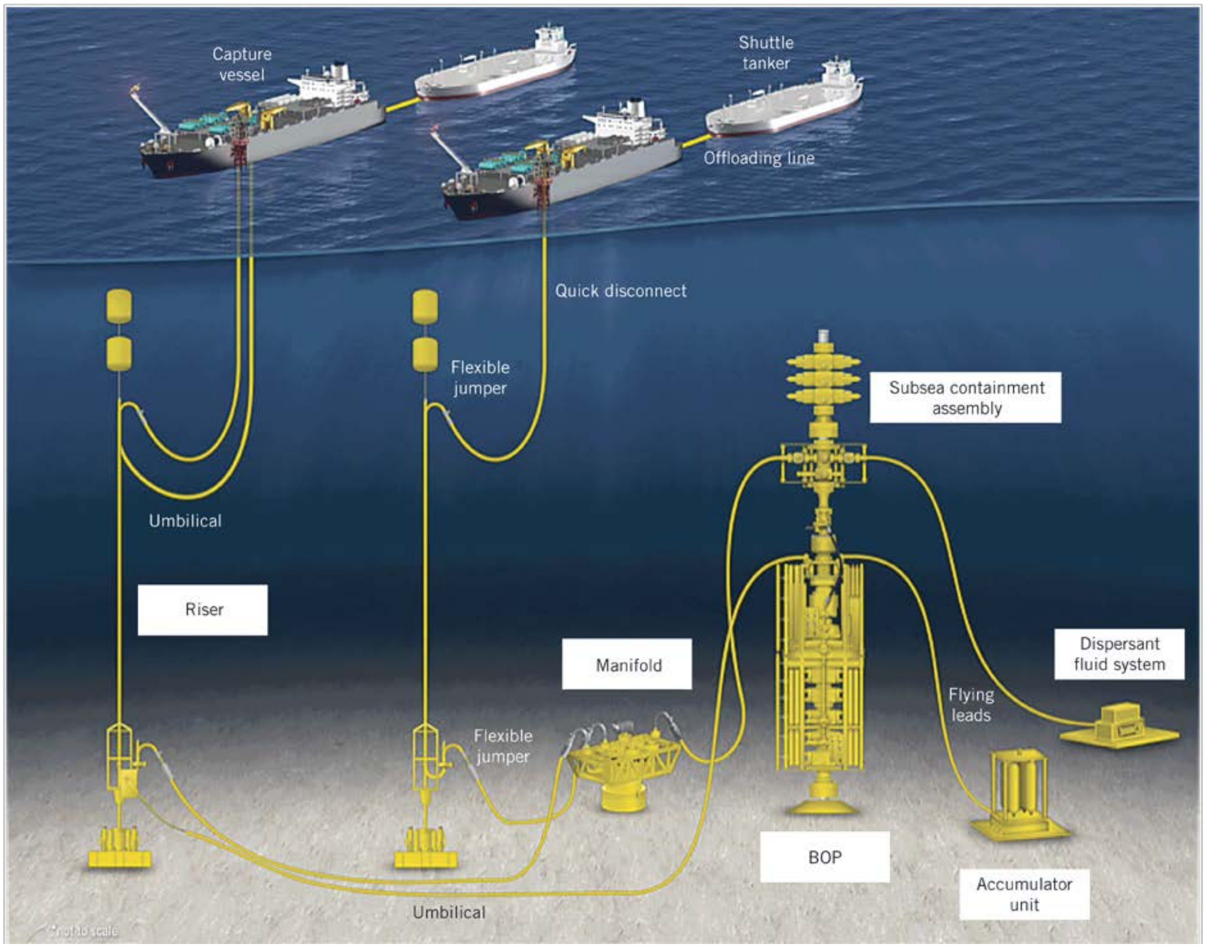


Figure 12. Diagram of a subsea containment system. Figure from Oil and Gas Journal Online https://www.ogj.com/articles/print/volume-108/issue-33/drilling-production/operator-group-plans.html accessed June 4, 2018.

Additionally, for drilling operations in water depths over 500 feet, the Final Drilling Safety Rule:

- Establishes new casing installation requirements.

- Establishes new cementing requirements.
- Requires independent third-party verification of blind-shear ram capability.
- Requires independent third-party verification of subsea BOP stack compatibility.
- Requires new casing and cementing integrity tests.
- Establishes new requirements for subsea secondary BOP intervention.
- Requires function testing for subsea secondary BOP intervention.
- Requires documentation for BOP inspections and maintenance.
- Requires a Registered Professional Engineer to certify casing and cementing requirements.
- Establishes new requirements for specific well-control training to include deepwater operations.

Notably, the Final Rule:

- Updates the incorporation by reference to the second edition of American Petroleum Institute (API) Standard 65-part 2, which was issued in December 2010. This standard outlines the process for isolating potential flow zones during well construction. The new Standard 65-part 2 enhances the description and classification of well-control barriers, and defines testing requirements for cement to be considered a barrier.
- Revises requirements from the Interim Final Rule on the Final Rule, which provides for the installation of dual mechanical barriers in addition to cement for the final casing string (or liner if it is the final string), to prevent flow in the event of a failure in the cement. An operator must install one mechanical barrier in addition to cement, to prevent flow in the event of a failure in the cement. The Final Rule clarifies that float valves are not mechanical barriers.
- Revises §250.423(c) to require the operator to perform a negative pressure test only on wells that use a subsea BOP stack or wells with a mudline suspension system instead of on all wells, as was provided in the Interim Final Rule.
- Adds new §250.451(j) stating that an operator must have two barriers in place before removing the BOP, and that the BSEE District Manager may require additional barriers.
- Extends the requirements for BOPs and well-control fluids to well-completion, well-workover, and decommissioning operations under Subpart E – Oil and Gas Well-Completion Operations, Subpart F – Oil and Gas Well-Workover Operations, and Subpart Q –Decommissioning Activities to promote consistency in the regulations.

The updated Rule made changes to subpart H:

- Restructured subpart H to have shorter, easier-to-read sections and clearer, more descriptive headings.
- Updated and improved safety and pollution prevention equipment (SPPE) design, maintenance, and repair requirements in order to increase the overall level of certainty that this equipment will perform as intended, including in emergency situations.
- Expanded the regulations to differentiate the requirements for operating dry tree and subsea tree production systems on the OCS.
- Incorporated by reference new industry standards and update the previous partial incorporation of other standards to require compliance with the complete standards.
- Added new requirements for firefighting systems, shutdown valves and systems, valve closure and leakage, and high pressure/high temperature (HPHT) well equipment.
- Rewrote the subpart in plain language.

On May 5, 2019, BSEE revised the well control rule,[12] which made revisions including deregulations to the existing rule. The updates impact offshore oil and gas drilling, completions, workovers, and decommissioning activities. The final regulations address various issues that BSEE identified during the implementation of the 2016 Well Control Rule, as well as numerous questions that have required interpretation of the rule. According to BSEE, the updated final rule:

- Clarifies the rig movement reporting requirements.
- Clarifies and revises the requirements for certain submittals to BSEE to eliminate redundant and unnecessary reporting.
- Clarifies the drilling margin requirements in §§ 250.414 and 250.427.
- Revises § 250.723 by removing references to lift boats from the section.
- Removes certain prescriptive requirements for RTM.
- Replaces the use of a BAVO with the use of an independent third party for certain certifications and verifications of BOP systems and components, and removes the

[12] https://www.bsee.gov/guidance-and-regulations/regulations/regulatory-reform/bsee-well-control-rule-2019 and https://www.federalregister.gov/documents/2019/05/15/2019-09362/oil-and-gas-and-sulfur-operations-in-the-outer-continental-shelf-blowout-preventer-systems-and-well

requirement to have a BAVO submit a Mechanical Integrity Assessment report for the BOP stack and system.

- Revises the accumulator system requirements and accumulator bottle requirements to better align with API Standard 53.
- Revises the control station and pod testing schedules to ensure component functionality without inadvertently requiring duplicative testing.
- Includes coiled tubing and snubbing requirements in Subpart G.
- Revises the text to ensure consistency and conformity across the applicable sections of the regulations.
- Revises the regulation to include a 21-day BOP testing frequency.

On several occasions, NMFS sought out clarification from BSEE on what these updates meant for the assumptions to drilling risk associated with this consultation. NMFS also provided comments on the proposed and final rules, but has not yet received response from BSEE regarding drilling risk as it relates to this consultation.

3.1.5.2 Enhanced Inspection Procedures

BSEE has enhanced inspection and enforcement procedures, including a strengthened inspector training program. BSEE has plans and schedules for conducting safety inspections of all deepwater drilling facilities. BSEE undertakes both annual scheduled inspections and periodic unscheduled (unannounced) inspections of oil and gas operations on the OCS. The inspections are to assure compliance with all regulatory constraints that allowed commencement of the operation. Following the DWH event, BSEE requires offshore inspectors to witness required testing of ROV operations and rams. BSEE engineers and inspectors now fly to offshore facilities to witness required testing of all ROV intervention functions on the subsea BOP stack during the stump test (on the rig floor at surface), testing of at least one set of rams during the initial test on the sea floor, and the required function testing of autoshear and deadman systems on the subsea BOP stack.

Installation of Dual Mechanical Barriers

The new regulatory section at 30 CFR §250.420(b)(3) requires that the operator install dual mechanical barriers in addition to cement barriers for the final casing string. These barriers prevent hydrocarbon flow in the event of cement failure at the bottom of the well. The operator must document the installation of the dual mechanical barriers and submit this documentation to BSEE within 30 days after installation. These new requirements will ensure that the best casing and cementing design will be used for a specific well.

Blowout Preventers

A BOP is a complex of choke lines and hydraulic rams mounted atop the well head that can seal off the casing of a well by remote control at the surface. There are different types of BOPs. The

BOPs have been required for OCS oil and gas operations from the time offshore drilling began in the late 1940s. BOPs are important for the safety of the drilling crew, as well as the rig and the wellbore itself. BOPs are typically activated as a last resort upon imminent threat to the integrity of the well or the surface rig. There are two types: ram and annular (also called spherical). Rams are designed to seal an open hole by closing the wellbore with a sharp horizontal motion that may cut through casing or tool strings, as a last resort. One type of ram blowout preventer is called a pipe ram because it closes on the drill pipe by pinching it; however it cannot seal an open hole. Blind ram blowout preventers are straight-edged rams used to close an open hole. An annular BOP closes around the drill string in a smooth simultaneous upward and inward motion. Both types of BOPs (annular and ram) are usually used together to create redundancy in a BOP stack.

The new regulatory section at 30 CFR §250.451(i) requires that, if a blind-shear ram or casing shear ram is activated in a well-control situation in which the pipe or casing is sheared, the BOP stack must be retrieved, fully inspected, and tested. This provision will ensure the integrity of the BOP and that the BOP will still function and hold pressure after the event.

Third-Party Shearing Verification of BOPs

Regulation 30 CFR §250.416(e) requires information verifying that BOP blind-shear rams are capable of cutting through any drill pipe in the hole under maximum anticipated conditions. This regulation has been modified to require the BOP verification be conducted by an independent third party. The independent third party provides an objective assessment that the blind-shear rams can shear any drill pipe in the hole if the shear rams are functioning properly. This confirmation will be required for both subsea and surface BOPs. The NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," clarifies how the regulations apply to operators conducting operations using subsea BOPs or surface BOPs on floating facilities. The NTL informs these operators that a statement, signed by an authorized company official stating that the operator will conduct all authorized activities in compliance with all applicable regulations, including the increased safety measures regulations, should be submitted with each application for a well permit.

Subsea ROV and Deadman Function Testing—Drilling

Previous regulations at 30 CFR §250.449(b) required a stump test of the subsea BOP system. In a stump test, the subsea BOP system is placed on a simulated wellhead (the stump) on the rig floor. The BOP system is tested on the stump to ensure that the BOP is functioning properly. The new regulatory section at 30 CFR §250.449(j) requires that all ROV intervention functions on the subsea BOP stack must be tested during the stump test and that one set of rams must be tested by an ROV on the sea floor. In addition to 30 §CFR 250.449(j), the new regulatory section at 30 CFR §250.449(k) requires that the autoshear and deadman systems be function-tested during the stump test and the deadman system during the initial test on the sea floor. The initial test on the sea floor is performed as soon as the BOP is attached to the subsea wellhead. These new requirements will confirm that a well will be secured in an emergency situation and prevent a possible loss of well control. The ROV test requirement will ensure that the dedicated ROV has the capacity to close the BOP functions on the sea floor. The deadman-switch test on the sea floor verifies that the wellbore closes automatically if both hydraulic pressure and electrical communication are lost with the drilling rig.

Subsea ROV Function Testing—Workover/Completions

Previous regulations did not require subsea ROV function testing of the BOP during workover or well completion operations. The new regulatory sections 30 CFR §250.516(d)(8) and 250.616(h)(1) extend the requirements added to deepwater drilling operations (discussed in the previous section) to well completion operations and workover operations using a subsea BOP stack.

Negative Pressure Tests

Previous regulations at 30 CFR §250.423 required a positive pressure test for each string of casing, except for the drive or structural casing string. This test confirms that fluid from the casing string is not flowing into the formation. The new regulatory section at 30 CFR §250.423(c) requires that a negative pressure test be conducted for all intermediate and production casing strings on all wells to ensure proper casing installation. This test will reveal whether gas or fluid from outside the casing is flowing into the well and ensures that the casing and cement provide an effective seal. Maintenance of pressure under both tests ensures proper casing installation and the integrity of the casing and cement.

Professional Engineer Certification for Well Design

Previous regulations at 30 CFR §250.420(a) specified well casing and cementing requirements but did not require verification by a registered professional engineer. The new regulatory section at 30 CFR §250.420(a)(6) requires that well casing and cementing specifications must be certified by a registered professional engineer. The registered professional engineer will verify that the well casing and cementing design is appropriate for the purpose for which it is intended under expected wellbore conditions. This verification adds assurance that the appropriate design is used for the well, thus decreasing the likelihood of a blowout.

3.1.5.3 Notices to Lessees

Reform has occurred through both prescriptive and performance based regulation and guidance, as well as OCS safety and environmental protection requirements. Under their authorities to issue NTLs (30 CFR §§ 250.103 and 550.103), BOEM and BSEE have issued numerous new NTLs since DWH, some of which are listed below, and apply to all future applicable drilling activities (see https://www.boem.gov/Notices-to-Lessees-and-Operators/ and https://www.bsee.gov/guidance-and-regulations/guidance/notice-to-lessees).

- NTL 2016-N01, "Incident of Noncompliance Response System."

- NTL 2016-N04, "Inspection Fees for Fiscal Year (FY) 2016."
- NTL 2015-N06, "Clarification of Cementing Requirements Following Indications or Identification of an Inadequate Cement Job."
- NTL 2015-G02, "Hurricane and Tropical Storm Effects Reports" supersedes NTL 2011-G01.
- NTL 2014-G02, "Designation of Operator of an OCS Oil and Gas or Sulphur Lease."
- NTL 2014-G03, "Release of Well Data and Information."
- NTL 2014-N03, "eWell Permitting and Reporting System" supersedes NTL No. 2007-G15.
- NTL 2013-N02, "Significant Change to Oil Spill Response Plan, Worst-Case Discharge Scenario."
- NTL 2012-N06, "Guidance to Owners and Operators of Offshore Facilities Seaward of the Coast Line Concerning Regional Oil Spill Response Plans."
- NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS.
- NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources."

On December 29, 2017, BSEE published a proposed rule that would revise some of the regulatory measures discussed above (82 FR 61703). The final rule (84 FR 21908) became effective July 15, 2019 This rule revises regulatory provisions in 30 CFR part 250, subparts A, B, D, E, F, G, and Q on topics such as, but not limited to: Notifications and submittals to BSEE; Drilling margins; Lift boats; Real-time monitoring; BSEE Approved Verification Organizations (BAVOs); Accumulator systems; BOP and control station testing; Coiled tubing; and Mechanical barriers (packers and bridge plugs). The rulemaking incorporates multiple documents by reference, and:

- Clarifies the rig movement reporting requirements.
- Clarifies and revises the requirements for certain submittals to BSEE to eliminate redundant and unnecessary reporting.
- Clarifies the drilling margin requirements in §§ 250.414 and 250.427.
- Revises § 250.723 by removing references to lift boats from the section.
- Removes certain prescriptive requirements for RTM.
- Replaces the use of a BAVO with the use of an independent third party for certain certifications and verifications of BOP systems and components, and removes the requirement to have a BAVO submit a Mechanical Integrity Assessment report for the BOP stack and system.

- Revises the accumulator system requirements and accumulator bottle requirements to better align with API Standard 53.
- Revises the control station and pod testing schedules to ensure component functionality without inadvertently requiring duplicative testing.
- Includes coiled tubing and snubbing requirements in Subpart G.
- Revises the text to ensure consistency and conformity across the applicable sections of the regulations.
- Revises the regulation to include a 21-day BOP testing frequency.

3.1.5.4 Oil-Spill Response Activities

The BSEE regulations (30 CFR §254) require that all owners and operators of oil handling, storage, or transportation facilities located seaward of the coastline submit an OSRP (Oil Spill Response Plan, also called a Facility Response Plan) for approval before an operator can use a facility (Figure 13). The OSRP describes how an operator intends to respond to an oil spill. The OSRP may be site-specific or regional (30 CFR §254.3). The term "regional" means a spill response plan that covers multiple facilities or leases of an owner or operator, including affiliates, which are located in the same BSEE region. The sub-regional plan concept is similar to the regional concept, which allows leases or facilities to be grouped together for the purposes of (1) calculating response times, (2) determining quantities of response equipment, (3) conducting oil-spill trajectory analyses, (4) determining worst-case discharge scenarios, and (5) identifying areas of special economic and environmental importance that may be impacted and the strategies for their protection. NTL No. 2012-N06 includes guidance on the preparation and submittal of sub-regional OSRP's (https://www.bsee.gov/notices-to-lessees-ntl/ntl-2012-n06-guidance-to-owners-and-operators-of-offshore-facilities-seaward).

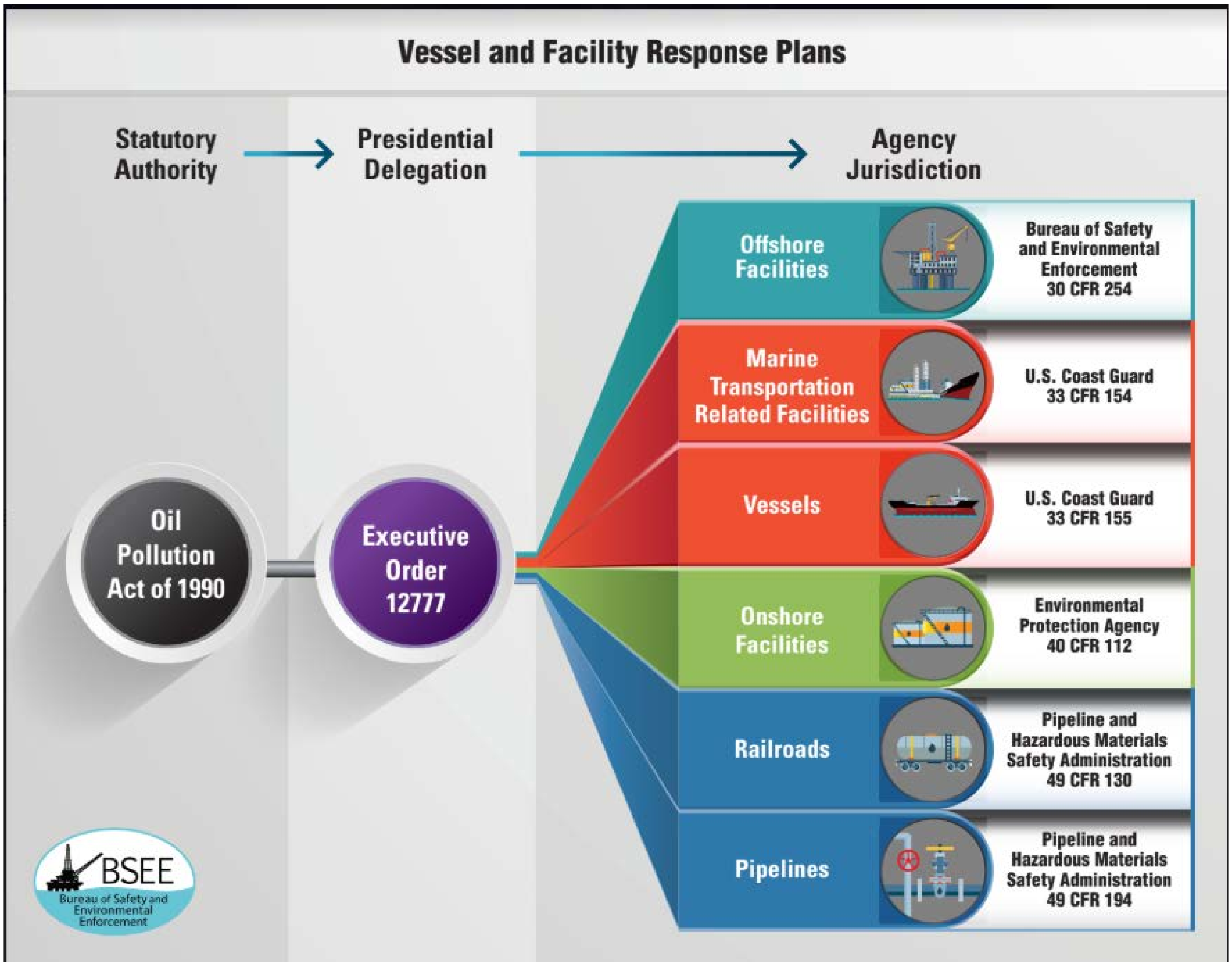


Figure 13. Regulatory agency jurisdictions for Facility Response Plans.

The Emergency Response Action Plan serves as the core of the BSEE-required OSRP. A requirement of the OSRP is to demonstrate adequate preparation and response to a WCD from that company's activities. In the Gulf of Mexico, a WCD is based on actual data and estimates of the largest reservoir size an operator intends to develop or produce. In accordance with 30 CFR §254, the Emergency Response Action Plan requires identification of (1) the qualified individual and the spill-response management team, (2) the spill-response operating team, (3) the oil-spill cleanup organizations under contract for response, and (4) the federal, state, and local regulatory agencies that an owner/operator must notify or that they must consult with to obtain site-specific environmental information when an oil spill occurs. The OSRP is also required to include an inventory of appropriate equipment and materials, their availability, and the time needed for deployment, as well as information pertaining to dispersant use, in-situ burning, a worst-case discharge scenario, contractual agreements, training and drills, identification of potentially impacted environmental resources and areas of special economic concern and environmental importance, and strategies for the protection of these resources and areas. The response plan must provide for response to an oil spill from the facility and the operator must immediately carry out the provisions of the plan whenever an oil spill from the facility occurs. The OSRP must be in compliance with the National Contingency Plan and the ACP. The operator is also required to carry out the training, equipment testing, and periodic drills described in the OSRP. All BSEE-approved OSRPs must be reviewed at least every two years. In addition, revisions must be submitted to BSEE within 15 days whenever (1) a change occurs that appreciably reduces an owner/operator's response capabilities; (2) a substantial change occurs in the worst-case discharge scenario or in the type of oil being handled, stored, or transported at the facility; (3) there is a change in the name(s) or capabilities of the oil-spill removal organizations cited in the OSRP; or (4) there is a change in the applicable ACPs.

The adequacy of OSRPs will be reviewed by BSEE according to "Guidance to Owners and Operators of Offshore Facilities Seaward of the Coast" described in NTL 2012-N06. All operators are required to provide a "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources" (NTL 2010-N10). Operators must submit and have an approved OSRP that must demonstrate adequate plans for the containment, response, and recovery of spilled oil for a WCD. The OSRP must demonstrate adequate preparedness to respond to protected species during a WCD. The OSRP must consider the location of the potential WCD and proximity to protected resources, wildlife protection, rescue and rehabilitation strategies, and real-time response capability.

As a result of the DWH event, supplemental information related to oil spill response is now required for new or previously submitted EPs, DPPs, or DOCDs. The required supplemental information includes the following:

- a description of the blowout scenario as required by 30 CFR §550.213(g) and 550.243(h)
- a description of the assumptions and calculations used in determining the volume of the WCD required by 30 CFR §550.219(a)(2)(iv) (for EPs) or 30 CFR §550.250(a)(2)(iv) (for DPPs and DOCDs)
- a description of the measures proposed that would enhance the ability to prevent a blowout, to reduce the likelihood of a blowout, and to conduct effective and early intervention in the event of a blowout, including the arrangements for drilling relief wells and any other measures proposed

The early intervention methods could actually include the surface and subsea containment resources that BOEMRE announced in NTL 2010-N10, which states that BOEMRE will begin reviewing to ensure that the measures are adequate to promptly respond to a blowout or other loss of well control. Additionally, to address new improved containment systems, NTL 2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," became effective on November 8, 2010. This NTL applies only to operators conducting operations using subsea or surface BOPs on floating facilities. It clarifies the regulatory requirement that lessees and operators must submit a certification statement signed by an authorized company official with each application for a well permit, indicating that they will conduct all of their authorized activities in compliance with all applicable regulations, including the Oil and Gas and Sulphur Operations on the Outer Continental Shelf—Increased Safety Measures for Energy Development on the Outer Continental Shelf (77 FR 50856, August 22, 2012). The NTL also informs lessees that BSEE will be evaluating whether or not each operator has submitted adequate information demonstrating that it has access to and can deploy surface and subsea containment resources that would be adequate to promptly respond to a blowout or other loss of well control.

While oil spills and response activities are expected as part of the proposed action, some oil spill response activities (perhaps those conducted by the USCG and regional response team) may also be analyzed under a separate consultation depending on the circumstances of the spill. Some USCG response activities may be pre-authorized under other consultations for use of dispersants and in-situ burning. This opinion discusses effects of oil spill response activities in section 8.8.1.5.

Vessel traffic associated with Oil Spill Response Activities

Localized vessel traffic around the area where an oil spill occurs may increase, according to the size of the spill, however we would not expect a meaningful increase in overall vessel traffic within the Gulf of Mexico. Therefore, we would expect that vessel traffic would be essentially the same across the Gulf of Mexico whether or not spill response was occurring.

Source Containment

Requirements related to the loss of well control and containment systems are described in NTL 2010-N10. Several oil and gas companies initiated the development of a rapid response system.

The companies that originated this system have formed a nonprofit organization, the Marine Well Containment Company (MWCC), to operate and maintain the system (https://www.marinewellcontainment.com/). The MWCC will provide fully trained crews to operate the system, will ensure the equipment is operational and ready for rapid response, and will conduct research on new containment technologies. BSEE will not allow an operator to begin drilling operations until adequate subsea containment and collection equipment, as well as subsea dispersant capability, is determined by BSEE to be available to the operator and is sufficient for use in response to a potential incident from the proposed well(s).

The containment system consists of equipment owned and maintained by MWCC along with mutual aid vessels released by member companies (https://www.marinewellcontainment.com/containment-system/). The system is designed to meet BSEE requirements for a subsea well containment system that can respond to an underwater well-control incident in the U.S. Gulf of Mexico, as outlined in NTL No. 2010-N10. The containment system has been available for use in the deepwater U.S. Gulf of Mexico since

February 2011. The containment system can handle pressure up to 15,000 pounds per square inch and temperatures up to 350 degrees Fahrenheit. The capping stack can cap a well in deepwater depths up to 10,000 feet (3,048 meters). It is engineered to cap and contain the flow of a well in deepwater depths up to 8,000 feet (2,438 meters). The system has the capacity to contain 100,000 barrels per day (and 200 million standard cubic feet of gas per day) and includes a 15,000 pounds per square inch single ram capping stack and dispersant injection capability.

Mechanical Cleanup

Generally, mechanical containment and recovery is the primary oil-spill-response method used. Mechanical recovery is the process of using booms and skimmers to pick up oil from the water surface. It is expected that the oil-spill-response equipment needed to respond to an offshore spill would be called out from one or more of the following oil-spill equipment base locations in Corpus Christi, Aransas Pass, Houston, La Porte, Ingleside, Port Arthur, and Galveston, Texas; Lake Charles, New Iberia, Belle Chase, Cameron, Cocodrie, Morgan City, New Orleans, Sulphur, Houma, Fourchon, Fort Jackson, and Venice, Louisiana; Pascagoula, Mississippi; Theodore and Mobile, Alabama; or Pensacola, Fort Lauderdale, Panama City, and Tampa, Florida. Response times for any of this equipment would vary, dependent on the location of the equipment, the staging area, and the spill site, and on the transport requirements for the type of equipment procured. Oil recovery systems typically have swath widths of only a few meters and move at slow speeds while recovering oil. Therefore, even if this equipment can become operational within a few hours, it would not be feasible for them to encounter more than a fraction of a widely spread slick. For this reason, it is assumed that a maximum of 10-30 percent of an oil spill in an offshore environment can be mechanically removed from the water prior to the spill making landfall (OTA 1990). During the DWH event, it was estimated that only three percent of the total oil spilled was picked up by mechanical equipment offshore (Lubchenco et al. 2010; Ramseur 2010).

Dispersants

When dispersants are applied to spilled crude oil, the surface tension of the oil is reduced, allowing wind and wave action to break the oil into tiny droplets that are dispersed into the upper portion of the water column. Oil that is chemically dispersed at the surface will move into the top 20 feet (six meters) of the water column where it will mix with surrounding waters and begin to biodegrade (OTA 1990, p. 19). Dispersant use, in combination with natural processes, breaks up the oil into smaller components that allows them to dissipate into the water and degrade more rapidly (Schmidt 2010). Dispersion is thought to increase the likelihood that the oil will be biodegraded, both in the water column and at the surface. Biodegradation is accomplished by bacteria that break down the dispersed and weathered surface oil. Dispersant use must be in accordance with the Regional Response Team's Preapproved Dispersant Use Manual and with any conditions outlined within a Regional Response Team's site-specific, dispersant approval given after a spill event. Consequently, dispersant use would be in accordance with the restrictions for specific water depths, distances from shore, or monitoring requirements. No preapproval has been authorized for the subsea application of dispersants. The effectiveness and impact of subsea dispersant use during DWH are still being studied and the subject of continued debate.

The USEPA issued a letter dated December 2, 2010, that provided interim guidance on the use of dispersants for major spills that are continuous and uncontrollable for periods greater than seven days and for expedited approval of subsurface applications. This letter outlines the following exceptions for the use of dispersants until guidelines for their use are revised:

- Dispersants may not be applied to major spills that are continuous in nature and uncontrollable for a period greater than seven days.
- Additional dispersant monitoring protocols and sampling plans may be developed that meet the unique needs of the incident.
- Subsurface dispersants may only be approved on an incident-specific basis as requested by the USCG On-Scene Commander.

In 2011, in response to hotline complaints about the use of dispersants during the DWH incident, USEPA's Office of Inspector General made recommendations to the USEPA Office of Solid Waste and Emergency Response to review and update contingency plans, to incorporate lessons learned from DWH, and to clarify roles and responsibilities for Spills of National Significance. Additionally, recommendations were made to the Office of Research and Development to develop a plan on long-term health and environmental effects of dispersants (USEPA 2011). The Office of Inspector General reported that the agency generally agreed with its recommendations. In January 2015, USEPA proposed amendments to Subpart J of the National Contingency Plan(80 FR 3379, January 22, 2015) (USEPA 2015). The proposed changes would help to ensure that chemical and biological agents have met efficacy and toxicity requirements, and that product manufacturers provide important use and safety information. Further, this would equip the planning and response community with the proper information to authorize and use products judiciously to effectively mitigate health and environmental effects from oil discharges. Proposed amendments include:

- Authorization of use to add clarifications, limitations, notification and guidance.
- Monitoring requirements for agent use.
- Dispersant testing and listing requirements.
- Submissions of confidential business information.

In-situ Burning

In-situ burning is an oil-spill cleanup technique that involves the controlled burning of the oil at or near a spill site. The use of this spill-response technique can provide the potential for removal of large amounts of oil over an extensive area in less time than other techniques. In-situ burning involves the same oil collection process used in mechanical recovery, but instead of going to a skimmer, the oil is funneled into a fire boom and set on fire. In-situ burning is typically more effective than skimmers, but has some limitations on the window of response such as freshness of the oil, meteorological conditions, and concentration of oil available for collection at the surface. Burning agent use is authorized on a case by case basis by concurrence of the USCG on-scene coordinator, Regional Response Team and Natural Resource Trustees.

Natural Dispersion

Depending upon environmental conditions and spill size, the best response to a spill may be to allow the natural dispersion of a slick to occur. Natural dispersion may be a preferred option for smaller, non-persistent oils and condensates that form slicks that are too thin to be removed by conventional methods. In addition, natural dispersion may also be a preferred option in some nearshore environments, such as a marsh habitat, when the potential damage caused by a cleanup effort could cause more damage than the spill itself.

Onshore Response and Cleanup

Offshore response and cleanup is preferable to shoreline cleanup; however, if an oil slick reaches the coastline, it is expected that the specific shoreline cleanup countermeasures identified and prioritized in the appropriate ACPs for various habitat types would be used. The sensitivity of the contaminated shoreline is the most important factor in the development of cleanup recommendations. The ACPs cover subregional geographic areas and represent the third tier of the National Response Planning System mandated by OPA. The ACPs are a focal point of response planning, providing detailed information on response procedures, priorities, and appropriate countermeasures. The single, most frequently recommended, spill-response strategy for the areas identified for protection in all of the applicable ACPs or its Geographic Response Plans is the use of a shoreline boom to deflect oil away from coastal resources such as seagrass beds, marinas, resting areas for migratory birds, bird and turtle nesting areas, etc.

3.1.6 Project Design Criteria to Avoid and Minimize Adverse Effects

As a result of previous consultations with NMFS, BOEM and BSEE (under the former MMS) have developed several NTLs for the Gulf of Mexico OCS Leasing Program. These are non-discretionary requirements that are part of the proposed action. Each NTL is a formal document that provides clarification, description, or interpretation of a regulation or OCS standard; provides guidelines on the implementation of a special lease stipulation or regional requirement; provides a better understanding of the scope and meaning of a regulation by explaining BOEM or BSEE’s interpretation of a requirement; or transmits administrative information such as current telephone listings and a change in BSEE personnel or office address.

Many effects minimization measures will be applied programmatically throughout the Gulf of Mexico through NTLs or other similar guidance documents, such as protocols included as appendices to this opinion (guidance documents henceforth referred to as NTLs). As needed, NTLs are reviewed to determine if any changes or updates are required. NTLs may also be updated when new ESA consultation requirements warrant an NTL revision.

In the context of this programmatic consultation, only the NTLs that pertain to threatened and endangered species protection are described here. Each of the NTLs summarized below can be found at http://www.boem.gov/Notices-to-Lessees-and-Operators and/or at https://www.bsee.gov/guidance-and-regulations/guidance/notice-to-lessees. Some or all of these proposed PDCs may be altered or augmented as a result of this consultation, through addition of RPMs and terms and conditions, or during project-specific step-down consultations.

3.1.6.1 Effects Avoidance or Minimization Measures for Lease Activity Implementation

The following sections describe measures taken by BOEM and BSEE to minimize effects of the Oil and Gas Program activities to ESA-listed species. These are measures that, to date, have been implemented as presented below by BOEM and BSEE following completion of previous ESA section 7 consultations with NMFS.

Protected Species Stipulation

The protected species stipulation is applied after a lease sale occurs and is issued for any lease block sold. It has been applied to post-lease G&G activities since 2001. The stipulation is currently as follows:

A. The ESA (16 USC §1531, et seq.) and the MMPA (16 USC §1361, et seq.) are designed to protect threatened and endangered species and marine mammals and apply to activities on the OCS. The OCLSA (43 USC §1331, et seq.) provides that the OCS should be made available for expeditious and orderly development subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs (see 43 USC §1332). Both BOEM and BSEE comply with these laws on the OCS.
B. The lessee and its operators must:
    1. Collect and remove flotsam resulting from activities related to exploration, development, and production of this lease;
    2. Post signs in prominent places on all vessels and platforms used as a result of activities related to exploration, development, and production of this lease detailing the reasons (legal and ecological) why release of debris must be eliminated;
    3. Observe for marine mammals and sea turtles while on vessels, reduce vessel speed to 10 knots or less when assemblages of cetaceans are observed, and maintain a distance of 91 meters or greater from whales, and a distance of 45 meters or greater from small cetaceans and sea turtles;
    4. Employ mitigation measures prescribed by BOEM/BSEE or NMFS for all seismic surveys, including the use of an "exclusion zone" based upon the appropriate water depth, ramp-up and shutdown procedures, visual monitoring, and reporting;
    5. Identify important habitats, including designated critical habitat, used by listed species (e.g., sea turtle nesting beaches, piping plover critical habitat), in oil spill contingency planning and require the strategic placement of spill cleanup

equipment to be used only by personnel trained in less-intrusive cleanup techniques on beaches and bay shores; and

6. Immediately report all sightings and locations of injured or dead protected species (e.g., marine mammals and sea turtles) to the appropriate stranding network. If oil and gas industry activity is responsible for the injured or dead animal (e.g., because of a vessel strike), the responsible parties must remain available to assist the stranding network. If the injury or death was caused by a collision with the lessee's vessel, the lessee must notify BSEE within 24 hours of the strike.

C. BOEM and BSEE issue NTLs, which more fully describe measures implemented in support of the other stipulations' implementing statutes and regulations, as well as measures identified by the USFWS and NMFS arising from, among others, conservation recommendations, rulemakings pursuant to the MMPA, or consultation. The lessee and its operators, personnel, and subcontractors, while undertaking activities authorized under this lease, must implement and comply with the specific mitigation measures outlined in the following NTLs:
    1. BOEM NTL No. 2016-G02 "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program" (available at http://www.boem.gov/BOEM-NTL-2016-G02);
    2. BSEE NTL 2010-G05 superceded by 2018-G03 "Idle Iron Decommissioning Guidance for Wells and Platforms";
    3. BSEE NTL No. 2015-G03 "Marine Trash and Debris Awareness and Elimination" (available at https://www.bsee.gov/sites/bsee.gov/files/notices-to-lessees-ntl/alerts/ntl-2015-g03.pdf); and
    4. BOEM NTL No. 2016-G01 "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting" (available at: http://www.boem.gov/BOEM-NTL-No-2016-G01http://www.boem.gov/BOEM-NTL-No-2016-G01).

At the lessee's option, the lessee, its operators, personnel, and contractors must comply with the most current measures to protect species in place at the time an activity is undertaken under this lease, including, but not limited to, new or updated versions of the NTLs identified in this paragraph. The lessee and its operators, personnel, and subcontractors will be required to comply with the mitigation measures, identified in the above referenced NTLs, and additional measures in the conditions of approvals for their plans or permits.

3.1.6.2 Effects Avoidance or Minimization Measures for Seismic Surveys

To minimize the effects of seismic surveys, BOEM proposes the continuation of the mitigation and monitoring requirements in NTL 2016-G02 "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program" that provides guidance to an operator for better understanding the regulations for the protection of marine mammals and sea turtles during seismic operations. The measures contained in this NTL apply to all on-lease surveys conducted under 30 CFR §550 and to all off-lease surveys conducted under 30 CFR §551. Although BOEM proposes no new measures for this consultation, it was indicated that this NTL will be updated with any new consultation requirements in the future. The NTL clarifies how operators should implement seismic survey mitigation measures under different conditions including ramp-up and shut-down procedures, passive acoustic monitoring (PAM) requirements, and protected species observer (PSO) requirements. The NTL specifies the minimum number of PSOs required on each source vessel that will be used, the certification that the minimum sound source required to conduct the survey is used, and protected species data collection and reporting requirements. Any unusual circumstances that may arise during a survey that involve listed species can be directly addressed through PSO reports, email, and satellite phone communication between PSOs and the survey company with BOEM/BSEE. The NTL also allows PSOs to implement cessation of airgun firing based on observed presence of whales within 500 meters of the sound source array.

3.1.6.3 Effects Avoidance or Minimization Measures for the Explosive Removal of Offshore Structures

BSEE NTL 2018-G03 “Idle Iron Decommissioning Guidance for Wells and Platforms” describes the regulations for explosive removal of structures. All explosives use will require NMFS PSOs from the Platform Removal Observer Program. These requirements necessitate different levels of mitigation, monitoring, and reporting for protected species based on the charge size, water depth (species delineations), and use above or below the sea floor. The use of PAM technicians is required when using explosives in water depths less than 200 meters in order to monitor for vocalizations of deep-diving marine mammals.

3.1.6.4 Effects Avoidance or Minimization Measures for Marine Debris

The BSEE NTL 2015-G03 “Marine Trash and Debris Awareness and Elimination” NTL provides guidance to prevent intentional and/or accidental introduction of debris into the marine environment. Operators are prohibited from deliberately discharging containers and other similar materials (i.e., trash and debris) into the marine environment (30 CFR §250.300(a) and (b)(6)) and are required to make durable identification markings on equipment, tools, containers (especially drums), and other material (30 CFR §250.300(c)). The intentional jettisoning of trash has been the subject of strict laws such as the International Convention for the Prevention of Pollution from Ships (MARPOL or marine pollution 73/78 for short), Annex V and the Marine Plastic Pollution Research and Control Act, and regulations imposed by various agencies including USCG and USEPA. The USCG and USEPA regulations require that operators become more proactive in avoiding accidental loss of solid-waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. The Marine Debris NTL states marine debris placards must be posted in prominent places on all fixed and floating production facilities that have sleeping or food preparation capabilities and on mobile drilling units. Operators must also ensure that all of their offshore employees and those contractors actively engaged in their offshore operations complete annual training that includes

(1) viewing a training video or slide show (specific options are outlined in the NTL) and (2) receiving an explanation from the lessee company's management that emphasizes their commitment to the NTL's provisions. An annual report that describes the marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year is to be provided to BSEE by January 31 of each year.

3.1.6.5 Effects Avoidance or Minimization Measures for Vessel Operations

The BOEM NTL 2016-G01 "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting" NTL explains how operators must implement measures to minimize the risk of vessel strikes to protected species and report observations of injured or dead protected species. This NTL will be required for every applicable permit and plan that has associated vessel traffic that is approved by BOEM or BSEE. Vessel operators and crews must maintain a vigilant watch for marine protected species and slow down or stop their vessel to avoid striking protected species. Crews must report sightings of any injured or dead protected species (marine mammals, sea turtles and Gulf sturgeon) immediately, regardless of whether the injury or death is caused by their vessel, to the Marine Mammal and Sea Turtle Stranding Hotline or the Marine Mammal Stranding Network. In addition, if it was the operator's vessel that collided with a protected species, BSEE must be notified within 24 hours of the strike.

3.1.6.6 Effects Avoidance or Minimization Measures for Site Clearance Trawling

Following decommissioning of a structure, operators are required to restore the sea floor to pre-lease conditions by removing any debris that may be on the sea floor. Site clearance is typically conducted with trawl nets. To minimize the effect on sea turtles that may be incidentally captured in the nets, under 30 CFR §§ 250.1740-1743 BOEM requires the use trawl net(s) with a net bag/cod end with minimum mesh size no smaller than four inches (10.2 centimeters) stretched mesh and abide by maximum trawl times of 30 minutes (time measured by doors in to the time doors are out of the water), allowing for the removal of any captured sea turtles. If sea turtles are captured, turtles must be resuscitated and released following the requirements for shrimp trawlers in the Gulf of Mexico.

3.1.7 Other Aspects of the Proposed Action Important to Effects Avoidance or Minimization

There are a number of statutory and regulatory requirements, other NTLs, review procedures and other practices that BOEM and BSEE adhere to, and this analysis assumes their continued implementation. These requirements and practices are described below, and while they do not directly avoid or minimize effects to listed species, their implementation indirectly benefits listed species by minimizing the risks of potential effects on marine environments from occurring. Continued implementation of these measures will reduce potential effects on the habitats and marine ecosystems in which listed species live.

3.1.7.1 Review Requirement for Safe Exploration Plans and Development Operations and

Coordination Documents

Environmental information requirements for lessees and operators submitting an EP are specified in 30 CFR §550.211 through 550.228, and are further explained in NTL 2008-G04, "Shallow Hazards Program," and NTL 2009-G27, "Submitting Exploration Plans and Development Operations Coordination Documents." NTL 2008-G04 provides guidance on information requirements and establishes the contents for OCS plans required by 30 CFR §250 Subpart B. NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," effective June 18, 2010, rescinded the limitations set forth in NTL 2008-G04 regarding a blowout and worst-case discharge scenarios and provides national guidance regarding the content of information in blowout and worst-case discharge scenario descriptions. NTL 2009-G27 clarifies guidance for submitting OCS plans and DOCD's to BOEM's Gulf of Mexico OCS Region.

3.1.7.2 Review Requirement for Safe Drilling Plans

BOEM/BSEE will review all APDs to ensure lessees are using the best available and safest technology to enhance the evaluation of abnormal pressure conditions and to minimize the potential for uncontrolled well flow. Prior to conducting drilling operations, the operator is required to submit and obtain approval from BOEM/BSEE, an APD detailing the project layout at a scale of 24,000:1, design criteria for well control and casing, specifications for blowout preventers, a mud program, cementing program, directional drilling plans, etc.—to allow for BOEM/BSEE's evaluation of operational safety and pollution-prevention measures.

3.1.7.3 Review Requirement for Safe Pipelines

BOEM/BSEE will review proposed pipelines for safe and pollution free design, installation, and maintenance of OCS producer-operated oil and gas pipelines (30 CFR §250 Subpart J). BSEE evaluates the design, fabrication, installation, and maintenance of all OCS pipelines. BOEM prepares NEPA analyses of proposed pipeline routes and installation/modification methodologies will be evaluated to determine the potential impacts on protected species. The design of proposed pipelines will be evaluated by: (1) reviewing the applicant's calculations to determine proper consideration of such elements as the grade of pipe to be used, the wall thickness of the pipe, derating factors (the practice of operating a component well inside its normal operating limits to reduce the rate at which the component deteriorates) related to the submerged and riser portions of the pipeline, the pressure rating of any valves or flanges to be installed in the pipeline, the pressure rating of any other pipeline(s) into which the proposed line might be tied, and the required pressure to which the line must be tested before it is placed in service; (2) protective safety devices such as pressure sensors and remotely-operated valves, the physical arrangement of those devices proposed to be installed by the applicant for the purposes of protecting the pipeline from possible overpressure conditions and for detecting and initiating a response to abnormally low pressure conditions; and (3) the applicant's planned compliance with regulations requiring that pipelines installed in water depths less than 200 feet (61 meters) be buried to a depth of at least three feet (one meter) (30 CFR §250.1003). In addition, pipelines crossing fairways require a USACE permit and must be buried to a depth of at least 10 feet (thre meters) and to 16 feet (five meters) if crossing an anchorage area. Operators are required to periodically inspect pipeline routes. Monthly overflights are conducted to inspect pipeline routes for leakage.

Applications for pipeline decommissioning must also be submitted for BOEM and BSEE review and approval. Decommissioning applications are evaluated to ensure they will render the pipeline inert and/or to minimize the potential for the pipeline becoming a source of pollution by flushing.

3.1.7.4 Review Requirement for Safe Wastewater Pollution Control

BOEM/BSEE must assure that oil and gas exploration, development, and production activities on the OCS are conducted in a safe and environmentally responsible manner. 43 USC §1347(b) of the OCSLA, as amended, requires that all OCS technologies and operations use best available and safe techologies whenever practical. Oil and gas production safety systems and equipment used on the OCS will be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments (30 CFR §250 Subpart H). BOEM/BSEE will assist USEPA with assuring that any effluent discharges from OCS facilities will be done in accordance with NPDES permits issued by USEPA. This includes all monitoring requirements as described in the NPDES permits.

3.1.7.5 Review Requirement for Safe Air Quality Control

BOEM will review all permit requests to ensure that lessees have applied for all necessary air quality permits and adequately described any possible emissions of regulated pollutants from their proposed activities.

3.1.7.6 Inspection and Enforcement

The OCSLA authorizes and requires BSEE to provide for both an annual scheduled inspection and periodic unscheduled (unannounced) inspections of all oil and gas operations on the OCS. The inspections are to assure compliance with all regulatory constraints that allowed commencement of the operation. The primary objective of an initial inspection is to assure proper installation of mobile drilling units and fixed structures, and proper functionality of their safety and pollution prevention equipment. After operations begin, additional announced and unannounced inspections are conducted. Unannounced inspections are conducted to foster a climate of safe operations, to maintain a BSEE presence, and to focus on operators with a poor performance record. These inspections are also conducted after a critical safety feature has previously been found defective. Poor performance generally means that more frequent, unannounced inspections may be conducted on a violator’s operation. The annual inspection examines all safety equipment designed to prevent blowouts, fires, spills, or other major accidents. These annual inspections involve the inspection for installation and performance of all facilities’ safety-system components. The inspectors follow the guidelines as established by the regulations, API RP 14C, and the specific BSEE-approved plan. BSEE inspectors perform these inspections using a national checklist called the Potential Incident of Noncompliance (PINC) list. This list is a compilation of yes/no questions derived from all regulated safety and environmental requirements.

BSEE administers an active civil penalties program (30 CFR §250 Subpart N). A civil penalty in the form of substantial monetary fines may be issued against any operator that commits a violation that may constitute a threat of serious, irreparable, or immediate harm or damage to life, property, or the environment. BSEE may make recommendations for criminal penalties if a willful violation occurs. In addition, the regulation at 30 CFR §250.173(a) authorizes suspension of any operation in the Gulf of Mexico Region if the lessee has failed to comply with a provision of any applicable law, regulation, or order or provision of a lease or permit. Furthermore, the Secretary of DOI may invoke his authority under 30 CFR §550.185(c) to cancel a nonproductive lease with no compensation. Exploration and development activities may be canceled under 30 CFR §§550.182 and 550.183.

3.1.7.7 Additional Effects Avoidance or Minimization Measures

Additional effects avoidance or mitigation measures may be required by NMFS for site specific activities as specified in an Incidental Take Authorization, Step-down Consultation or by BOEM in a specific exploration plan or by BSEE in a drilling permit. However, because these measures may, or may not, be incorporated in future permits and authorizations, they are not considered as part of this proposed action.

3.2 Environmental Protection Agency

Air and water emissions associated with Gulf of Mexico oil and gas activities and permitted by the USEPA are interdependent actions. As such, USEPA is a co-federal action agency for this consultation.

3.2.1 Clean Water Act Responsibilities

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

The USEPA, through NPDES general permits issued by the USEPA Region that has jurisdictional oversight, regulates specific waste streams associated with or generated from offshore oil and gas activities. Section 301(a) of the CWA, 33 USC §1311(a), makes it unlawful for any person to discharge any pollutant, except in compliance with other CWA provisions that may apply, including compliance with an NPDES permit. CWA section 402, 33 USC Section 1342, authorizes issuance of NPDES permits allowing discharges on the condition the discharge will meet certain requirements, including CWA Sections 301, 304, 306, 401 and 403. Those statutory provisions require NPDES permits to include effluent limitations for authorized discharges that: (1) reflect pollutant reductions achievable through statutorily-specified levels of technology, (2) comply with applicable USEPA-approved state water quality standards, (3) comply with other state requirements adopted under authority retained by states under CWA section 510, 33 USC Section 1370, and (4) are evaluated to determine the degree of degradation to the territorial seas, waters of the contiguous zone, or the oceans. When issuing permits for discharges into waters of the territorial sea, contiguous zone, or oceans, CWA Section 403 requires the USEPA to consider guidelines for determining potential degradation of the marine environment. Prior to permit issuance, ocean discharges must be evaluated against USEPA's published criteria (40 CFR §125, Subpart M) for determination of ocean degradation. Permit conditions are based on both technology-based effluent limitations guidelines and other prohibitions and conditions based on the best professional judgment of the permit writer such as the prohibition of discharges near sensitive aquatic communities or federally designated disposal sites. Water-quality based whole effluent toxicity limits are included to ensure certain discharges do not cause unreasonable degradation of the marine environment.

As mentioned previously, two regional offices issue NPDES general permits in the Gulf of Mexico based on geographic location. Region 4 permits all CWA Gulf activities beyond the territorial seas of Mississippi, Alabama, and Florida, while Region 6 permits all CWA activities off the coast of Texas and those beyond the territorial seas of Louisiana (Figure 14). Each region issues general NPDES permits for discharges from new sources, existing sources, and new discharges in the Offshore and Coastal Subcategories of the Oil and Gas Extraction Point Source Category, as defined in EPA regulations at 40 CFR Part 435, Subpart A.

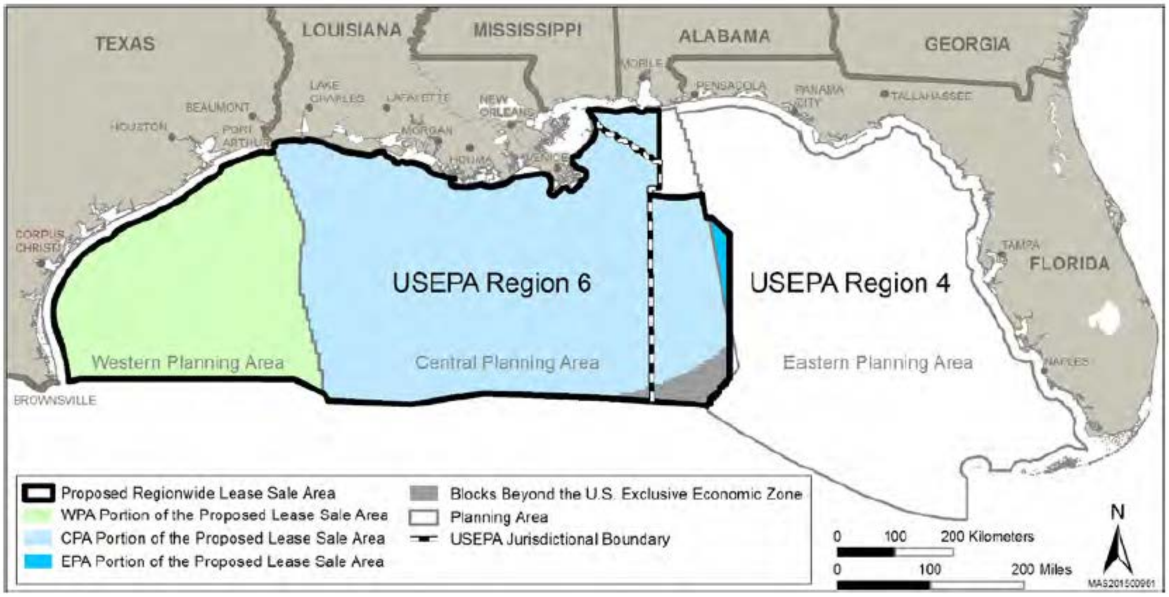


Figure 14. U.S. Environmental Protection Agency Jurisdictional Boundaries in the Gulf of Mexico (Figure from the USEPA's Draft Environmental Assessment for the NPDES General Permit for Eastern GOM Offshore Oil and Gas Exploration, Development, and Production).

Permits issued under section 402 of the CWA for offshore activities must comply with any applicable water quality standards and/or federal water quality criteria as well as section 403 of the CWA. Water quality standards consist of the waterbody's designated uses, water quality criteria to protect those uses and to determine if they are being attained, and anti-degradation policies to help protect high-quality waterbodies. General permits have been issued for oil and gas related discharges into the Gulf of Mexico that at a minimum incorporate the 1993 effluent guidelines and 2001 effluent guidelines for synthetic based fluid-wetted cuttings.The USEPA has issued general NPDES permits GMG290000 (Region 6 – Federal waters seaward of Texas and Louisiana) and GEG460000 (Region 4 – Federal waters seaward of Texas and Louisiana) and GEG460000 (Region 4 – Federal waters seaward of the outer boundary of the territorial seas in water depths greater than 200 meters offshore the coasts of Alabama and Florida and in the Mobile and Visoca Knoll lease blocks seaward of the territorial seas offshore Mississippi and Alabama) for new and existing sources in the Offshore Subcategory of the Oil and Gas Extraction Category located in the Gulf of Mexico. NPDES permits can be found at https://www.epa.gov/npdes-permits.

The general permits authorize discharges from exploration, development, and production facilities located in and discharging to Gulf of Mexico waters. For the Region 4 permit, areas covered include federal waters offshore of Alabama and Mississippi in the Viosca Knoll and Mobile Lease Blocks, and seaward of 200 meter depth contour offshore of Florida and offshore of Alabama in the Destin Dome lease block. The permits allow the discharge of water-based drilling fluid, water- and synthetic-based drill cuttings, produced water, deck drainage, well treatment, completion, and workover fluids (usually brine), sanitary waste, domestic waste, and miscellaneous discharges. Each of these discharges is regulated by conditions outlined in the permit. The USEPA has established effluent limitations, toxicity testing requirements, and monitoring requirements for the various discharges that operators must comply with to ensure the health of Gulf of Mexico waters (**Appendix E**).

Operators of facilities within the NPDES general permit coverage area must submit an NOI to the Regional Administrator, prior to discharge, that indicates they intend to be covered by the general permit. USEPA evaluates each NOI on a case-by-case basis. The NPDES general permit includes restrictions on the discharge of pollutants. Operators report discharge monitoring data into another USEPA electronic system. Failure to submit or falsification of information is considered a violoation. Up to 50 production platforms and rigs per year have NPDES inspections performed by BSEE on behalf of the USEPA region 6 (region 4 has no installed structures), but those inspections do not include sampling.

USEPA ensures compliance through several enforcement actions: warning letter; administrative orders (smaller violations); penalty orders (large or continuous violations); or will refer to the Department of Justice (e.g., if an operator does not have permit coverage). The USEPA may use documentation, information or pictures from BSEE, BOEM or USCG to support enforcement actions, which are publicly available on their online database at https://echo.epa.gov/.

3.2.2 Clean Air Act Responsibilities

The USEPA is also responsible for administering the CAA in a portion of the Gulf of Mexico. The 1990 CAA amendments granted authority for implementation of the CAA for sources subject to the OCSLA to the USEPA for areas of the OCS in the Gulf of Mexico east of 87.5˚W longitude. Section 328(a)(1) of the CAA requires the USEPA to establish requirements to control air pollution from OCS sources within USEPA's jurisdiction, including that portion of the Gulf of Mexico east of 87.5˚W longitude, in order to attain and maintain federal and state ambient air quality standards and to comply with the provisions of Part C (Prevention of Significant Deterioration) of Title I of the CAA. The OCS Air Regulations at 40 CFR Part 55 implement Section 328 of the CAA and establish the air pollution control requirements for OCS sources within USEPA jurisdiction as well as the procedures for implementation and enforcement of the requirements. Applicants located within 25 nautical miles of a state seaward boundary are required to comply with 40 CFR §55 and the federal, state, and local air quality requirements of the nearest onshore area, including applicable permitting requirements. Applicants with operations planned beyond 25 nautical miles from the state seaward boundary are subject to federal air quality requirements (see 40 CFR §55) and will need an OCS air quality permit complying with the USEPA's Prevention of Significant Deterioration (PSD) preconstruction permit program (see 40 CFR §52.21), and/or Title V operating permit program requirements (see 40 CFR §71), as well as applicable New Source Performance Standards and National Emissions Standards for Hazardous Air Pollutants. Under this programmatic opinion, USEPA intends to issue general permits, similar to those used by the NPDES program, or individual permits to operators working on the OCS east of longitude 87.5°W. The USEPA has a website that posts all of their OCS air permits for the southeast at https://www.epa.gov/caa-permitting/outer-continental-shelf-ocs-permit-activity-southeastern-us.

In a report to Congress, Ramseur (2012) identified a difference between USEPA and BOEM/BSEE programs as the federal emission threshold used to identify substantive requirements. For facilities that emit over 250 tons per year of a criteria pollutant (this would include all oil and gas exploration and production facilities), USEPA requires best available control technology for each piece of equipment that emits a pollutant for which the facility is considered a major source. (The equipment doesn't have to emit over the threshold, rather the cumulative emissions of the source are over the threshold – these are low levels, for example 15 tons per year (tpy) of Particulate Matter (PM), 40 tpy of Nox, VOC, and SO2, etc.) Hence, a control technology review is generally required for all equipment at the source. These major source facilities are also required to perform air quality modeling that allows USEPA to determine that the facility will not cause or contribute to a violation of the NAAQS, and also allows USEPA to determine impacts on sensitive "Class I" areas. If a source remains above the allowable amount, then modeling must be conducted to assess whether its emissions would have a significant effect on onshore air quality. Further, the USEPA's permitting process allows for public involvement (Ramseur 2012).

The USEPA does not use BOEM's exemption threshold approach, which according to USEPA is substantially different. BOEM conducted an air quality study in 1980 and based exemption thresholds on this review. The exemption thresholds are based on distance and typically do not result in modelling for technology review for most equipment.The USEPA reviews air quality sections in NEPA documents from BOEM and makes comments. Regular comments from USEPA include that BOEM's approach does not ensure that sources are not impacting the standards in the state tidelands, which are part of the state. USEPA indicated they know that some facilities are likely contributing to a violation of the NAAQS and have discussed this with BOEM staff.

USEPA Air Permitting Requirements

USEPA's OCS air quality regulations incorporate applicable requirements from the federal PSD and Title V operating permit programs, New Source Performance Standards (NSPS), and National Emission Standards for Hazardous Air Pollutants (NESHAP) as well as the applicable State Implementation Plan and air quality requirements of the nearest adjacent coastal state.

Forty CFR section 328 and Part 55 distinguish between OCS sources located within 25 miles of a state's seaward boundary and those located beyond 25 miles of a state's seaward boundary (*see* CAA § 328(a)(1); 40 CFR §§ 55.3(b) and (c)). Sources located beyond 25 miles of a state's seaward boundary are only subject to federal requirements and not those of the State Implementation Plan for the nearest adjacent coastal state. Below is brief summary of USEPA's Air Quality Regulations, 40 CFR §55, applicable to OCS Sources within USEPA's jurisdiction:

- The PSD program, as set forth in 40 CFR §52.21, is incorporated by reference into the OCS Air Regulations and is applicable to major OCS sources. The PSD program requires an assessment of air quality impacts from the proposed project on the NAAQS and PSD increments (PSD increment is the amount of pollution an area is allowed to increase) and the utilization of BACT. Under the PSD regulations, a stationary source is generally considered "major" if, among other things, it emits or has the potential to emit 250 tons per year or more of a "regulated New Source Review pollutant." Emissions from vessels servicing or associated with an OCS source that are within 25 miles of the OCS source are considered in determining the "potential emissions" for the purpose of applying the PSD regulations (see 40 CFR §52.21(b)(50)).
- Title V: The requirements of the title V operating permit program, as set forth in 40 CFR Parts 70 and 71, apply to major OCS sources. USEPA's OCS permits include conditions necessary to meet the requirements of the Title V operating permit program, as applicable. For example, permits include requirements for submittal of annual compliance certifications and annual fee payments (based on actual emissions), as well as monitoring, recordkeeping, and reporting requirements. OCS permits generally require the use of an approved continuous emission monitoring system, an approved parametric monitoring method, and/or stack testing of emissions units.
- A specific NSPS subpart applies to an OCS source based on equipment source category, equipment capacity, and the date equipment commences construction or modification. Potentially applicable NSPS include requirements for diesel engines, steam generating units (such as boilers or heaters), and petroleum storage tanks (see 40 CFR §55.l3(c)).
- National Emission Standards for Hazardous Air Pollutants: Applicable NESHAP promulgated under section 112 of the CAA apply to OCS sources if rationally related to the attainment and maintenance of federal and state ambient air quality standards or the requirements of part C of Title I of the CAA (see 40 CFR §55.13(e)). NESHAP regulations apply to an OCS source based on its source category listing. On the OCS, within EPA's jurisdiction, these standards control hazardous air pollutants from equipment such as diesel engines.

USEPA's OCS regulations also contain provisions for monitoring, reporting, inspections, compliance, and enforcement; they establish procedures that allow the USEPA Administrator to exempt any OCS source from an emissions control requirement if it is technically infeasible or poses an unreasonable threat to health or safety, and they include provisions that allow USEPA's authority to be delegated to state or local air quality agencies (see 40 CFR §§ 55.7, 55.8, 55.9, and 55.11).

The USEPA air quality requirements are incorporated into air construction and operating permits that are issued to the owner or operator of the OCS source. These permits may be issued for temporary, portable, or permanent OCS sources and for single operations or for multiple projects conducted over the life of the OCS source. Public notice and opportunity for public comment and hearing on USEPA's OCS permits are provided pursuant to the administrative procedures of 40 CFR §124 and 40 CFR §71.

3.3 NMFS Permits and Conservation Division Responsibilities under the MMPA

The MMPA of 1972 established a national policy to prevent marine mammal species and population stocks from declining beyond the point where they ceased to be significant functioning elements of the ecosystems of which they are a part. The MMPA established a moratorium on the taking of marine mammals in U.S. waters. It defines "take" to mean "to hunt, harass, capture, or kill" any marine mammal or attempt to do so (16 USC § 1362 (13)). NMFS Permits and Conservation Division can permit actions as exceptions to the moratorium for take incidental to commercial fishing and other non-fishing activities, for scientific research, and for public display at licensed institutions such as aquaria and science centers. The MMPA was amended in 1994 to define two levels of harassment: Level A for injury and Level B for behavioral disturbance. The Permits and Conservation Division's responsibilities under the MMPA includes rulemaking and issuance of Letters of Authorization for oil and gas related activities.

BOEM requested a rulemaking to authorize incidental take of marine mammals from oil and gas related G&G activities in federal waters of the Gulf of Mexico, except in those waters restricted under the GOMESA[13] moratorium. Once a regulation is issued, individual industry companies will apply to the NMFS Permits and Conservation Division for Letters of Authorization (LOAs) for their proposed activities. Each permit application will include the specific location and G&G survey details so that NMFS can make the determination if an incidental take authorization is warranted. Measures under the MMPA rule would include: (1) Standard detection-based mitigation measures, including use of visual and acoustic observation to detect marine mammals and shut down acoustic sources in certain circumstances; (2) Time-area restrictions designed to avoid effects to certain species of marine mammals in times and/or places believed to be of greatest importance; (3) Vessel strike avoidance measures; and (4) Monitoring and reporting requirements. These measures are described in more detail below.

The rule, as proposed under 50 CFR Part 217 [RIN 0648-BB38], will establish a framework under the authority of the MMPA (16 USC §1361 et seq.) to allow for the authorization of take of marine mammals incidental to the conduct of oil and gas related geophysical survey activities in the Gulf of Mexico. It is important to note that this rule will be valid for, and will authorize oil and gas related G&G activities only over the next five years, while this opinion is analyzing a 50-year time period for all oil and gas activities. Take authorized under the rule would occur by Level A and/or Level B harassment (defined in the key assumptions section 8.1 below) incidental to use of active acoustic sound sources.

[13] On December 20, 2006, President Bush signed into law the Gulf of Mexico Energy Security Act of 2006 (GOMESA), which made available new areas for leasing in the EPA and placed a moratorium on other areas in the Gulf of Mexico through June 30, 2022. This area is detailed below in section 4 (Action Area).

The Permits and Conservation Division's proposed action is to mitigate effects of G&G in the Gulf of Mexico waters not under the GOMESA moratorim through monitoring and conservation measures described below. The ESA-listed species in the Gulf of Mexico that are also protected under the MMPA are the sperm whale and Gulf of Mexico Bryde's whale.

The following subsections summarize other requirements the final rule would place on lessees or operators; the proposed rule is available at https://federalregister.gov/d/2018-12906. Upon release, the final rule will be available through the federal register as well as on NMFS' website (https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-oil-and-gas). There may be need for an amendment to the opinion to make some changes to this section following release of the final rule.

3.3.1 Mitigation Measures

As part of the rulemaking and subsequent issuance of letters of authorization, the NMFS Permits and Conservation Division is enacting the following mitigation measures to minimize adverse effects to marine mammals, including sperm whale and Gulf of Mexico Bryde's whale, from sound related to geophysical surveys.

(1) A copy of any issued LOA must be in the possession of the LOA-holder, vessel operator, other relevant personnel, the lead protected species observer (PSO), and any other relevant designees operating under the authority of the LOA.

(2) The LOA-holder shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team (PSO team), and shall ensure that relevant vessel personnel and PSO team participate in a joint onboard briefing, led by the vessel operator and lead PSO, prior to beginning work to ensure that responsibilities, communication procedures, protected species monitoring protocols, operational procedures, and LOA requirements are clearly understood. This briefing must be repeated when relevant new personnel join the survey operations before work involving those personnel commences.

(3) The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source must be avoided. For surveys using airgun arrays as the acoustic source, notified operational capacity (*i.e.*, total array volume) (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be communicated to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(4) Approved PSOs must be used during all geophysical surveys.

    (1) The LOA-holder must use independent, dedicated, trained PSOs, meaning that the PSOs must be employed by a third-party observer provider, must have no tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation

requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course appropriate for their designated task (visual or acoustic) (except as defined in this subpart at § 217.184(d)(3)(iii)). Acoustic PSOs are required to complete specialized training for operating passive acoustic monitoring (PAM) systems and are encouraged to have familiarity with the vessel with which they will be working. PSOs can act as both acoustic and visual observers (but not simultaneously) as long as they demonstrate that their training and experience are sufficient to perform each task.

(2) The LOA-holder must submit PSO resumes for NMFS review and approval prior to commencement of the survey (except as defined in this subpart at § 217.184(d)(3)(iii)). Resumes should include dates of training and any prior NMFS approval, as well as dates and description of last experience, and shall be accompanied by information documenting successful completion of an approved training course. NMFS is allowed one week to approve PSOs from the time that the necessary information is received by NMFS, after which PSOs meeting the minimum requirements will automatically be considered approved.

(3) At least one visual PSO and two acoustic PSOs (when required) aboard each acoustic source vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, with no more than eighteen months elapsed since the conclusion of the at-sea experience (except as defined in this subpart at § 217.184(d)(3)(iii)). One visual PSO with such experience must be designated as the lead for the entire PSO team. The lead must coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. (Note that the responsibility of coordinating duty schedules and roles may instead be assigned to a shore-based, third-party monitoring coordinator.) To the maximum extent practicable, the lead PSO must devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

3.3.1.1 Deep penetration surveys

(1) Deep penetration surveys are defined as surveys using airgun arrays with total volume greater than 400 in^3.

(2) Visual monitoring:

(i) During survey operations (*i.e.*, any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.*, from 30 minutes prior to sunrise through 30 minutes following sunset).

(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

(iii) Visual PSOs must coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and must conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

(iv) Visual PSOs must immediately communicate all observations of marine mammals to the on-duty acoustic PSO, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(v) Any observations of marine mammals by crew members aboard any vessel associated with the survey must be relayed to the PSO team.

(vi) During good conditions (*e.g.*, daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs must conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

(vii) Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at the same time) must not exceed 12 hours per 24-hour period for any individual PSO.

(3) Acoustic monitoring:

(i) All source vessels must use a towed PAM system at all times when operating in waters deeper than 100 m, which must be monitored by a minimum of one acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source. “PAM system” refers to calibrated hydrophone arrays with full system redundancy to detect, identify, and estimate distance and bearing to vocalizing cetaceans. The PAM system must have at least one calibrated hydrophone (per each deployed hydrophone type and/or set) sufficient for determining whether background noise levels on the towed PAM system are sufficiently low to meet performance expectations, and must incorporate appropriate hydrophone elements (1 Hz to 180 kHz range) and sound data acquisition card technology for sampling relevant frequencies (i.e., to 360 kHz).

(ii) Acoustic PSOs must immediately communicate all detections of marine mammals to visual PSOs (when visual PSOs are on duty), including any determination by the PSO regarding species identification, distance, and bearing, and the degree of confidence in the determination.

(iii) Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches, and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at the same time) must not exceed 12 hours per 24-hour period for any individual PSO.

(iv) Survey activity may continue for 30 minutes when the PAM system malfunctions or is damaged, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring during daylight hours only under the following conditions:

(A) Sea state is less than or equal to BSS 4;

(B) No marine mammals (excluding delphinids) detected solely by PAM in the applicable exclusion zone in the previous two hours;

(C) NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and

(D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

(4) Exclusion Zone and Buffer Zone – PSOs shall establish and monitor applicable exclusion and buffer zones. These zones shall be based upon the radial distance from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source (i.e., anytime the acoustic source is active, including ramp-up), occurrence of marine mammals within the relevant buffer zone (but outside the exclusion zone) should be communicated to the operator to prepare for the potential shutdown of the acoustic source (when required).

(i) Two exclusion zones are defined, depending on the species and context. A standard exclusion zone encompassing the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0-500 m) is defined. For special circumstances (defined at § 217.184(b)(9)(v)), the exclusion zone encompasses an extended distance of 1,500 meters (0-1,500 m).

(ii) During pre-clearance monitoring (i.e., before ramp-up begins), the buffer zone acts as an extension of the exclusion zone in that observations of marine mammals within the buffer zone would also preclude airgun operations from beginning (i.e., ramp-up). For all marine mammals (except where superseded by the extended 1,500-m exclusion zone), the buffer zone encompasses the area at and below the sea surface from the edge of the 0-500 meter exclusion zone out to a radius of 1,000 meters from the edges of the airgun array (500-1,000 m). The buffer zone is not applicable when the exclusion zone is greater than 500 meters, i.e., the observational focal zone is not increased beyond 1,500 meters.

(5) Pre-Clearance and Ramp-up – A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total active array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. A 30-minute pre-clearance observation period must occur prior to

the start of ramp-up. The LOA-holder must adhere to the following pre-clearance and ramp-up requirements:

(i) The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up.

(ii) Ramp-ups must be scheduled so as to minimize the time spent with source activated prior to reaching the designated run-in.

(iii) A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.

(iv) Ramp-up must not be initiated if any marine mammal is within the applicable exclusion zone or the buffer zone. If a marine mammal is observed within the exclusion zone or the buffer zone during the 30-minute pre-clearance period, ramp-up must not begin until the animal(s) has been observed exiting the zones or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and 30 minutes for all other species).

(v) Ramp-up must begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration must not be less than 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed.

(vi) Ramp-up must cease and the source shut down upon observation of marine mammals within the applicable exclusion zone. Once ramp-up has begun, observations of marine mammals within the buffer zone do not require shutdown.

(vii) Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections (excluding delphinids) in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances.

(viii) If the acoustic source is shut down for brief periods (i.e., less than 30 minutes) for reasons other than implementation of prescribed mitigation (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual or acoustic detections of any marine mammal have occurred within the applicable exclusion zone. For any longer shutdown, pre-clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.*, BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation maintained, pre-clearance watch is not required.

(ix) Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require the pre-clearance observation period.

(6) Shutdown requirements:

(i) Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source pursuant to the requirements of this subpart.

(ii) The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch.

(iii) When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs.

(iv) When the airgun array is active (*i.e.*, anytime one or more airguns is active, including during ramp-up) and (1) a marine mammal appears within or enters the applicable exclusion zone and/or (2) a marine mammal (excluding delphinids) is detected acoustically and localized within the applicable exclusion zone, the acoustic source must be shut down. When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation.

(v) The expanded 1,500-m exclusion zone must be applied upon detection (visual or acoustic) of a baleen whale, sperm whale, beaked whale, or *Kogia* spp. within the zone.

(vi) Shutdown requirements are waived for dolphins of the following genera: *Tursiops*, *Stenella*, *Steno*, and *Lagenodelphis*.

(A) If a delphinid is detected within the exclusion zone, no shutdown is required unless the PSO confirms the individual to be of a genus other than those listed above, in which case a shutdown is required. Acoustic detection of delphinids does not require shutdown.

(vii) If there is uncertainty regarding identification or localization, PSOs may use best professional judgment in making the decision to call for a shutdown.

(viii) Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable exclusion zone or following a 30-minute clearance period with no further detection of the marine mammal(s).

3.3.1.2 Shallow penetration surveys

(1) Shallow penetration surveys are defined as surveys using airgun arrays with total volume equal to or less than 400 in^3, single airguns, boomers, or equivalent sources.

(2) LOA-holders shall follow the requirements defined for deep penetration surveys at § 217.184(b), with the following exceptions:

(i) Acoustic monitoring is not required for shallow penetration surveys.

(ii) Ramp-up for small airgun arrays must follow the procedure described above for large airgun arrays, but may occur over an abbreviated period of time. Ramp-up is not required for surveys using only a single airgun. For sub-bottom profilers, power should be increased as feasible to effect a ramp-up.

(iii) Two exclusion zones are defined, depending on the species and context. A standard exclusion zone encompassing the area at and below the sea surface out to a radius of 100 meters from the edges of the airgun array (if used) or from the acoustic source (0-100 m) is defined. For special circumstances (§ 217.184(b)(6)(v)), the exclusion zone encompasses an extended distance of 500 meters (0-500 m).

(iv) The buffer zone encompasses the area at and below the sea surface from the edge of the 0-100 meter exclusion zone out to a radius of 200 meters from the edges of the airgun array (if used) or from the acoustic source (100-200 meters). The buffer zone is not applicable when the exclusion zone is greater than 100 meters.

3.3.1.3 High-resolution geophysical (HRG) surveys

(1) HRG surveys are defined as surveys using an electromechanical source that operates at frequencies less than 180 kHz, other than those defined at § 217.184(c)(1) (*i.e.*, side-scan sonar, multibeam echosounder, or CHIRP subbottom profiler).

(2) LOA-holders conducting HRG surveys shall follow the requirements defined for shallow penetration surveys at § 217.184(c), with the following exceptions:

(i) No shutdowns are required for HRG surveys. Pre-clearance watch is required as defined at § 217.184(c), i.e., for a period of 30 minutes and over a 200-m radius from the acoustic source.

(ii) During survey operations (e.g., any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of one trained and experienced independent PSO must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset) when operating in waters deeper than 100 m.

(iii) When operating in waters shallower than 100 m, LOA-holders shall employ one trained visual PSO, who may be a crew member, only for purposes of conducting pre-clearance monitoring.

3.3.1.4 Restriction areas

(1) From January 1 through May 31, no use of airguns may occur shoreward of the 20-m isobath and between 90-84º W (buffered by 10 km).

(2) No use of airguns may occur within the area bounded by the 100- and 400-m isobaths, from 87.5° W to 27.5° N (buffered by 10 km).

(3) No use of airguns may occur within the area bounded by the 200- and 2,000-m isobaths from the northern border of BOEM's Howell Hook leasing area to 81.5°W (buffered by 10 km).

3.3.1.5 To avoid the risk of entanglement

LOA-holders conducting surveys using ocean-bottom nodes or similar gear must:

(1) Use negatively buoyant coated wire-core tether cable;
(2) Retrieve all lines immediately following completion of the survey; and
(3) Attach acoustic pingers directly to the coated tether cable; acoustic releases should not be used.

3.3.1.6 Vessel Strike Avoidance

LOA-holders must adhere to the following requirements:

(1) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel, which shall be defined according to the parameters stated in this subsection. Visual observers monitoring the vessel strike avoidance zone may be third-party observers (*i.e.*, PSOs) or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a baleen whale, sperm whale, or other marine mammal;
(2) All vessels, regardless of size, must observe a 10 kn speed restriction within the restriction area described previously at § 217.184(e)(2);
(3) Vessel speeds must also be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel;
(4) All vessels must maintain a minimum separation distance of 500 m from baleen whales;
(5) All vessels must maintain a minimum separation distance of 100 m from sperm whales;
(6) All vessels must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel; and
(7) When marine mammals are sighted while a vessel is underway, the vessel shall take action as necessary to avoid violating the relevant separation distance, *e.g.*, attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area. If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel towing gear or any vessel that is navigationally constrained.
(8) These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply.

3.3.2 Monitoring and Reporting

3.3.2.1 Protected Species Observer Qualifications

(1) PSOs must successfully complete relevant, approved training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

(2) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Requests will be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to:

  (i) secondary education and/or experience comparable to PSO duties;
  (ii) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or
  (iii) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

3.3.2.2 Equipment

LOA-holders are required to:

  (i) Provide PSOs with bigeye binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel.
  (ii) For each vessel required to use a PAM system, provide a PAM system that has been verified and tested by an experienced acoustic PSO that will be using it during the trip for which monitoring is required;
  (iii) Work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals. (Equipment specified in A. through G. below may be provided by an individual PSO, the third-party observer provider, or the LOA-holder, but the LOA-holder is responsible for ensuring PSOs have the proper equipment required to perform the duties specified herein.) Such equipment, at a minimum, must include:

(A) Reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one per PSO, plus backups);
(B) Global Positioning Unit (GPS) (plus backup);

(C) Digital camera with a telephoto lens (the camera or lens should also have an image stabilization system) that is at least 300 mm or equivalent on a full-frame single lens reflex (SLR) (plus backup);
(D) Compass (plus backup);
(E) Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups); and
(F) Any other tools necessary to adequately perform necessary PSO tasks.

3.3.2.3 Data collection

PSOs must use standardized data forms, whether hard copy or electronic. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of marine mammals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up or activation of the acoustic source. If required mitigation was not implemented, PSOs must record a description of the circumstances. At a minimum, the following information should be recorded:

(1) Vessel names (source vessel and other vessels associated with survey), vessel size and type, maximum speed capability of vessel, port of origin, and call signs;
(2) PSO names and affiliations;
(3) Dates of departures and returns to port with port name;
(4) Date and participants of PSO briefings;
(5) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;
(6) Vessel location (latitude/longitude) when survey effort begins and ends and vessel location at beginning and end of visual PSO duty shifts;
(7) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;
(8) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including Beaufort sea state and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
(9) Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions change (e.g., vessel traffic, equipment malfunctions);
(10) Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in an array, tow depth of an acoustic source, and any other notes of significance (i.e., pre-clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.); and
(11) Upon visual observation of a marine mammal, the following information:

(i) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
(ii) PSO who sighted the animal;
(iii) Time of sighting;
(iv) Vessel coordinates at time of sighting;
(v) Water depth;
(vi) Direction of vessel's travel (compass direction);
(vii) Direction of animal's travel relative to the vessel;
(viii) Pace of the animal;
(ix) Estimated distance to the animal and its heading relative to vessel at initial sighting;
(x) Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;
(xi) Estimated number of animals (high/low/best);
(xii) Estimated number of animals by cohort (adults, juveniles, group composition, etc.);
(xiii) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
(xiv) Detailed behavior observations (e.g., number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior), including an assessment of behavioral responses to survey activity;
(xv) Animal's closest point of approach (CPA) and/or closest distance from any element of the acoustic source;
(xvi) Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and
(xvii) Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up) and time and location of the action.

(12) Upon acoustic detection of a marine mammal using a PAM system, the following information:
(i) An acoustic encounter identification number, and whether the detection was linked with a visual sighting;
(ii) Date and time when first and last heard;
(iii) Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal); and
(iv) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

3.3.2.4 Letters of Authorization

- To incidentally take marine mammals pursuant to these regulations, prospective LOA-holders must apply for and obtain a LOA.
- A LOA, unless suspended or revoked, may be effective for a period not to exceed the expiration date of these regulations.
- In the event of projected changes to the activity or to mitigation and monitoring measures required by a LOA, the LOA-holder must apply for and obtain a modification of the LOA as described in § 217.187.
- The LOA shall set forth:
  (1) Permissible methods of incidental taking;
  (2) Means of effecting the least practicable adverse impact (i.e., mitigation) on the species or stock and its habitat; and
  (3) Requirements for monitoring and reporting.

Issuance of the LOA shall be based on a determination that the level of taking will be consistent with the findings made for the total taking allowable under these regulations and a determination that the amount of take authorized under the LOA is of no more than small numbers.

For LOA issuance, where either (1) the conclusions put forth in an application (e.g., take estimates) are based on analytical methods that differ substantively from those used in the development of the rule, or (2) the proposed activity or anticipated impacts vary substantively in scope or nature from those analyzed in the preamble to the rule, NMFS may publish a notice of proposed LOA in the Federal Register, including the associated analysis of the differences, and solicit public comment before making a decision regarding issuance of the LOA.

Notice of issuance or denial of a LOA shall be published in the Federal Register within thirty days of a determination.

3.3.2.5 Modifications of Letters of Authorization

A LOA issued under § 216.106 of this chapter and § 217.186 for the activity identified in § 217.180 shall be modified upon request by the applicant, provided that:

(1) The proposed specified activity and mitigation, monitoring, and reporting measures, as well as the anticipated impacts, are the same as those described and analyzed for these regulations (excluding changes made pursuant to the adaptive management provision in paragraph (c)(1) of this section); and
(2) NMFS determines that the mitigation, monitoring, and reporting measures required by the previous LOA under these regulations were implemented.

For LOA modification requests by the applicant that include changes to the activity or the mitigation, monitoring, or reporting (excluding changes made pursuant to the adaptive management provision in paragraph (c)(1) of this section) that result in more than a minor change in the total estimated number of takes (or distribution by species or years), NMFS may publish a notice of proposed LOA in the Federal Register, including the associated analysis of the change, and solicit public comment before issuing the LOA.

A LOA issued under § 216.106 of this chapter and § 217.186 for the activity identified in § 217.180 may be modified by NMFS under the following circumstances:

(1) Adaptive Management – NMFS may modify (including augment) the existing mitigation, monitoring, or reporting measures (after consulting with the LOA-holder regarding the practicability of the modifications) if doing so is practicable and creates a reasonable likelihood of more effectively accomplishing the goals of the mitigation and monitoring set forth in the preamble for these regulations;
   (i) Possible sources of data that could contribute to the decision to modify the mitigation, monitoring, or reporting measures in a LOA:
      (A) Results from monitoring from previous years;
      (B) Results from other marine mammal and/or sound research or studies; and
      (C) Any information that reveals marine mammals may have been taken in a manner, extent or number not authorized by these regulations or subsequent LOAs.
   (ii) If, through adaptive management, the modifications to the mitigation, monitoring, or reporting measures are substantial, NMFS will publish a notice of proposed LOA in the Federal Register and solicit public comment.

(2) Emergencies – If NMFS determines that an emergency exists that poses a significant risk to the well-being of the species or stocks of marine mammals specified in a LOA issued pursuant to § 216.106 of this chapter and § 217.186, a LOA may be modified without prior notice or opportunity for public comment. Notice would be published in the Federal Register within thirty days of the action.

3.3.3 Adaptive Management

The regulations governing the take of marine mammals incidental to geophysical survey activities would contain an adaptive management component. The comprehensive reporting requirements associated with the rule are designed to provide NMFS Permits and Conservation Division with monitoring data from the previous year to allow consideration of whether any changes are appropriate. The use of adaptive management allows NMFS Permits and Conservation Division to consider new information from different sources to determine (with input from the LOA-holders regarding practicability) on an annual or biennial basis if mitigation or monitoring measures should be modified (including additions or deletions). Mitigation measures could be modified if new data suggests that such modifications would have a reasonable likelihood of reducing adverse effects to marine mammal species or stocks or their habitat and if the measures are practicable. The adaptive management process and associated reporting requirements would serve as the basis for evaluating performance and compliance.

The following are some of the possible sources of applicable data to be considered through the adaptive management process: (1) results from monitoring reports, as required by MMPA authorizations; (2) results from general marine mammal and sound research; and (3) any information which reveals that marine mammals may have been taken in a manner, extent, or number not authorized by these regulations or subsequent LOAs or that the specified activity may be having more than a negligible impact on affected stocks.

3.3.3.1 Reporting

Annual reporting:

(i) LOA-holders must submit a summary report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the LOA, whichever comes sooner, and must include all information described above under § 217.185(c). If an issued LOA is valid for greater than one year, the summary report must be submitted on an annual basis.

(ii) The report must describe activities conducted and sightings of marine mammals, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). In addition to the report, all raw observational data must be made available to NMFS.

(iii) For operations requiring the use of PAM, the report must include a validation document concerning the use of PAM, which should include necessary noise validation diagrams and demonstrate whether background noise levels on the PAM deployment limited achievement of the planned detection goals.

(iv) The LOA-holder must provide geo-referenced time-stamped vessel tracklines for all time periods in which airguns (full array or single) were operating. Tracklines shall include points recording any change in airgun status (e.g., when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa). GIS files shall be provided in ESRI shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system.

(v) The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring.

(vi) A final report must be submitted within 30 days following resolution of any comments on the draft report.

Comprehensive reporting:

LOA-holders must contribute to the compilation and analysis of data for inclusion in an annual synthesis report addressing all data collected and reported through annual reporting in each calendar year. The synthesis period shall include all annual reports deemed to be final by NMFS from July 1 of one year through June 30 of the subsequent year. The report must be submitted to NMFS by October 1 of each year.

Reporting of injured or dead marine mammals:

(1) In the event that personnel involved in the survey activities discover an injured or dead marine mammal, the LOA-holder must report the incident to the Office of Protected Resources (OPR), NMFS and to the Southeast Regional Stranding Network as soon as feasible. The report must include the following information:
   - (i) Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);
   - (ii) Species identification (if known) or description of the animal(s) involved;
   - (iii) Condition of the animal(s) (including carcass condition if the animal is dead);
   - (iv) Observed behaviors of the animal(s), if alive;
   - (v) If available, photographs or video footage of the animal(s); and
   - (vi) General circumstances under which the animal was discovered.

(2) In the event of a ship strike of a marine mammal by any vessel involved in the survey activities, the LOA-holder must report the incident to OPR, NMFS and to the Southeast Regional Stranding Network as soon as feasible. The report must include the following information:
   - (i) Time, date, and location (latitude/longitude) of the incident;
   - (ii) Species identification (if known) or description of the animal(s) involved;
   - (iii) Vessel's speed during and leading up to the incident;
   - (iv) Vessel's course/heading and what operations were being conducted (if applicable);
   - (v) Status of all sound sources in use;
   - (vi) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;
   - (vii) Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;
   - (viii) Estimated size and length of animal that was struck;
   - (ix) Description of the behavior of the marine mammal immediately preceding and following the strike;
   - (x) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;
   - (xi) Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and
   - (xii) To the extent practicable, photographs or video footage of the animal(s).

(3) In the event of a live stranding (or near-shore atypical milling) event within 50 km of the survey operations, where the NMFS stranding network is engaged in herding or other interventions to return animals to the water, the Director of OPR, NMFS (or designee) will advise the LOA-holder of the need to implement shutdown procedures for all active acoustic sources operating within 50 km of the stranding. Shutdown procedures for live stranding or milling marine mammals include the following:

    (i) If at any time, the marine mammal(s) die or are euthanized, or if herding/intervention efforts are stopped, the Director of OPR, NMFS (or designee) will advise the LOA-holder that the shutdown around the animals' location is no longer needed.
    (ii) Otherwise, shutdown procedures will remain in effect until the Director of OPR, NMFS (or designee) determines and advises the LOA-holder that all live animals involved have left the area (either of their own volition or following an intervention).
    (iii) If further observations of the marine mammals indicate the potential for re-stranding, additional coordination with the LOA-holder will be required to determine what measures are necessary to minimize that likelihood (e.g., extending the shutdown or moving operations farther away) and to implement those measures as appropriate.

(4) If NMFS determines that the circumstances of any marine mammal stranding found in the vicinity of the activity suggest investigation of the association with survey activities is warranted, and an investigation into the stranding is being pursued, NMFS will submit a written request to the LOA-holder indicating that the following initial available information must be provided as soon as possible, but no later than 7 business days after the request for information. In the event that the investigation is still inconclusive, the investigation of the association of the survey activities is still warranted, and the investigation is still being pursued, NMFS may provide additional information requests, in writing, regarding the nature and location of survey operations prior to the time period above.

    (i) Status of all sound source use in the 48 hours preceding the estimated time of stranding and within 50 km of the discovery/notification of the stranding by NMFS; and
    (ii) If available, description of the behavior of any marine mammal(s) observed preceding (i.e., within 48 hours and 50 km) and immediately after the discovery of the stranding.

3.4 Step-down Review

Step down review involves the action agency and/or NMFS conducting a project-specific review of an activity that is authorized under the programmatic action under review in this biological opinion. The need for and type of project specific review will vary depending on the level of uncertainty at the programmatic consultation stage regarding aspects or potential effects of specific projects, approvals, or other actions that will be implemented in the future. The greater the uncertainty at the programmatic consultation stage, the greater the need for step down procedures, which may reveal that a stand-alone consultation is necessary for some actions. There were several assumptions made to complete this programmatic consultation that are discussed in Section 8.1. Many of the activities that will be implemented under this programmatic action have a long regulatory history and a great deal of uniformity in how they are implemented. Thus, there is little uncertainty about the methods that will be implemented for many of the activities covered under this programmatic consultation. In addition, the nature of the anticipated effects of many of these activities often does not vary significantly from location to location. However, for other Oil and Gas Program activities there is a higher degree of uncertainty regarding the methods applied and the anticipated effects on ESA-listed resources.

We have determined that some categories of activities under the proposed action will have “no effect” on ESA-listed species and designated critical habitat or would be “not likely to adversely affect” ESA-listed species and designated critical habitat, while some categories of activities would be “likely to adversely affect” ESA-listed species and designated critical habitat. Many of the “likely to adversely affect” categories of activities would include those that are so routine and predictable that we are able to project their effects fully at the programmatic level in this opinion. Thus, while they may be likely to adversely affect ESA-listed species or designated critical habitat, we have projected the associated effects over the 50 year Oil and Gas Program duration in this consultation. Those activities that are likely to adversely affect but that we are not able to project the degree of impact, and those that could have the potential to affect in the future (i.e., need action agency consistency determination), require step down review. In some instances, such step down review may determine a need for an individual consultation, e.g., one that would refer back to the programmatic or a separate, independent consultation.

This opinion requires that BOEM, BSEE, USEPA and NMFS Permits and Conservation Division make project-specific findings for every action they review, permit or otherwise authorize, except for those activities described below in Part A that are so routine that their effects are determined to have been covered programmatically. Other actions and activities, as described below in Part B, require a step-down review to determine consistency with this opinion, including its effects analyses, and determine the potential need for additional step-down procedures. If the action agency is unsure about an activity or associated effects, then they should confer with NMFS.

Where a step-down review is required, that process begins with a consistency determination by the action agency in conferral with NMFS. In a consistency determination, an action agency would determine: 1) whether the effects of an action or activity is anticipated to be consistent with the effects that have been analyzed in this opinion; 2) whether there are any potential different effects to ESA-listed species; and 3) whether or not the activity would require further consultation. In response, NMFS would either: 1) agree with the consistency determination; 2) add mitigation to ensure the activity's effects would be consistent with those addressed in this opinion, or 3) determine a new consultation would be required.

NMFS' step-down review will assess and confirm whether the anticipated effects of these actions are consistent with and addressed by the programmatic effects analysis conducted in this opinion. Where additional step-down review is needed, NMFS may recommend additional avoidance or mitigation measures that bring the effects of the subsequent action within the analysis of the programmatic biological opinion. In other instances, NMFS may determine that the step-down action requires its own separate ESA consultation. Such consultation may be formal or informal as appropriate, and will refer back to the programmatic biological opinion as appropriate (for example, some components of the step-down action should already be addressed by the programmatic opinion, and the step-down consultation may rely to the degree appropriate on other components of the programmatic opinion such as its discussion of the status of the species, cumulative effects, etc. Where the step-down consultation determines that the step-down action will reasonably likely cause incidental take not addressed already in the programmatic biological opinion's incidental take statement, it will require its own incidental take statement. BOEM has indicated that if an application for a permit or plan is outside the scope of the programmatic consultation, the plan or permit would likely be denied, or not approved until consultation is completed with NMFS. Aspects of this step-down review process may be discussed and possibly revised during annual activity reviews, as necessary (e.g., phasing out of certain type reviews).

A. Criteria for Actions and Activities Covered by this Programmatic Opinion

Many of the activities that BOEM/BSEE approve for development and production are routine activities that have no effects or well understood effects that do not differ greatly depending on the timing or location of the activity. These would have routine mitigation required under the BOEM/BSEE authorization. Such activities would be covered under this programmatic biological opinion. Based on NMFS Southeast Regional Office's review of 1,100 BOEM/BSEE permit applications beginning in 2012, we believe that BOEM/BSEE's reviews of plans, include biological reviews and protected species biologist reviews of most EP and DOCD applications are generally sufficient to ensure ESA compliance under this programmatic opinion and would require only annual activity reporting.

Actions and activities carried out as described in the programmatic biological opinion's Description of the Action will not require a step-down review, unless included below in the criteria for actions and activities potentially requiring step-down review in Part B below. These actions and activities not requiring step-down review will include, but are not limited to, the following actions and activities:

- Pipeline segment design, installation and maintenance not making landfall and that are reviewed by BSEE. This does not include in-place decommissioning of subsea equipment associated with pipelines.
- Decommissioning activities that are submitted to BSEE via various forms listed in NTL 2010-G05 or NTL 2018-G03; and that go through BOEM/BSEE biological review to determine appropriate mitigations or whether there is need for NMFS review.
- Vessel and helicopter operations that are associated with activities described in Section 3.1.4 and that abide by the requirements of this opinion.
- Development, construction and installation of structures that have no associated stressors as presented in the *Effects Analyses* Section 8 of this opinion and are not expected to result in effects to ESA-listed species or their designated critical habitats.

B. Criteria for Actions and Activities that Require Step-Down Review with NMFS

Types of actions that would require step-down review under this opinion are identified below.

- *Actions or activities within the scope of this opinion but whose effects may not yet be addressed or analyzed and that may differ from what is described in Section 3 "Description of the Proposed Action."*
    - A step down, project-specific review will be required with NMFS prior to approval of the activity. Inconsistencies requiring step down process include but are not limited to:
        - The action may not be implemented as described in this opinion.
        - The PDCs (i.e., NTLs, protected species stipulations, and/or other guidance documents [as appendices] in this opinion or new or updated regulations) for a category of actions described in this opinion are proposed to be altered or eliminated.
- *BOEM G&G Activities*
    - Step-down review will be required for G&G permit applications. We expect to phase out these reviews to eventually be only part of the annual review process.
- *New and unusual technologies*
    - Any activity that may use emergent technologies requires step-down review. BOEM/BSEE should fully describe the new or unusual technology, consider all potential impacts to protected species, and provide clear effect determinations. New technologies may be part of the program at any stage including but not limited to oil spill response, G&G, development and production, pipelines, or other stages/activities described in Section 3 *Description of the Action*.

- *BOEM/BSEE Development and Production Activities*
  - The cases that would require step-down review with NMFS for EPs, DWOPs and DOCDs are:
    - Use of NUTs- It is recommended that the action agency seeks out consultation as early in the process as possible.
    - Use of equipment that has potential for entanglement or entrapment risk including but not limited to moon pools, flexible lines/ropes in the water, or other gear without turtle guards.
    - Those activities requiring use of large airgun arrays (greater than 400 in^3).
  - Pipelines
    - Step-down review will be required for any new pipelines expected to make landfall.
    - Decommissioning-in-place of subsea equipment other than pipelines (i.e., manifolds, valves, pumps or other various equipment as described in 83 FR 67343).

- *Proposals or revisions to new guidance documents (e.g., NTL revisions)*
  - Regarding impacts to protected resources, if such revisions could change the effects of activities on ESA-listed species or critical habitats (i.e., step-down consultation would be required for changes to minimization measures for avoiding effects to listed species; but would likely not be required for non-substantive alterations to language or removal of sunset dates).

3.4.1 Project-Specific Review Procedures: BOEM and BSEE

The action agencies are responsible for assessing each action and activity associated with this opinion and making the agencies' own finding as described earlier as to whether that action or activity falls under one of the following three categories (1) the action or activity will have no effect on listed species or critical habitat; (2) the action or activity may affect listed species or critical habitat, but it is an action or activity whose effects have been covered programmatically by this programmatic biological opinion; or (3) it is an action or activity whose effects may not be addressed in this programmatic biological opinion, and requires an additional step-down review in conferral with NMFS. The determination whether an action or activity falls under (2) or (3) is to be made according to the criteria provided above. The action agency is encouraged to contact NMFS for technical assistance if it is uncertain whether an action or activity falls under (2) or (3).

If the action agency makes a determination of (3) that additional step-down review in conferral with NMFS is required, then the action agency will inform NMFS in writing of this determination and its basis prior to taking the action or performing the activity. NMFS will respond within the time period referenced in each section below. The following additional step-down procedures will also be followed for specific types of actions and activities.

3.4.1.1 Procedures for G&G Permit Applications

Step-down reviews for G&G permit applications will be conducted to assess G&G activities at a project-specific level and validate the projections used for the analyses in the opinion. To Request for Step-down Review:

1. Upon completion of the BOEM plan or permit review for consistency with this opinion, BOEM/BSEE will notify NMFS by sending an email of the completed review to NMFS at nmfs.ser.gom.leases@noaa.gov with the subject header, “BOEM G&G Project-Specific Review Request.”
2. The appropriate plan or permit application must be attached to the email with any supporting LOA, EA, EIS, and other supporting documentation, as relevant. At a minimum, BOEM must provide the following information to NMFS ESA section 7 consulting biologist regarding G&G permits:
    a. Duration of the Activity (number of survey days).
    b. Survey location and configuration (including line kilometers).
    c. Number of vessels involved.
    d. Energy source details – source type; number, size, and layout of arrays (number of airguns, configuration, and total volume); shot intervals; emitted frequencies and associated pressures of seismic sources; vessel speed; duration of a single shot; and source level (both peak to peak and RMS reported in dB re 1 μPa @1 meter).
    e. Type and scale of receiving arrays (streamers, OBN, tethered OBN, etc.).
    f. Type of bathymetry, mapping or sampling equipment.
    g. Separation distance from other surveys.

3. The body of the email must detail: (a) the activities in the permit or plan (b) location (block number) of those activities (c) a finding on whether the action will be implemented as described in the opinion (d) a statement whether the PDCs applicable to that type of action will be implemented, or are proposed to be altered or eliminated (e) findings as to whether the anticipated effects from the proposed project are consistent with those described in the programmatic biological opinion, and (f) a request for NMFS’s review and agreement with BOEM/BSEE’s determination.
4. NMFS Review and Response: NMFS will acknowledge receipt of the email submission through an auto reply email, and will review the submitted materials and BOEM’s or BSEE’s findings. NMFS’ response will provide any additional recommendations that may be appropriate to include in the specific plan or permit to avoid or minimize adverse effects to listed species or critical habitat, and provide confirmation or non-confirmation of BOEM/BSEE’s determination. NMFS will respond to BOEM/BSEE within 15 days. If BOEM/BSEE does not receive a response within 15 day time period, then NMFS and BOEM/BSEE will discuss and agree on appropriate future procedures. If NMFS

disagrees with the action agency's determination, and it is determined that the impacts are similar enough in scope to those analyzed in this opinion, then the action agency will need to request a step-down informal or formal consultation with NMFS on that activity. Otherwise, if the activity or action is found to be completely beyond the scope of this opinion, a separate consultation must be requested.

3.4.1.2 Procedures for New and Unusual Technologies

Some new Oil and Gas Program technologies differ from established technologies in how they function or interface with the environment. These include equipment or procedures that have not been previously installed or used in Gulf of Mexico OCS waters. Having no operational history, they have not been assessed by BOEM through technical and environmental reviews. New technologies may be outside the framework established by BOEM regulations and, thus, their performance (safety, environmental protection, efficiency, etc.) has not been addressed by BOEM. At the project-specific review stage, BOEM/BSEE will identify any NUTs and conduct an internal review according to their agency procedures (see Section 3.1.4). Once an application or plan is received via the online application system or by email to the appropriate BOEM or BSEE office:

1. BOEM/BSEE NUT Review: BOEM/BSEE will complete a review on any NUTs by lessees or operators to ensure the action is consistent with the elements of this programmatic opinion. BOEM/BSEE will make an initial determination as to whether: (1) the action can be implemented in accordance with PDCs, effects avoidance/minimization measures of this programmatic opinion; and (2) it is consistent with the effects addressed and analyzed in this programmatic opinion (i.e., does not have the potential for types of effects or levels of effects not considered in this consultation.)
2. Request for step-down review: Upon completion of the NUT review, if BOEM/BSEE determines step-down review is needed, the agency will notify NMFS of its determinations and email the completed review to NMFS at nmfs.ser.gom.leases@noaa.gov with the subject header, "BOEM Project-Specific Review Request."
3. Content: BOEM review and any supporting documentation must be attached to the email including the information provided by the applicant, an EA, and other supporting documentation. The action agency should fully describe the NUT, consider all potential impacts to species, and provide clear effect determinations. The review should include identification of any listed species and designated critical habitat that may be affected, and the analysis supporting the determinations for the two elements listed in Number 1 above.
4. NMFS Review and Response: If NMFS agrees with BOEM's determinations, it will provide input to notify BOEM via an email response within 30 days of receipt of the project-specific consultation request. If BOEM/BSEE does not receive a response within 30 day time period, then NMFS and BOEM/BSEE will discuss and agree on appropriate

future procedures. If instead NMFS' review reveals questions or concerns, an in-person meeting or conference call will be scheduled with BOEM/BSEE to resolve any protected species or critical habitat issues. If BOEM/BSEE determines that the NUT may affect any listed (or proposed) species or designated critical habitat that were not considered in this opinion or in a way that was not considered in this opinion, BOEM/BSEE shall conduct a project-level consultation with NMFS regarding approval of the permit or plan that includes the NUT. NMFS will work with BOEM to provide technical assistance regarding steps that can be taken to minimize impacts.

3.4.1.3 Procedures for New NTLs, Revised NTLs or Other Guidance

Whenever a NTL or other guidance will be updated or created (see Section 3.1.6), BOEM/BSEE will request, at least 60 days in advance, a step-down review with NMFS to determine if any changes to the NTL/guidance are warranted so that the effects of reissuance are consistent with the effects analyzed in the programmatic opinion.

1. Requests for Step-down Review: Upon review of or prior to expiration of a guidance document (e.g., NTL) listed in the proposed minimization measures, or proposal for a new guidance document to address protected resources impacts, BOEM/BSEE will notify NMFS of the NTL review or proposed new document and email it to NMFS at nmfs.ser.gom.leases@noaa.gov the subject header, "BOEM Proposed/Revised Guidance Review Request."
2. Content: The requests will include any proposed changes or provisions, including any changes identified as necessary during the previous annual review with NMFS. The changes will be reviewed to ensure: (1) the changes will allow future activities to continue to be implemented in accordance with PDCs/effects minimization measures, and reasonable and prudent measures and terms and conditions of this programmatic opinion; and (2) the changes or newly proposed document will not result in any actions implemented under this opinion, individually or additively, exceeding the types and levels of effects anticipated in this programmatic opinion.
3. NMFS Review and Response: NMFS will provide its comments on proposed changes, including no changes, via an email response within 60 days of receipt of the NTL review request. If NMFS' review identifies questions or concerns, an in-person meeting or conference call will be scheduled with BOEM/BSEE to resolve any protected species or critical habitat issues in the document. If BOEM/BSEE does not receive a response within the 60 day time period, then NMFS and BOEM/BSEE will discuss and agree on appropriate future procedures.

3.4.1.4 Other Actions Identified as Requiring Step-down Reviews

Other proposed activities that require a BOEM/BSEE consistency determination and may result in additional step-down review are: (1) the use of any equipment with an entanglement or entrapment risk, (2) ancillary G&G activities (that are not otherwise permitted by BOEM or

BSEE) that may affect ESA-listed species, and (3) pile driving activity associated with a project. For such proposed activities, BOEM or BSEE will notify NMFS of its project-specific determination of consistency with the opinion and email BOEM's completed review including images, sound exposure modeling (in the case of pile driving or ancillary G&G activities), and other relevant information used to make the determination to NMFS at nmfs.ser.gom.leases@noaa.gov with the subject header, "BOEM Minimization Measure Review Request." NMFS will work with BOEM to provide technical assistance regarding steps that can be taken to minimize impacts.

NEPA document review

BOEM/BSEE will provide larger programmatic documents prepared under the NEPA for NMFS review of consistency with what is analyzed in the opinion. The purpose of these reviews will be to verify conclusions regarding the potential effects to ESA-listed species and critical habitat, review data on the impacts of the action, and ensure any changes recommended from the annual reviews are implemented. These reviews are conducted programmatically at a higher level scale, such as on a programmatic EIS, and BOEM/BSEE will post the project-specific EAs and EISs on their website. Programmatic level reviews will be included as part of the normal environmental review processes that BOEM/BSEE completes. BOEM/BSEE will continue to provide larger, programmatic NEPA documents for NMFS review by emailing the document to the ESA section 7 consultation lead. For example, NEPA documents for NMFS review would include BOEM's Leasing Proposed Program EIS, BSEE's Programmatic EA/EIS, or regional lease sale EISs, and would not include individual project-specific EAs. This will result in the assurance that BOEM's program continues to implement activities and actions addressed in this opinion.

3.4.2 Project-Specific Review Procedures: NMFS' Permits and Conservation Division

The MMPA rulemaking will programmatically impose any measures used to mitigate effects from G&G sound for the five years covered by the rule. The NMFS Permits and Conservation Division will conduct activity reviews to issue LOAs for oil and gas activity under the MMPA rule, and those activities that may affect ESA-listed species will require step-down ESA review for all incoming applications. Importantly, if one of the situations specified for step-down review section 3.4.1 above for step-down procedures is part of the LOA application, then step-down review is required. Those situations include:

- Proposed New and Unusual Technologies for G&G;
- New, Revised NTLs or other guidance related to G&G;
- Proposed G&G activities not otherwise permitted by BOEM/BSEE that may include:
    - Ancillary Activities
    - G&G activities associated with pipelines
    - G&G activities associated with Liquid Natural Gas ports

    - G&G activities associated with Platform abandonment

- A piece of equipment with an entanglement or entrapment risk is proposed for use.

If an activity is identified as one that requires step-down review, then the Permits and Conservation Division will provide the ESA Consulting Biologist with a copy of the LOA application after it is deemed complete by the Permits and Conservation Division. The Permits and Conservation Division will annually summarize LOA information in a report to the ESA Consulting Biologist, as described in Sections 3.5 and 15.4 during the annual review process.

3.4.3 Project-Specific Review Procedures: Environmental Protection Agency

The USEPA has completed several ESA section 7 consultations with NMFS in the past on NPDES general permits of discharges to the Gulf of Mexico that all resulted in NMFS concurrence with a “may affect, not likely to adversely affect” determination. This opinion evaluates the programmatic-level effects of USEPA’s issuance of NPDES general permits and air permits for the timeframe of this opinion. To ensure that future permits are within the scope of the current opinion, the following USEPA actions require step-down review with NMFS:

- *USEPA NPDES water quality permitting*
    - USEPA NPDES consultation (every five years) for general permitting
    - USEPA NPDES individual permits for oil and gas related activity in the Western, Central, or Eastern Planning Area

The action agency, USEPA, should fully describe the new information or changes to permit, consider all potential impacts to species, and provide clear effect determinations for those changes. If NMFS agrees with the action agency’s determination that an activity is consistent with those described in this opinion, then NMFS will notify USEPA that the new or changing information is consistent with this opinion. If NMFS disagrees with the action agency’s determination, and it is determined that the impacts are similar enough in scope to those analyzed in this opinion, then the action agency will need to request a tiered informal or formal consultation with NMFS on that activity. Otherwise, if the activity or action is found to be completely beyond the scope of this opinion, reinitiation of this consultation is required or a separate consultation must be requested.

3.4.3.1 National Pollutant Discharge Elimination System Permits issued by the U.S. Environmental Protection Agency

As part of the proposed action, the USEPA will issue NPDES general permits that regulate the discharge of effluents from oil and gas operations into marine waters of the OCS. NPDES permits are authorized for five years; however, terms may be administratively continued beyond five years based on the discretion of the Water Protection Division Director. Because the life of this biological opinion exceeds the reissuance cycle, new NPDES general permits, and on rare occasions, individual permits will be issued during the course of the proposed action. To assess any changes that may result from the reissuance of NPDES permits, NMFS will require a step-down review of the NPDES general permits prior to their reissuance and review of any individual permits for oil and gas related activity. This step-down review will allow NMFS to determine if the new NPDES general permits or site-specific permits are consistent with the programmatic opinion. Details for initiating step-down review include:

1. Request for Step-down Review: Prior to the expiration or reissuance of NPDES general permits or prior to site-specific permitting, the USEPA will notify NMFS via email at nmfs.ser.gom.leases@noaa.gov with the subject header, "Request for USEPA NPDES Review."
2. Content: The request will include any proposed changes from the previous NPDES permit and information about effects of discharges permitted under the previous five-year permit. The changes will be reviewed to ensure (1) they can be implemented in accordance with the PDCs/effects minimization measures and reasonable and prudent measures of this programmatic opinion, and (2) the reissued permit, with any revisions clearly laid out, is consistent with the effects analyzed in this programmatic opinion.
3. NMFS Review and Response: NMFS will provide a response to the proposed changes via email within 60 days of receipt of the request. If this review results in questions or concerns by NMFS, an in-person meeting or conference call will be scheduled with the USEPA to resolve any protected species or critical habitat issues stemming from the proposed changes. If USEPA does not receive a response within 60 day time period, then NMFS and USEPA will discuss and agree on appropriate future procedures.

3.5 Annual Activity Review

Action agencies will submit annual reviews including summaries (example tables included below) of the previous year's activity levels including the location and number of actions. The annual review will cover all projects that occur within a year and will occur during the second quarter of the year for the previous calendar year. This will provide a summary of annual aggregate activities and associated effects for the action agencies and NMFS to review and ensure that the activities remain in scope of the opinion and/or so that adjustments to mitigations can be made, as necessary.

- The review process will include periodic meetings with the action agencies and NMFS' ESA section 7 Consulting Biologist.
- For the first year following completion of the consultation, to ensure consistency with what is in the opinion, there may be need for more frequent calls/meetings/reporting so all agencies can be made aware of any issues during the initial implementation of the new processes or terms and conditions under this opinion.
- Separate program reviews will be conducted to evaluate, among other things, whether the nature and scale of the assumptions and effects predicted for the entire Oil and Gas Program continue to be valid; whether the PDCs continue to be appropriate; whether RPMs and Terms and Conditions of this opinion are ensuring take levels are not exceeded; and whether the project-specific consultation procedures are being complied with and are

effective. Program-level reviews by themselves do not authorize any oil and gas leasing activities; however, programmatic planning documents should contain PDCs, revisions or amendments resulting from annual reviews, as well as any new information that should be considered in an ESA review. Reviews will be conducted by:

   - NMFS' ESA Consulting Biologist and BOEM/BSEE representative(s);
   - NMFS' ESA Consulting Biologist and Permits and Conservation Division representative(s); and
   - NMFS' ESA Consulting Biologist and the USEPA representative(s).

3.5.1 BOEM/BSEE Annual reviews

- In addition to location and activities, BOEM/BSEE will provide PSO reports, takes reported, minimization measure effectiveness, any new developments in oil and gas activities including NUT evaluations, and recommendations for procedural changes that may be needed. These reviews will allow for adaptive management, as necessary. The annual reviews will be subdivided into four main areas: (1) G&G surveys; (2) construction and operations (which will cover all activities other than those in the other three reported areas); (3) oil spills and response planning; and (4) decommissioning.
- Following the first year, if we determine the process of G&G survey review is working well, we may move to annual meetings. This process, in turn, may satisfy concern over the more specific details regarding individual activities and the cumulative impacts of the combined amount of activities.
   - For example: After six months of implementation of the new process for BOEM biological review of G&G applications, NMFS will evaluate the process to determine if it is sufficient to ensure minimization of effects, by examining past compliance with mitigation measures. This could also be determined by examining the periodic report for redundancies or information that would imply that something could have been overlooked. If so, then the process will remain and NMFS will continue discussions with BOEM/BSEE until effects minimization is maximized to the extent practicable.
- Once there have been improvements made to the BOEM/BSEE specific activitiy permit application review process, there may be a reduction in NMFS' oversight of individual G&G permit reviews (reduction to annual post-reporting).
- Annual activity reviews should help with streamlining consultations, perhaps even by indirectly reducing the need for certain re-initiation triggers, and ensure that NMFS retains a reasonable level of regulatory oversight in future proposed activities for programmatic consultations.
- BOEM will provide annual summary reporting of all air quality permitting for sources in the Gulf of Mexico west of 87.5ºW longitude and make determination of compliance with OCSLA.
- BOEM and BSEE will be required to report on all of the agencies' reviews for adaptive management of the review process. This will fold into the larger review process that covers all annual reporting covered under the biological opinion described herein (e.g.,

turtle takes from decommissioning). The BOEM/BSEE annual reporting will provide the following:

- Number of each type of permit/plan application reviewed and approved by BOEM/BSEE;
- Number of each type of permit/plan application flagged for anomalies thus necessitating further consideration or additional information from the applicants;
- Number of each type of permit/plan application requiring BOEM/BSEE biologist review, and of those, the number sent to NMFS for step-down review and the rationale as to why each review was sent; and
- Summary of mitigations implemented (number of activities, mitigations applied, description of interpreted mitigation effectiveness; i.e., instances in which mitigation led to identified effects to ESA listed species being reduced or avoided) with as much detail and quantitative description as possible.

The annual report will include the following (see also Section 3.5.4):

1. Microsoft Excel summary table(s) and/or reports for each of the specified permits and plans (see examples below).
2. A summary of the aggregate effects needs to be evaluated by tallying the number of each occurring both annually and cumulatively:
    a. the number of animals observed in an exclusion zone, observed takes and estimated takes (e.g., sperm whale LOAs under the MMPA);
    b. the number of actions for each activity type (i.e., G&G, Development, Production, Decommissioning) in each Planning Area (note: if an activity plan or permit covers more than one action, such as drilling multiple wells, that should be included but tallied separately from the total number of plans/permits);
    c. the number of permitted actions in the Mississippi and DeSoto Canyon Protraction areas; and
    d. the number and volume of hydrocarbon spills occurring annually in each planning area in water depths less than 200 meters and greater than 200 meters.

The annual summary of G&G activities from BOEM will also include a written report summarizing annual G&G survey activities and any mitigation implemented. This summary will include the table below and the annual summary from the G&G PSO Program including, but not limited to, protected species sightings, the number and duration of delays due to sightings or adverse monitoring conditions, a summary of PAM effort, any observed takes of each species, and any issues encountered. There may be increased or reduced reporting requirements as the annual review process proceeds.

3.5.2 USEPA Annual Reviews

- Actions regulated under the NPDES General Permit will be summarized.
- Region 6 will annually summarize number of activities reported under their electronic data submission system (https://echo.epa.gov/).

- Region 6 will annually provide a summary report of all non-compliance events under the NPDES General Permit by lease holder or operator, as well as any penalties for violations of permit conditions. Data collection would begin at the time of the release of this opinion.
- Region 4 NPDES division will annually provide a summary report of all water quality permitting associated with oil and gas activities and make a determination whether or not they complied with the applicable general or site-specific permit.
- Region 4 will provide an annual summary of all site-specific air permits.
- Example summary tables can be found below in section 3.5.4. There may be increased or reduced reporting requirements as the annual review process proceeds.

3.5.3 NMFS' Permits and Conservation Division

- NMFS Permit's and Conservation Division may contribute or combine information with the BOEM/BSEE annual summary for the purposes of annual review, or provide information separately on the G&G activities being reviewed.
- Table 17 below displays the proposed timeline for MMPA monitoring requirements. We expect that the annual reporting and review process under this opinion will follow a similar, if not the same, timeline as the MMPA annual reporting.

Table 17. Proposed timeline for Marine Mammal Protection Act required monitoring plan and annual monitoring report preparation, review, and finalization.

	2017	2018				2019			
Activity	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
MP Review/Revision/Joint Meeting	■								
Mitigation Monitoring Data Collection		■	■						
AMR preparation				■					
AMR & MP Review/Revision/Joint Meeting					■				
Mitigation Monitoring Data Collection				■	■	■	■		
AMR preparation								■	
AMR & MP Review/Revision/Joint Meeting									■
Mitigation Monitoring Data Collection								■	■
		cycle repeats for duration of 5-year regulations...							

If the results of the annual review show that the anticipated impacts to listed species or critical habitat identified in this programmatic opinion have been exceeded or different/new impacts are expected, reinitiation of consultation may be required. The annual review will cover all projects that occur within a given calendar year and the review will occur no later than the end of second quarter of the following year (i.e., by March 31).

Example summary tables can be found below in section 3.5.4. There may be increased or reduced reporting requirements as the annual review process proceeds.

3.5.4 Example Summary Tables for Activities

Table 18. Example reporting table for geological and geophical activities.*

Plan No.	Plan Type	Survey Type	Lease Block(s)	Lease Block No.(s)	Min. Water Depth Range (m)	Max. Water Depth Range (m)	Line kilo-meters	No. of Seismic Source Vessels	No. of Seismic Support Vessels	Start Date	End Date	Peak Source Level (dB re 1 µPa)	RMS Source Level (dB re 1 µPa)
L15-000	G&G	WAZ	MC	195, 196, 197, 198, 207	700	800		5				260	250
R-8888	Revised EP	VSP	KC	140	150	162		1				252	220

** Summary PSO reports will account for implemented mitigation.*

Table 19. Example reporting for exploration, development, and production activities.

Plan No.	Permit Type	Approval Date	Lease Block(s)	Lease Block No.(s)	Min. Water Depth (m)	Max. Water Depth (m)	Mitigation implemented	Description of mitigation effectiveness
N1234	EP	YR/MM/DD	MC	195, 196, 197, 198, 207	700	800		
S5678	DOCD	YR/MM/DD	KC	140	150	162		
	DWOP							
	DPP							

	Drill							
	Air							

Table 20. Example reporting for structure installation permits.

Permit No.	Structure Type	Install Date	Number of Driven Piles/Anchor Points	Sound source Peak SL	Sound source RMS SL	Sound source Cum SEL	Lease Block	Lease Block No.(s)	Min. Water Depth (m)	Max. Water Depth (m)	Mitiga-tion imple-mented	Description of mitigation effectiveness
1	Tension leg	YR/MM/DD					MC	256	700	800		
2	FPSO	YR/MM/DD					KC	140	150	150-162		
3	Fixed platform											
4	Compliant Tower											
5	SPAR											

Table 21. Example report for oil spills.

Spill Date	Spill Volume (bbl)	Spill Duration (days)	Lease Block	Lease Block No.(s)	Cause	Min. Water Depth (m)	Max. Water Depth (m)	Response measures	Description of response effectiveness
YR/MM/DD	20	1	MC	256	Pipeline	700	800		
YR/MM/DD	750	1	KC	140	Valve	150	162		
YR/MM/DD	300	1			Fuel Tank				

The annual summary for explosive removal of offshore structures will also include a written report summarizing structure removal permits using explosives. This will include the summary table below and the annual summary from the PROP including, but not limited to, protected species sightings, the number and duration of delays due to sightings or adverse monitoring conditions, any observed takes of each species, and any issues encountered.

Table 22. Example report for explosive removal of offshore structures.

Permit No.	Removal Date(s)	Number of Detonation Events	Charge Size/Delay for each Event	Lease Block	Lease Block No.(s)	Min. Water Depth (m)	Max. Water Depth (m)	Mitigation implemented	Description of mitigation effectiveness
1xx	YR/MM/DD	1		MC	256	700	800		
2xx	YR/MM/DD	3		KC	140	150			

4 ACTION AREA

Action area means all areas affected directly, or indirectly, by the federal action, and not just the immediate area involved in the action (50 CFR §402.02). Indirect effects for purposes of the ESA are defined as those that occur later in time relative to the proposed action, but are still reasonably certain to occur.

The action area for this consultation includes the federal OCS waters in the Gulf of Mexico, as well as coastal areas, ports, airspaces, and waterways used by transport vessels related to coastal infrastructure, fabrication sites, and pipelines connecting to the offshore pipeline system, and other estuarine and marine areas affected directly and indirectly by the proposed action.

In the Gulf of Mexico, the OCS refers to the offshore waters beginning 10 miles (16 kilometers) offshore of Florida; 3.5 miles (5.6 kilometers) offshore of Louisiana, Mississippi, and Alabama; and 10.3 miles (16.5 kilometers) offshore of Texas; and extending seaward to the limits of the United States jurisdiction, the Exclusive Economic Zone (EEZ), to water depth of approximately 10,978 feet (3,346 meters). Figure 15 displays the extent of BOEM's jurisdiction on the OCS.

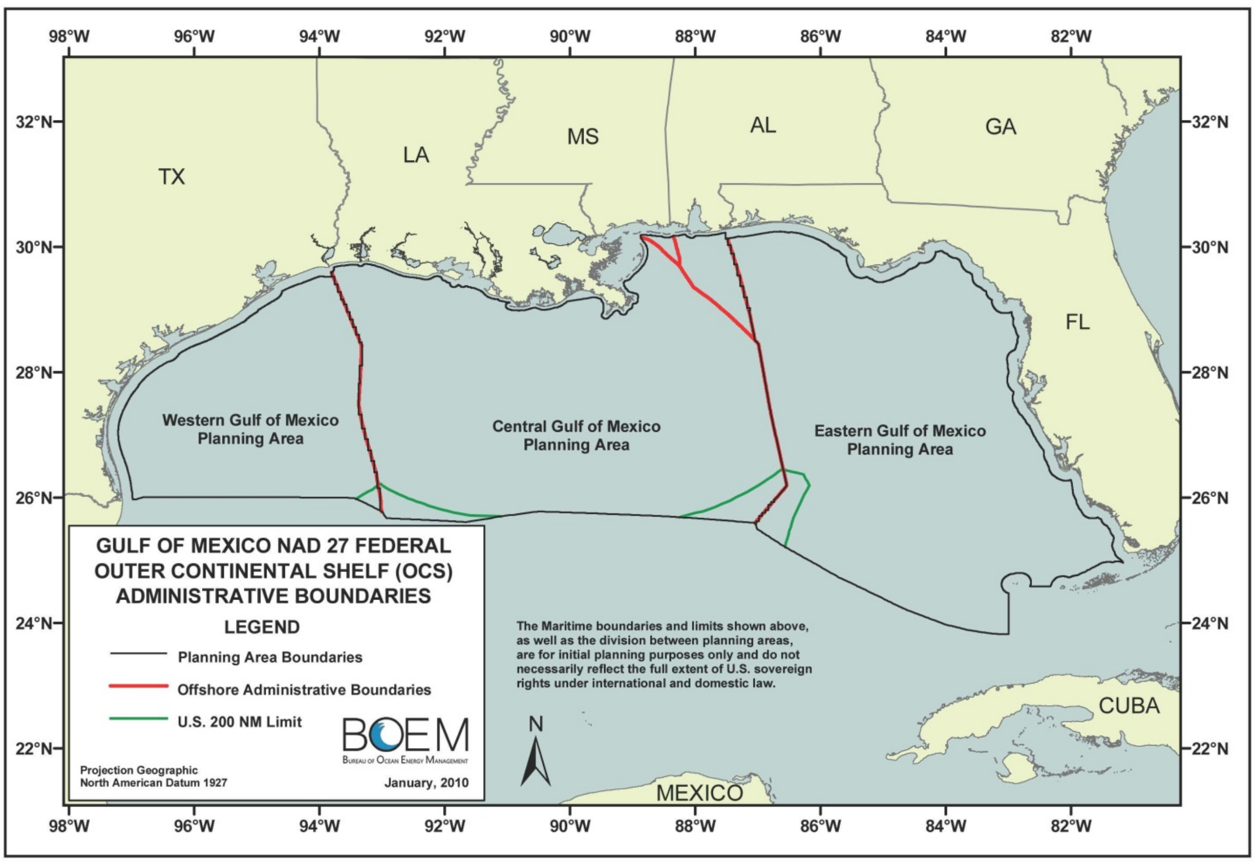
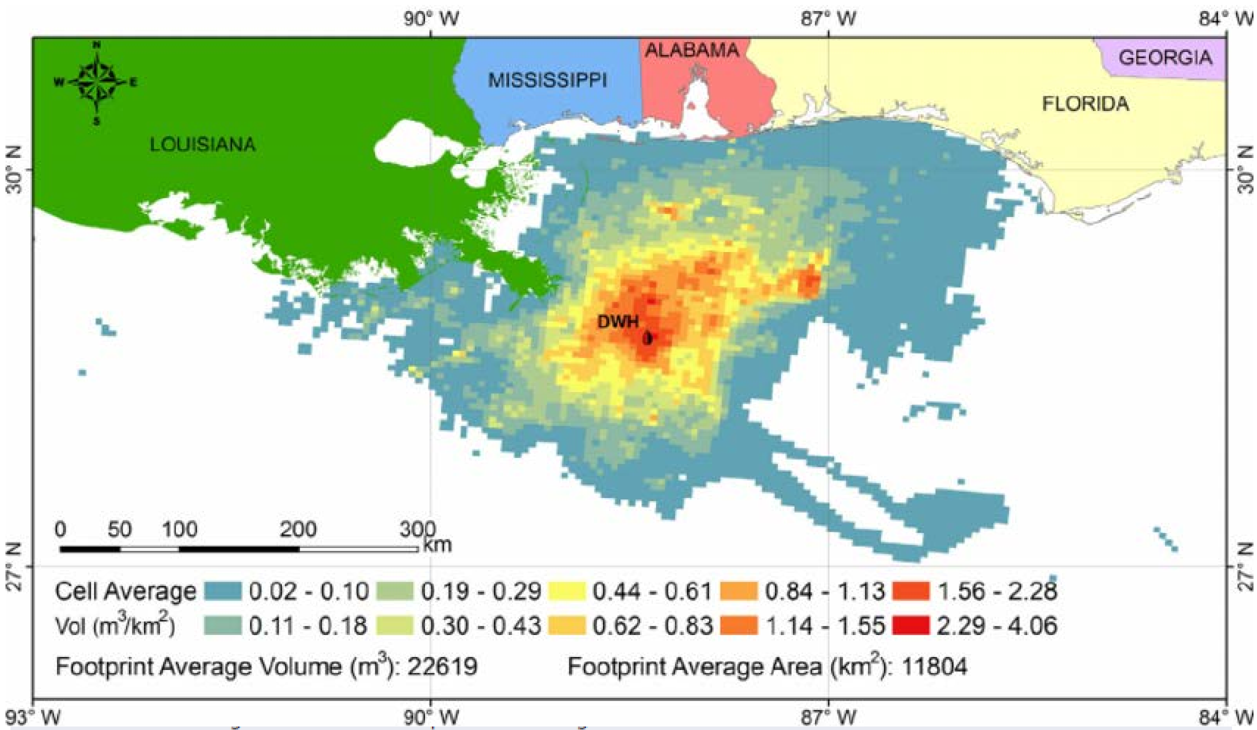


Figure 15. Federal leasing boundaries in the Gulf of Mexico. Figure from BOEM BA supplemental information.

Figure 17, below, portrays the action area that is included in the analysis for this opinion. The action area also includes areas that may be affected by accidental oil spills and response actions predicted to result from the proposed action. BOEM has completed extremely large spill modeling for seven points of origin throughout the WPA, CPA, and EPA that was included as supplemental information in their BA prepared for this consultation.

To create a representative example of a footprint for a very large oil spill, we used one third of the maximum footprint area (9,400 km^2 of 28,200 km^2) from DWH as shown below in Figure 16. We decided on one third because BOEM has indicated that they expect the ability for a well in any water depth to be capped within 30 days, which is about one third the time that DWH spilled, therefore we considered one third the volume of what was spilled during DWH. Assuming that there is a chance of a very large oil spill occurring at any active lease location, and using the edges of the planning areas with probabilities in Figure 84 greater than or equal to one percent with the radius of a very large oil spill footprint (2,994 km^2 = 55 km radius[14]) we were able to create a buffer using that distance to determine the areal extent beyond US waters that could be affected by a very large oil spill when originating from a particular location within a BOEM planning area. The buffer was added to the southern edge of the colored polygons in Figure 84 to extend 55 km out into Mexican waters, to signify the southernmost extent of the action area, or the farthest reach of oil possible to be spilled under the proposed action.

[14] Square root of the areal extent divided by 3.14 (π) with rounding.



	Peak Values			Summary Values		
Units	6 May	23 May	18 June	Average	Maximum	SD
Area (km^2)	8,500	18,900	28,100	11,800	28,200	5,028
Thick volume (m^3)	16,000	29,500	10,500	10,800	29,500	2,001
Total volume (m^3)	26,000	48,500	38,500	20,000	48,500	5,412
Total volume/area	2.90	2.57	1.37	1.80	5.04	0.4897

[a]Peak area and volume values for all surface oil occurred in May and June. Units of area, volume, and concentration are reported to three significant figures; standard deviation (no units) is reported to four significant figures.

Figure 16. Surface oil footprint from DWH Spill including average areal extents (upper) and Surface Oil Variation Statistics (lower)(Macdonald et al. 2015).

For a 30-day release duration for spills in BOEM's oil spill risk analysis (Section 8), all the spill locations where there is a more than one percent chance of a spill contacting shoreline considered together were used to determine the greatest possible extent of the action area. Our oil spill analysis (section 8.8) using the BOEM modeling shows that oiling could occur over an area that extends from Florida, Alabama, Mississippi, Louisiana, Texas, and extending to 55 km past federal waters. Therefore, our action area includes offshore oceanic areas of the WPA, CPA, and EPA and beyond including Mexican waters and coastal waters of the states of Texas, Louisiana, Mississippi, Alabama, to Tampa, Florida (Figure 17). Note that the area under moratorium shown in Figure 17 (hatch-marked) is not included in BOEM's proposed action for planning purposes, however there is vessel traffic associated with the oil and gas program that may transit across that area from Florida ports. Therefore, the area under moratorium is still part of the action area, but BOEM is not planning any exploration or development activities within that area.

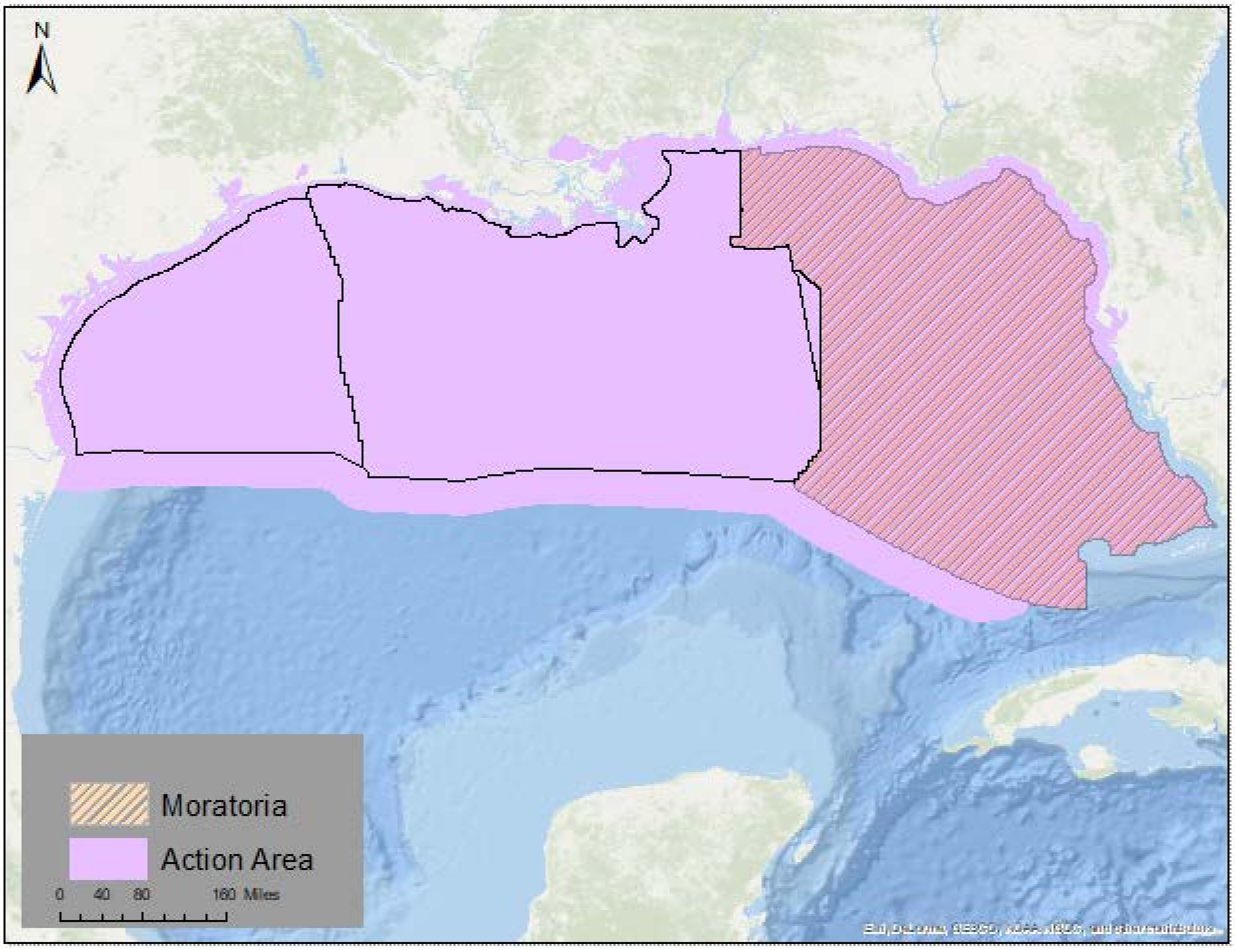


Figure 17. The action area for this consultation includes BOEM Gulf of Mexico planning areas (outlined in black), extends into state coastal waters to shore and 55 km out beyond federal waters.

The WPA covers approximately 28.58 million acres and is located 10.4 miles (16.7 kilometers) offshore of Texas and extends seaward to the limits of the EEZ. It is bounded on the west and north by the federal-state boundary offshore of Texas. The eastern boundary begins at the offshore boundary between Texas and Louisiana and proceeds south-southeasterly. The WPA is bounded on the south by the maritime boundary with Mexico, as established by the "Treaty Between The Government Of The United States Of America And The Government Of The United Mexican States On The Delimitation Of The Continental Shelf In The Western Gulf Of Mexico Beyond 200 Nautical Miles," effective January 2001.

The CPA covers approximately 66.45 million acres and is located 3.5 miles (5.6 kilometers) offshore of Louisiana, Mississippi, and Alabama and extends seaward to the limits of the EEZ. The eastern boundary begins at the Florida Alabama border and proceeds south-southeasterly. A small portion of the CPA (within 100 miles of Florida and south of Alabama-Florida border) is currently under a leasing moratorium as a result of GOMESA. The CPA moratorium area covers approximately 1.942 million acres.

The EPA, a large part of which is not included as part of BOEM's proposed action, covers approximately 64.56 million acres and is located 10.4 miles (16.7 kilometers) offshore of Florida extending westward to the boundary of the CPA. The portion of the EPA included as part of the proposed action covers approximately 657,905 acres, bordered by the CPA boundary on the west. The area is located south of the Florida-Alabama border and displayed as a pink polygon sliver in Figure 18. On December 20, 2006, President Bush signed into law the Gulf of Mexico Energy Security Act of 2006 (GOMESA), which made available new areas for leasing in the EPA and placed a moratorium on other areas in the Gulf of Mexico through June 30, 2022. The moratorium does not restrict geophysical surveys, but BOEM is not planning any geophysical survey activity in those areas for the time period covered under this opinion. All areas under consideration for leasing are more than 125 miles (200 kilometers) from Florida and GOMESA, or the portion of the EPA that is not included in the proposed action, covers the majority of the EPA (shown in yellow in Figure 18). Therefore, any BOEM- or BSEE-permitted oil and gas related activities that are planned in the GOMESA portion of the EPA would need to undergo a separate consultation to be covered under the ESA.

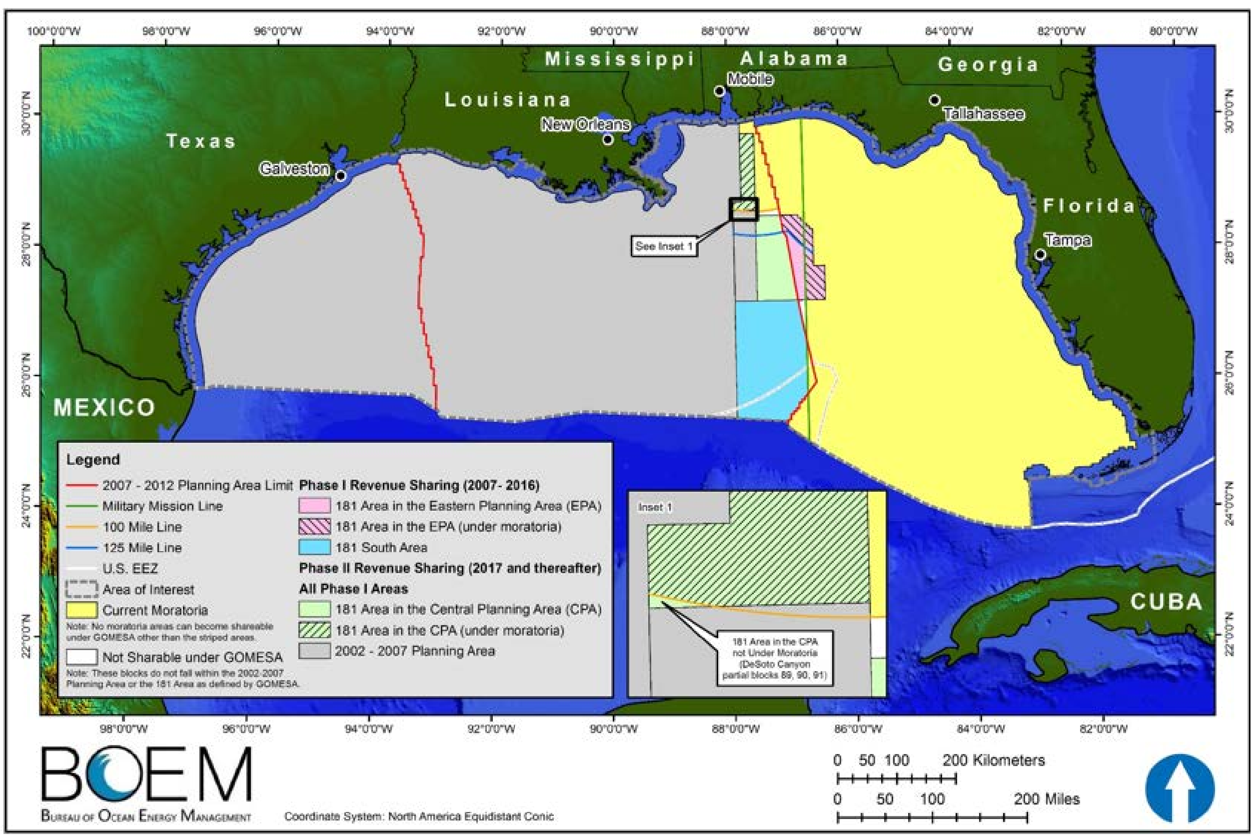


Figure 18. Gulf of Mexico Energy Security Act Moratorium Area shown in yellow (BOEM 2017b).

5 STRESSORS CREATED BY THE PROPOSED ACTION

Stressors are any physical, chemical or biological agent, environmental condition, external stimulus or an event that may induce an adverse response either in an ESA-listed species or their designated critical habitat. The proposed action is very complex, consisting of multiple phases of oil and gas development from (1) lease sales and exploration, (2) construction of facilities and oil and gas extraction, and (3) decommissioning and removal of facilities at the end of the lease term. Each of the activities can create stressors that may affect ESA-listed species or designated critical habitat. We deconstructed each phase of the proposed action to identify stressors from each activity within each phase. As described in Section 2.2 the Federal action agencies have varied roles and responsibilities in each phase, and the stressors for each phase are displayed in each of the following tables:

Phase 1: Leasing and Exploration (Table 23)

- BOEM: Pre-lease Environmental Review; Geophysical Data Permit; Lease Sale; Exploration Plan; Administer air pollution control requirements for GOM OCS sources (west of 87.5˚W longitude)
- BSEE: Exploration Plan; Permit to Drill
- USEPA: NPDES Permits; Administer CAA air pollution control requirements for GOM OCS sources (east of 87.5˚W longitude)
- NMFS Permits and Conservation Division: MMPA LOA

Phase 2: Development and Production (Table 24)

- BOEM: Development Plan; Administer air pollution control requirements for GOM OCS sources (west of 87.5˚W longitude)
- BSEE: Oil Spill Response Plan; Deepwater Operations Plan; Permit to Drill; Platform Approval/Verification; Pipeline Installation Permit; Production Safety System Permit; Production Measurement/Verification; Conservation of Resources
- USEPA: NPDES Permits; Administer CAA air pollution control requirements for GOM OCS sources (east of 87.5˚W longitude)

Phase 3: Decommissioning (Table 25)

- BOEM: Administer air pollution control requirements for GOM OCS sources (west of 87.5˚W longitude)
- BSEE: Platform Removal Permit
- USEPA: NPDES Permits; Administer CAA air pollution control requirements for GOM OCS sources (east of 87.5˚W longitude)

The major categories of stressors are: vessel strike, sound from multiple sources (e.g., vessels, seismic air guns, drilling machines), emissions and discharges, entanglement and entrapment, marine debris, and oil spills. All phases of the proposed action (i.e., leasing and exploration, development and production, and decommissioning) will have stressor-causing activities.

Table 23. Phase 1: Leasing and Exploration activities and stressors.

Activity Producing Stressor[15]	Vessel strike (V)	Sound (S)	Underwater explosion (S)	Contaminants and toxins (D)	Water quality degradation (D)	Air pollution (D)	Entanglement in equipment (E)	Entrapment (E)	Capture in trawl gear (E)	Increased turbidity (Z)	Disturbance to ocean floor (Z)	Marine debris ingestion (M)	Marine debris entanglement (M)	Oil (O)	Dispersants (O)	In-situ oil burning (O)
Deep penetration seismic surveys[16]		X														
HRG surveys[17]		X														
Deployment and retrieval of seismic survey equipment[18]							X			X	X	X	X			
Sediment sampling (box & piston cores)				X	X		X			X	X	X				
Service vessel operation	X	X			X	X						X	X	X		
Seismic survey vessel operation		X			X	X						X	X	X		
Aircraft operation		X				X										

[15] Stressor categories are identified as vessel strike (V); Sound (S); Emissions or Discharges (D); Entanglement and Entrapment (E); Marine Debris (M); Oil spills (O); and Other (Z), and the other category represent stressors that are represented in multiple categories.
[16] See Table 62 for specific types of deep penetration seismic surveys
[17] See Table 62 for specific types of HRG surveys
[18] Includes OBN, hydrophones, geophones, cables, and other gear used for seismic surveys

Activity Producing Stressor[15]	Vessel strike (V)	Sound (S)	Underwater explosion (S)	Contaminants and toxins (D)	Water quality degradation (D)	Air pollution (D)	Entanglement in equipment (E)	Entrapment (E)	Capture in trawl gear (E)	Increased turbidity (Z)	Disturbance to ocean floor (Z)	Marine debris ingestion (M)	Marine debris entanglement (M)	Oil (O)	Dispersants (O)	In-situ oil burning (O)
Drilling exploration & delineation wells		**X**		**X**	**X**					**X**	**X**			**X**		
Use of generators and engines		**X**				**X**								**X**		
Discharge of drilling fluids, drill cuttings, and produced water				**X**	**X**					**X**						
Venting/Flaring to dispose of vapors or natural gas						**X**										
MODU operation[19]		**X**			**X**	**X**				**X**	**X**	**X**	**X**	**X**		
Use of moon pools								**X**								

[19] MODUs used include jack-up rigs, semi-submersible rigs, submersibles, platform rigs, and drill ships.

Table 24. Phase 2: Development and Production activities and the stressors.

Activity Producing Stressor[20]	Vessel strike (V)	Sound (S)	Underwater explosion (S)	Contaminants and toxins (D)	Water quality degradation (D)	Air pollution (D)	Entanglement in equipment (E)	Entrapment (E)	Capture in trawl gear (E)	Increased turbidity (Z)	Disturbance to ocean floor (Z)	Marine debris ingestion (M)	Marine debris entanglement (M)	Oil (O)	Dispersants (O)	In-situ oil burning (O)
MODU operation[21]		X			X	X				X	X	X	X	X		
Drilling development and production wells		X		X	X					X	X			X	X	X
Use of generators and engines		X			X	X								X		
Use of moon pools								X			X					
Discharge of drilling fluids, drill cuttings, and produced water				X	X					X		X				
Discharge of waste products from offshore structures and support vessels[22]					X							X				

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[20] Stressor categories are identified as vessel strike (V); Sound (S); Emissions or Discharges (D); Entanglement and Entrapment (E); Marine Debris (M); Oil spills (O); and Other (Z), and the other category represent stressors that are represented in multiple categories.
[21] MODUs used include jack-up rigs, semi-submersible rigs, submersibles, platform rigs, and drill ships.

[22] Discharged wastes include treated sewage, treated wastewater, engine waste, biodegradable food waste, desalination brine, boiler blowdown fluids, blowout preventer fluids, excess cement slurry, subsea production fluids and uncontaminated freshwater and saltwater.

Activity Producing Stressor[20]	Vessel strike (V)	Sound (S)	Underwater explosion (S)	Contaminants and toxins (D)	Water quality degradation (D)	Air pollution (D)	Entanglement in equipment (E)	Entrapment (E)	Capture in trawl gear (E)	Increased turbidity (Z)	Disturbance to ocean floor (Z)	Marine debris ingestion (M)	Marine debris entanglement (M)	Oil (O)	Dispersants (O)	In-situ oil burning (O)
Venting and flaring to dispose of hydrocarbon vapors or natural gas						**X**										
Oil tanker and barge operation	**X**	**X**			**X**	**X**								**X**	**X**	**X**
Service vessel operation	**X**	**X**			**X**	**X**								**X**		
Aircraft operation		**X**				**X**										
Shuttle tanker operation	**X**	**X**			**X**	**X**								**X**	**X**	**X**
Installation of fixed & floating platforms		**X**								**X**	**X**					
Installation of caissons		**X**								**X**	**X**					
Installation of well protectors		**X**								**X**	**X**					
Installation of wellheads		**X**								**X**	**X**			**X**	**X**	**X**
Installation of casing conductors		**X**								**X**	**X**					

Activity Producing Stressor[20]	Vessel strike (V)	Sound (S)	Underwater explosion (S)	Contaminants and toxins (D)	Water quality degradation (D)	Air pollution (D)	Entanglement in equipment (E)	Entrapment (E)	Capture in trawl gear (E)	Increased turbidity (Z)	Disturbance to ocean floor (Z)	Marine debris ingestion (M)	Marine debris entanglement (M)	Oil (O)	Dispersants (O)	In-situ oil burning (O)
Installation of pipelines		**X**								**X**	**X**			**X**	**X**	**X**
Installation of mooring buoys							**X**				**X**		**X**			**X**

Table 25. Phase 3: Decommissioning activites and the resulting stressors.

Activity Producing Stressor[23]	Vessel strike (V)	Sound (S)	Underwater explosion (S)	Contaminants and toxins (D)	Water quality degradation (D)	Air pollution (D)	Entanglement in equipment (E)	Entrapment (E)	Capture in trawl gear (E)	Increased turbidity (Z)	Disturbance to ocean floor (Z)	Marine debris ingestion (M)	Marine debris entanglement (M)	Oil (O)	Dispersants (O)	In-situ oil burning (O)
Pipeline flushing				**X**	**X**											
Tank and deck cleaning				**X**	**X**							**X**				
Pile jetting				**X**	**X**					**X**						

[23] Stressor categories are identified as vessel strike (V); Sound (S); Emissions or Discharges (D); Entanglement and Entrapment (E); Marine Debris (M); Oil spills (O); and Other (Z), and the other category represent stressors that are represented in multiple categories.

Activity Producing Stressor[23]	Vessel strike (V)	Sound (S)	Underwater explosion (S)	Contaminants and toxins (D)	Water quality degradation (D)	Air pollution (D)	Entanglement in equipment (E)	Entrapment (E)	Capture in trawl gear (E)	Increased turbidity (Z)	Disturbance to ocean floor (Z)	Marine debris ingestion (M)	Marine debris entanglement (M)	Oil (O)	Dispersants (O)	In-situ oil burning (O)
Structure severance using explosives (bulk, shaped and fracturing charges)[24]		**X**	**X**								**X**	**X**	**X**			
Structure severance using non-explosive methods[25]			**X**							**X**						
Site clearance trawling									**X**	**X**	**X**					
Artificial reef creation											**X**					
Removal of severed structure from seabed										**X**	**X**					
Welders cut severed structure for lift vessel				**X**												

[24] Target structures include wellheads and conductors, production devices, jacketed platforms, caissons, well protectors, pipelines, cement structures and foundations.
[25] Non-explosive methods include abrasive cutters (sand and abrasive-water jets), mechanical cutters (e.g., carbide or rotary), diamond wire cutting devices, and cutting facilitated by commercial divers using arc/gas torches.

Activity Producing Stressor[23]	Vessel strike (V)	Sound (S)	Underwater explosion (S)	Contaminants and toxins (D)	Water quality degradation (D)	Air pollution (D)	Entanglement in equipment (E)	Entrapment (E)	Capture in trawl gear (E)	Increased turbidity (Z)	Disturbance to ocean floor (Z)	Marine debris ingestion (M)	Marine debris entanglement (M)	Oil (O)	Dispersants (O)	In-situ oil burning (O)
Transport of severed structures to service base or shore	**X**	**X**			**X**	**X**										
Transport of topside equipment to shore	**X**	**X**			**X**	**X**										
Lift and support vessel operation	**X**	**X**			**X**	**X**										
Load barge operation	**X**	**X**			**X**	**X**										
Aircraft operation		**X**				**X**										

While all of these stressors are reasonably certain to result from the proposed action, oil spills stand out as one stressor for which the level, location, duration, and other parameters are difficult to predict. Based on decades of experience with oil and gas exploration, leases, and extraction we can reasonably assume one or more oil spill(s) will occur in the Gulf of Mexico associated with this BOEM Oil and Gas Program over the next 50 years.

6 SPECIES AND DESIGNATED CRITICAL HABITAT EVALUATED

NMFS uses two criteria to identify the ESA-listed species or critical habitat that are likely to be adversely affected by the proposed action, as well as the full scope of effects of activities associated with the Federal agencys' proposed action.

The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitat that is exposed to a potential stressor but is likely to be unaffected by the exposure is also not likely to be adversely affected by the proposed action.

An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly *beneficial, insignificant* or *discountable*. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat. Beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect. That means the ESA-listed species may be expected to be affected, but not harmed or harassed.

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is very unlikely to occur.

During consultation we evaluated the spatial and temporal overlap of species in the action area and the stressors that are likely to cause a response. Our results are summarized below.

6.1 Species Not Carried Forward for Analysis

BOEM/BSEE did not make effects determinations for blue, sei, and North Atlantic right whales, Nassau grouper, smalltooth sawfish or ESA listed corals.

Whales

Blue whale (*Balaenoptera musculus*), sei whale (*Balaenoptera borealis*), and North Atlantic right whale (*Eubalaena glacialis*) have been reported in the Gulf of Mexico on rare occasions. These whale species are very rare in the action area and are considered extralimital in the Gulf of Mexico. Hence, they are not documented as inhabitants of the Gulf of Mexico in NMFS' stock assessment reports (Waring 2016) and we consider the risk of overlap of these species with the Oil and Gas Program activities to be extremely unlikely to occur. Therefore, we find the risk to these species to be discountable. For this reason, NMFS concludes that the proposed action is not likely to adversely affect blue, sei, or North Atlantic right whales. These species will not be discussed further in this opinion.

Fish

ESA-listed smalltooth sawfish (*Pristis pectinata*) are rare in the action area and their designated critical habitat is outside the action area. Small, juvenile smalltooth sawfish are generally restricted to estuarine waters of peninsular Florida, whereas larger adults have a broader distribution and could be found in the southeastern Gulf of Mexico which is generally outside of the action area.

Decades of oil and gas activities have not documented any interactions, such as through entanglement/entrapment or oil spill response, with smalltooth sawfish. The sound stressors of the proposed action are not likely to occur at levels to create a risk to smalltooth sawfish because the sounds would occur in deepwater areas away from sawfish preferred habitats. Marine debris from the proposed action is expected to occur in deep water areas of the Gulf of Mexico. BOEM's oil spill risk analysis (Figure 81 in Section 8.8) concluded that there is little to no risk of oil making contact with southern Florida coastal waters where smalltooth sawfish reside. Based on the above we find the risk of smalltooth sawfish interacting with the stressors of vessel strike, sound, emissions/discharges, entanglement/entrapment, marine debris, and oil spill is extremely unlikely to occur and therefore discountable. Because, we determined that smalltooth sawfish and their designated critical habitat are not likely to be adversely affected by the Oil and Gas Program, we do not discuss this species further in this opinion.

BOEM determined that their activities will have no effect on Nassau grouper. Nassau grouper (*Epinephelus striatus*) may occur in southeastern portion of BOEM's Eastern Planning Area, which is currently located far from any oil and gas activities due to the GOMESA moratorium (see Section 4) on the majority of this area, which bans oil and gas development until June 30, 2022. As noted previously, BOEM and BSEE did not project any leases in the EPA after the moratorium expires. If new leases were to be offered in the EPA during the timeframe of this opinion, reinitiation of consultation would be required as effects of oil and gas development and production in that area have not been considered in this opinion.

Nassau grouper may be exposed to and detect sound generated by oil and gas activities, specifically from Oil and Gas Program associated vessel traffic that passes through the Florida straights, but because their range is separated from the majority of sound-producing activities, we expect effects from sound to be insignificant.

The risk of a vessel strike resulting from the proposed action is also considered discountable because vessel strikes of marine fish offshore are rare events in general and not considered a threat to Nassau grouper. While it is possible that the presence of vessels or aircraft used for oil and gas activities may result in a short-term behavioral response from this species (e.g., startle, dive), the effects are not expected to result in any injury or reduced fitness of individuals (i.e., insignificant). Because their range is a great distance from where the oil and gas activities will occur, we do not expect Nassau grouper will be affected by any of the following activities or associated stressors (i.e., no effect): marine debris, G&G sediment sampling, entanglement, entrainment or entrapment in equipment, emissions and discharges, offshore infrastructure/construction, and decommissioning and structure removal.

Further, oil spill risk analyses have shown low to zero risk in the areas where Nassau grouper would occur. Given the low to zero risk of an oil spill affecting this species, oil spill response activities, including the use of dispersants and in-situ burning, are also unlikely to affect these species (i.e., discountable). Because pipeline construction is also unlikely to occur in the portions of the action area that overlap with the ranges of Nassau grouper, we consider the effects of this activity to be discountable. In addition, any new pipelines expected to make landfall in areas where Nassau grouper may be present would require step-down review under this programmatic consultation (see Sections 3.4). In summary, we conclude that any effects to Nassau grouper resulting from activities conducted as part of the proposed action will be either discountable or insignificant. Therefore, we determined that Nassau grouper are not likely to be adversely affected by the Oil and Gas Program and we do not discuss this species further in this opinion.

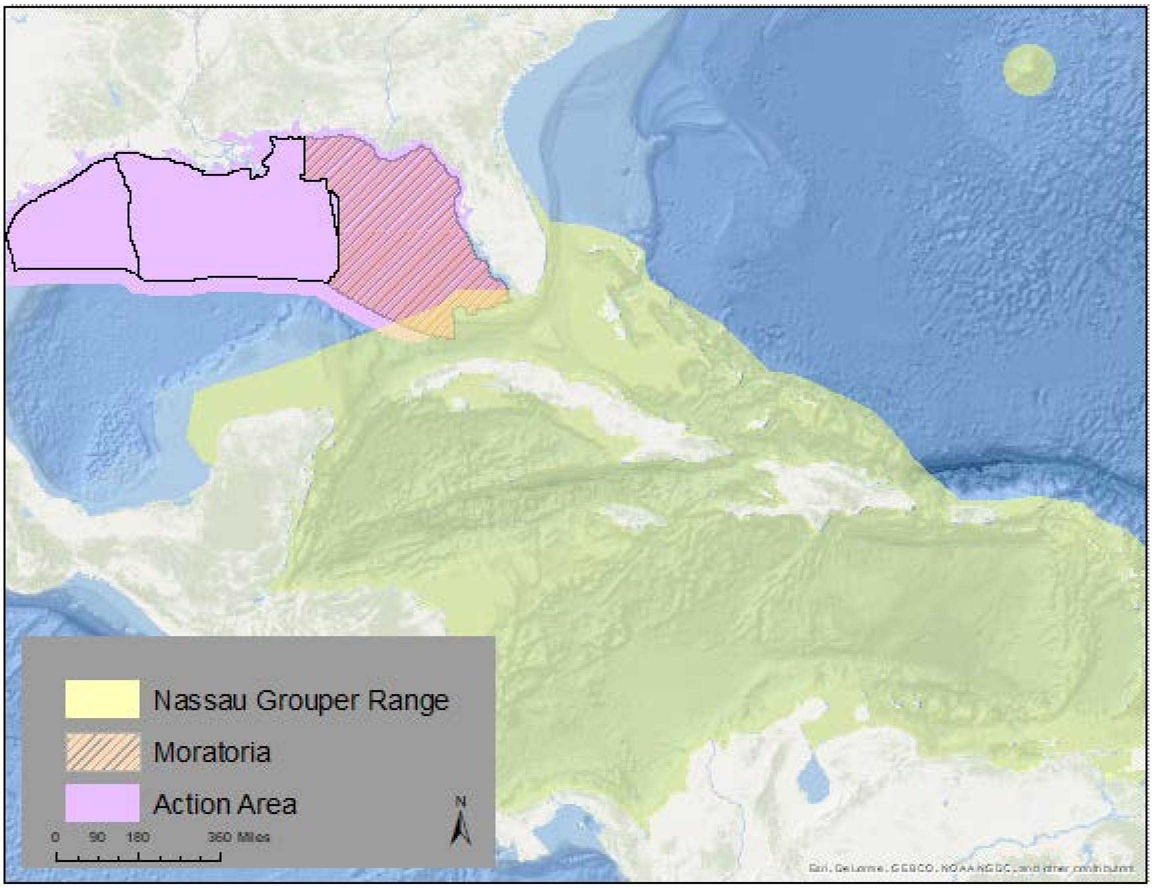

Figure 19. Nassau grouper range as it relates to the action area.

ESA-listed Corals

Four coral species listed under the ESA occur in the action area boulder star coral (*Orbicella franksi*), elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolta*). These species occur in the Flower Garden Bank National Marine Sanctuary (FGBNMS). No federally managed oil and gas activities are proposed in these coral locations, however some activities may be approved by FGBNMS on a case by case basis.

FGBNMS has monitored the abundance of corals in the Sanctuary since 1989. FGBNMS has some of the highest percent coral cover in the United States, and unlike other areas, coral cover still dominates benthic communities. In 2016, mean coral cover based on random transects was 49.92 percent within the East Flower Garden Bank (EFGB) study site and 58.54 percent within the West Flower Garden Bank (WFGB) study site (Johnston et al. 2017). Boulder star coral (*Orbicella franksi*) was the principal component of mean percent coral cover within the EFGB study site (20.38 percent) and the WFGB study site (29.29 percent). When Johnston et al. (2017) combined the *Orbicella* species complex, it made up 50.99 percent of the observed coral species within EFGB study sites and 61.67 percent of the observed coral species within WFGB study sites. Boulder star coral covered the greatest total area (58,615,875 cm^3) within EFGB study site surveys and mountainous star coral (*Orbicella faveolata)* covered the greatest total area within WFGB (36,290,058 cm^3) study site surveys (Johnston et al. 2017).

Coral communities have been characterized on less than two percent of oil rigs in the Gulf of Mexico. Of the nine hermatypic (requiring light) coral species known to occur on surveyed oil rigs, none are listed under the ESA (Sammarco et al. 2013).

We believe it is highly unlikely that the types of marine debris originating from this industry will ultimately reach and smother corals. As previously mentioned, oil and gas activities are prohibited within FGBNMS. PlasticP and wood materials will generally float on the surface while any tools or heavier objects will sink directly below the rigs where they are lost. Because these rigs will not be located directly above sensitive areas such as coral reefs, it is extremely unlikely that marine debris will settle on corals, thus discountable. Therefore, we find marine debris from the Oil and Gas Program is not likely to adversely affect ESA-listed corals.

Corals are benthic and less susceptible to oiling than animals that utilize the water column and surface for feeding, breathing, and swimming. Listed coral species only occur in the action area within the FGBNMS. Due to the depth of corals in the Flower Gardens Banks (from 55 ft [17 m] to about 160 ft [49 m]), the likelihood of coral being oiled is least of all the listed species.

Coral exposure via the water column is the more likely route of contact. Because much of the constituent material in oil has a relatively low solubility in water, in general coral may be protected from exposure by overlying waters. Rough seas and dispersants may result in a greater solubility and dispersion of oil into the water column where it can come into contact with and be taken in by corals. For most spills, the absolute levels of exposure would be expected to be low, because only a small fraction of the total oil can mix into the water column either in solution or physically suspended. Still, if a large spill was able to be transported by currents to coral habitat, exposure to higher oil concentrations that could be acutely toxic could occur. Oil that becomes weathered and/or mixes with sediment material can sink and impact corals. Although acute toxicity characteristics of weathered oil mats and tarballs would be expected to be low, the potential for smothering is greatly increased.

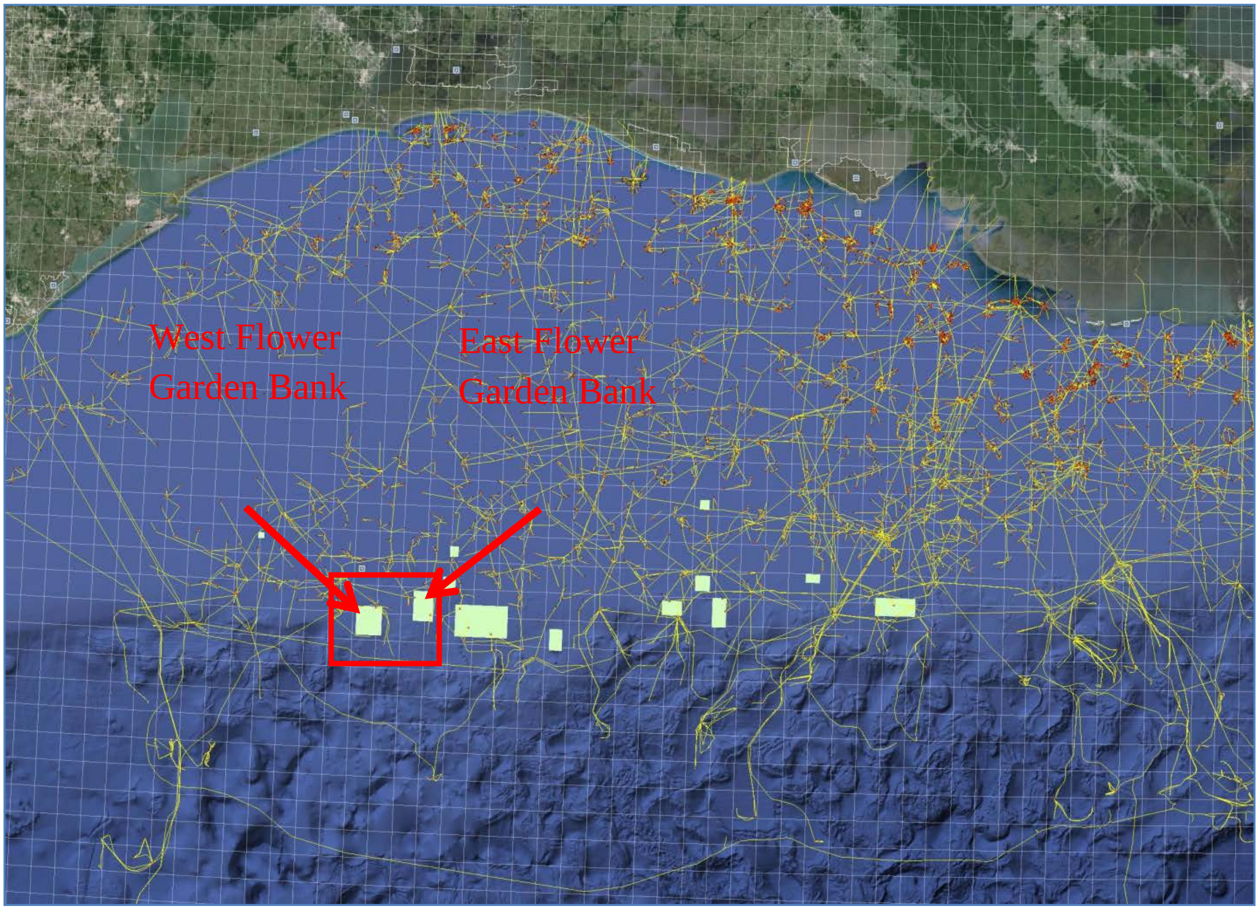

Figure 20. The location of the Flower Garden Banks National Marine Sanctuary in the Western Gulf of Mexico indicated by red box. Green boxes represent topographic features that are protected. Pipelines are shown in yellow and platforms by red dots. (Google Earth© 2013, 2014).

In a review of oil spill effects on coral prepared for oil spill planning and response purposes (NOAA 2010), some key findings were made in regard to the toxicity of oil to corals:

- Spill impacts vary in severity with the specific conditions at a given spill, including oil type and quantity, species composition, and the nature of oil exposure.
- Oil can kill corals, depending on species and exposure.
- Longer exposure to lower levels of oil may kill corals as well as shorter exposure to higher concentrations.
- Chronic oil toxicity impedes coral reproduction, growth, behavior, and development.
- The time of year when a spill happens is critical, since coral reproduction and early life stages are particularly sensitive to oil.
- Branching corals (e.g., elkhorn coral) are more sensitive to oil impacts than are massive or plate-like corals.

Direct oiling would mostly occur in the intertidal zone which is not a concern for corals found in the FGBNMS given that this area is not within this zone. Laboratory studies of oil impacts on corals have had varied results, and the applicability of laboratory study methods to exposure under natural conditions have been treated with caution. One of the best examples of a field study of oil exposure under natural conditions occurred during the 1986 Bahía Las Minas crude oil spill in Panama. An extensive series of studies documented both short-term mortality to corals and long-term, sublethal impacts to reproduction and growth lasting five years or longer. A comparison of the cover of common coral species at six reefs before 1985 and three months after the oil spill at Bahía Las Minas showed that at one heavily oiled reef, total coral cover decreased by 56 percent in the greater than 3-6 m range and decreased with moderately oiled reefs. The branching corals on the reef appeared to be much more susceptible to oiling due to their morphology. Elkhorn coral nearly disappeared at the heavily oiled site in this study.

A laboratory study showed that low-level exposures almost completely disintegrated coral tissues after 48 hrs suggesting that longer exposure periods to low concentrations of oil may be just as lethal as exposure to higher concentrations for brief periods (Harrison et al. 1986).

Studies have found enhanced phototoxicity from short-term and very low exposures to fluoranthene (a polynuclear aromatic hydrocarbon in oil) under outdoor light conditions (thus including ultraviolet radiation during the day) with the coral *Porites* (Martínez et al. 2007; Peachey and Crosby 1995; Tarrant et al. 2014). The upper sides of the coral fragments exposed to outdoor light exhibited bleaching and mortality within three to six days; however, the under sides of the corals were normal. Because corals grow in shallow, clear water with good light penetration, photo-enhanced toxicity is likely to be a significant mechanism, making corals much more sensitive to oil impacts than previously understood.

NOAA (2010) concluded the long-standing notion that coral reefs do not suffer acute toxicity effects from oil floating over them is probably incorrect. Certainly, direct coating increases the severity of impact, but high oil concentrations in the water column during a spill may also kill some species. Oil quickly and readily bioaccumulates in coral tissues and is slow to leave the body. Uptake into the symbiotic zooxanthellae also occurs and can impair the photosynthetic relation between corals and symbiotic algae. Chronic effects of oil exposure have been consistently noted in corals and, ultimately, can kill the entire colony. A summary of the reported impacts to coral are: tissue death, impared feeding response, impaired polyp retraction, impaired ability to clear sediment, increased mucus production, change in calcification rate, gonadal damage, premature extrusion of planulae, larval death, impaired larval settlement, expulsion of zooxanthellae, change in zooxanthellae photosynthesis, and muscle atrophy.

Corals reproduce annually during spawning events that are synchronized by seawater temperature changes, lunar cycle, and time of day. Broadcast spawning events in the FGBNMS occur when corals release gametes over the course of a few nights. This occurs every year seven to ten days after the full moon in August. Because eggs are generally lipid-rich and positively buoyant, whole slicks of gametes are often seen at the surface during and after spawning events.

This life stage is particularly sensitive to surface oils occurring in the Garden Banks area at the time of a broadcast spawning event. Impacts could include gamete death, failure to reproduce, and decreased recruitment of new corals into the population.

A study examined the potential effects of oil spill and dispersant-oil exposure on coral larvae in the Florida Keys. Larvae of the brooding coral, *Porites astreoides*, and the broadcast spawning coral, *Montastraea faveolata* (now reclassified as *Orbicella faveolta* and listed as threatened), were exposed to multiple concentrations of DWH source oil (crude, weathered and soluble oil), oil in combination with the dispersant CorexitH 9500, and dispersant alone, and analyzed for behavior, settlement, and survival (Goodbody-Gringley et al. 2013). Settlement and survival of *P. astreoides* and *O. faveolata* larvae decreased with increasing concentrations of soluble oil, Corexit H 9500, and dispersant-oil mixture; however, the degree of the response varied by species and solution. *P. astreoides* larvae experienced decreased settlement and survival following exposure to 0.62 ppm source oil, while *O. faveolata* larvae were negatively impacted by 0.65, 1.34, and 1.5 ppm, suggesting that *O. faveolata* larvae are more sensitive to soluble oil than *P. astreoides* larvae. Exposure to medium and high concentrations of dispersant-oil mixture and CorexitH 9500, significantly decreased larval settlement and survival for both species. Furthermore, exposure to CorexitH 9500 resulted in settlement failure and complete larval mortality after exposure to 50 and 100 ppm for *O. faveolata*. These results indicate that exposure of coral larvae to oil spill chemicals, particularly the dispersant Corexit H 9500, has the potential to negatively impact coral settlement and survival, thereby affecting the resilience and recovery of coral reefs following exposure to oil and dispersants.

Dispersed oil rapidly dilutes into the water and a plume of dispersed oil is transported away from the treated site. The subsurface plume may move in a different direction and speed than the untreated surface slick. Dispersed oil is more available to biodegradation by naturally occurring bacteria, but it is also available to smaller animals and filter filters such as corals. With adequate planning and coordination with NOAA, dispersant may be safely used near coral reefs as long as subsurface currents are known to carry dispersed oil away from the reef.

While there could be adverse effects to corals should they come into contact with oil, we do not believe there will be adverse impacts to listed corals from oil spills because the likelihood of that contact is extremely low. There have not been any documented impacts to listed corals in the FGBNMS from oil. The distance of the reefs from shore do not risk exposing coral to surface oil, or oil mixed in the upper water column by wind and wave action. The likelihood of listed coral spawning events for such a small number of corals happening at the same time and place that a large spill would occur is so low as to be extremely unlikely. Exposure of the FGBNMS reefs to submerged or dispersed oil is possible under the right conditions, but it has never been documented and is expected to be an extremely unlikely event. Therefore, the effects of oil on listed species of coral in the action area are expected to be discountable. Since the listed corals are located in the FGBNMS, it is anticipated that NOAA will coordinate with a responsible party to take preventative measures to avoid impacts to coral resources in the National Marine

Sanctuary from oil-spill response activities. Section 304(d) of the National Marine Sanctuaries Act requires interagency consultation between NOAA and federal agencies taking actions, including authorization of private activities, "likely to destroy, cause the loss of, or injure a sanctuary resource." Therefore, we conclude that listed corals are not likely to be adversely affected by oil spills that result from the proposed action.

6.2 Status of Species and Critical Habitat Analyzed Further

This section identifies the ESA-listed and proposed species and designated critical habitat that occur within the action area that may be adversely affected by the proposed action (Table 26). It then summarizes the biology, ecology, and life histories of those species in the action area if known. The designated critical habitat that occurs with in the action area and that may be affected by the proposed action is identified in Table 27.

Table 26: Endangered Species Act-listed species that may be adversely affected by the proposed action.

Species	ESA Status	Recovery Plan
Marine Mammals – Cetaceans		
Gulf of Mexico Bryde's Whale (*Balaenoptera edeni*)	E – 84 FR 15446	-- --
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	75 FR 81584
Marine Reptiles		
Green Turtle (*Chelonia mydas*) – North Atlantic DPS and South Atlantic DPS	T – 81 FR 20057	10/1991
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 28359 and 57 FR 38818
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	9/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	63 FR 28359 and 10/1991
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	74 FR 2995
Fishes and Elasmobranchs		
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)	T – 56 FR 49653	09/1995
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 FR 4153	-- --
Giant Manta Ray (*Manta birostris*)	T – 83 FR 2916	-- --

Table 27. Endangered Species Act designated critical habitat that may be adversely affected by the proposed action.

Designated Critical Habitat	Federal Register Notice	Unit
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS Critical Habitat	79 FR 39856	LOGG-N-31 to LOGG-N-36 and LOGG-S-02
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)	68 FR 13370	Units 8-14

During consultation we reviewed the status of each species that is likely to be adversely affected by the proposed action. The status is determined based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR §402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the Federal Register, status reviews, recovery plans, and on NMFS' Web site: http://www.nmfs.noaa.gov/pr/species/esa/listed.htm.

This section also examines the condition of critical habitat throughout the designated area (such as various watersheds and coastal and marine environments that make up the designated area), and discusses the condition and current function of designated critical habitat, including the essential physical and biological features that contribute to that conservation value of the critical habitat.

Gulf of Mexico Bryde's whales, sperm whales, green sea turtles (North and South Atlantic DPSs), Kemp's ridley sea turtles, hawksbill sea turtles, leatherback sea turtles, loggerhead sea turtles (Northwest Atlantic Ocean DPS), Gulf sturgeon, giant manta ray and oceanic whitetip shark are all likely to be adversely affected by the proposed action. The sea turtles species and sperm whales use Gulf waters extensively, while Bryde's whales mainly inhabit the northeastern Gulf, although it is possible that they were historically more widespread and there are anecdotal sightings of Bryde's whales outside of this area. These species will be exposed to a variety of stressors from oil and gas operations. While many specific oil and gas activities are not likely to adversely affect these species, several activities present stressors that may lead to harassment, injury, or death. These stressors include vessels strikes, ingestion of or entanglement in marine debris, impacts from sound and explosives, and oil spills. Gulf sturgeon use nearshore coastal waters in the Gulf of Mexico and could be affected by oil spills stemming from the proposed action. Similarly, the giant manta ray and oceanic whitetip shark considered in this opinion mainly inhabit waters outside of where oil and gas activities would occur (as described below in the status section), but could be affected by oil spills depending on the location and size of the spill and environmental conditions. In addition, designated critical habitat for Gulf sturgeon and loggerhead sea turtles may be adversely affected by the proposed action.

Below we describe the status of the species and designated critical habitat that are likely to be adversely affected by the proposed action.

6.2.1 Whales

6.2.1.1 Threats to Whales in the Gulf of Mexico

Large whales in the Gulf of Mexico considered in this opinion include sperm whale and Gulf of Mexico Bryde's whale. Both species are threatened by vessel strikes, entanglement, oil spills, pollution, loss of prey and habitat, and sound. In this section we will discuss general threats and in sections 6.2.2 and 6.2.3 below, we discuss species-specific threats.

Vessel strike

Various types and sizes of vessels have been involved in ship strikes with large whales, including container/cargo ships/freighters, tankers, steamships, military vessels, cruise ships, ferries, recreational vessels, research vessels, fishing vessels, whale-watching vessels, and other vessels (Jensen and Silber 2004a). The majority of vessel strikes of large whales occur when vessels are traveling at speeds greater than approximately ten knots, with faster vessels, especially of large vessels (80 m or greater), being more likely to cause serious injury or death (Conn and Silber 2013b; Jensen and Silber 2004b; Laist et al. 2001; Vanderlaan and Taggart 2007a). Injury is generally caused by the rotating propeller blades, but blunt injury from direct impact with the hull also occurs. Injuries to whales killed by vessel strikes include huge slashes, cuts, broken vertebrae, decapitation, and animals cut in half (Carillo and Ritter 2010).

Entanglement

Entanglement in fishing gear or other marine debris represents an important source of injury and mortality in marine mammals. Fisheries interactions are likely to have significant demographic effects on many populations of marine mammals (Read et al. 2006). Bycatch mortality is estimated globally to exceed hundreds of thousands of marine mammals each year (Read et al. 2006). Many marine mammals that die from entanglement in commercial fishing gear tend to sink rather than strand ashore, thus making it difficult to fully assess the magnitude of this threat. When not immediately fatal, entanglement or ingestion of fishing gear can impede the ability of marine mammals to feed and can cause injuries that eventually lead to infection and death (Cassoff et al. 2011; Moore and Van der Hoop 2012; Wells et al. 2008). Other sublethal effects of entanglement include increased vulnerability to additional threats, such as predation and ship strikes, by restricting agility and swimming speed. There are also costs likely to be associated with nonlethal entanglements in terms of energy and stress (Moore and Van der Hoop 2012). There is a strong spatial component to bycatch of marine mammals, with ‘hotspots’ influenced by marine mammal density and fishing intensity (Lewison et al. 2014).

Pollution

Pollution from noise and oil spills are threats to whales in the Gulf of Mexico. The Gulf of Mexico has an established fisheries industry, commercial shipping as well as oil and gas development and production. The DWH oil spill affected many species of cetaceans including the sperm whale and Gulf of Mexico Bryde’s whale populations. Sound from constant, chronic sources such as vessel traffic and other construction noises can mask sound of whales trying to communicate, navigate, reproduce, or feed. These topics are also discussed in Sections 8.5 through 8.8.

6.2.2 Sperm Whales

Sperm whales were first listed under the precursor to the ESA, the Endangered Species Conservation Act of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973. The sperm whale is endangered as a result of past commercial whaling. The IWC estimates that nearly 250,000 sperm whales were killed worldwide in whaling activities between 1800 and 1900. From 1910 to 1982, nearly 700,000 sperm whales were killed worldwide by whaling activities (IWC Statistics 1959 to 1983). A compilation of all whaling catches in the North Atlantic north of 20ºN from 1905 onward gave totals of 28,728 males and 9,507 females (NMFS 2010a). Sperm whales are also protected under the MMPA and listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), meaning that commercial trade in products of sperm whales is prohibited.

6.2.2.1 Species Description and Distribution

The sperm whale occurs in all oceans of the world. Sperm whales are perhaps the most widely distributed mammal on earth. It is the largest of the toothed whales, reaching a length of 60 feet (18.3 meters) in males and 40 feet (12.2 meters) in females (Odell 1992). Sperm whales are distributed throughout most oceanic areas, but are found in deeper waters seaward of the continental shelf. Deep water is required so they can make prolonged, deep dives to locate prey, breed, and nurse their young. In general, females and immature sperm whales appear to be restricted in range, whereas males are found over a wider range and do make occasional movements across and between ocean basins (Dufault et al. 1999). Stable, long-term associations among related and unrelated females form the core units of sperm whale societies (Christal and Whitehead 1998). Females and juveniles form groups that are generally distributed within tropical and temperate latitudes between 50°N and 50°S, while the solitary adult males can be found at higher latitudes between 75ºN and 75ºS (Reeves and Whitehead 1997). The home ranges of individual females seem to span distances of approximately 1,000 kilometers (Best 1979; Dufault and Whitehead 1995). Although there is strong evidence for geographic, matrilineal structuring in sperm whales, there is no evidence the management stocks presented in the following paragraph represent distinct populations of whales.

The Recovery Plan (NMFS 2010a) identifies recovery criteria geographically across three ocean basins: the Atlantic Ocean/Mediterranean Sea, the Pacific Ocean, and the Indian Ocean. This geographic division by basin is due to the wide distribution of sperm whales and presumably little movement of whales between ocean basins. For management purposes under the MMPA, sperm whales inhabiting U.S. waters have been divided into five stocks: (1) the California-Oregon-Washington Stock, (2) the North Pacific (Alaska) Stock, (3) the Hawaii Stock, 4) the Northern Gulf of Mexico Stock, and (5) the North Atlantic Stock. In the Gulf of Mexico, sperm whales are the most common large cetacean seaward of the continental shelf (Davis et al. 1998; Jefferson and Schiro 1997; Mullin et al. 1991; Mullin and Fulling 2004; Mullin et al. 1994; Weller et al. 2000; Wursig et al. 2000). Sperm whales in the Gulf of Mexico are not evenly distributed, showing greater densities in areas associated with oceanic features that provide the best foraging opportunities (Figure 21).

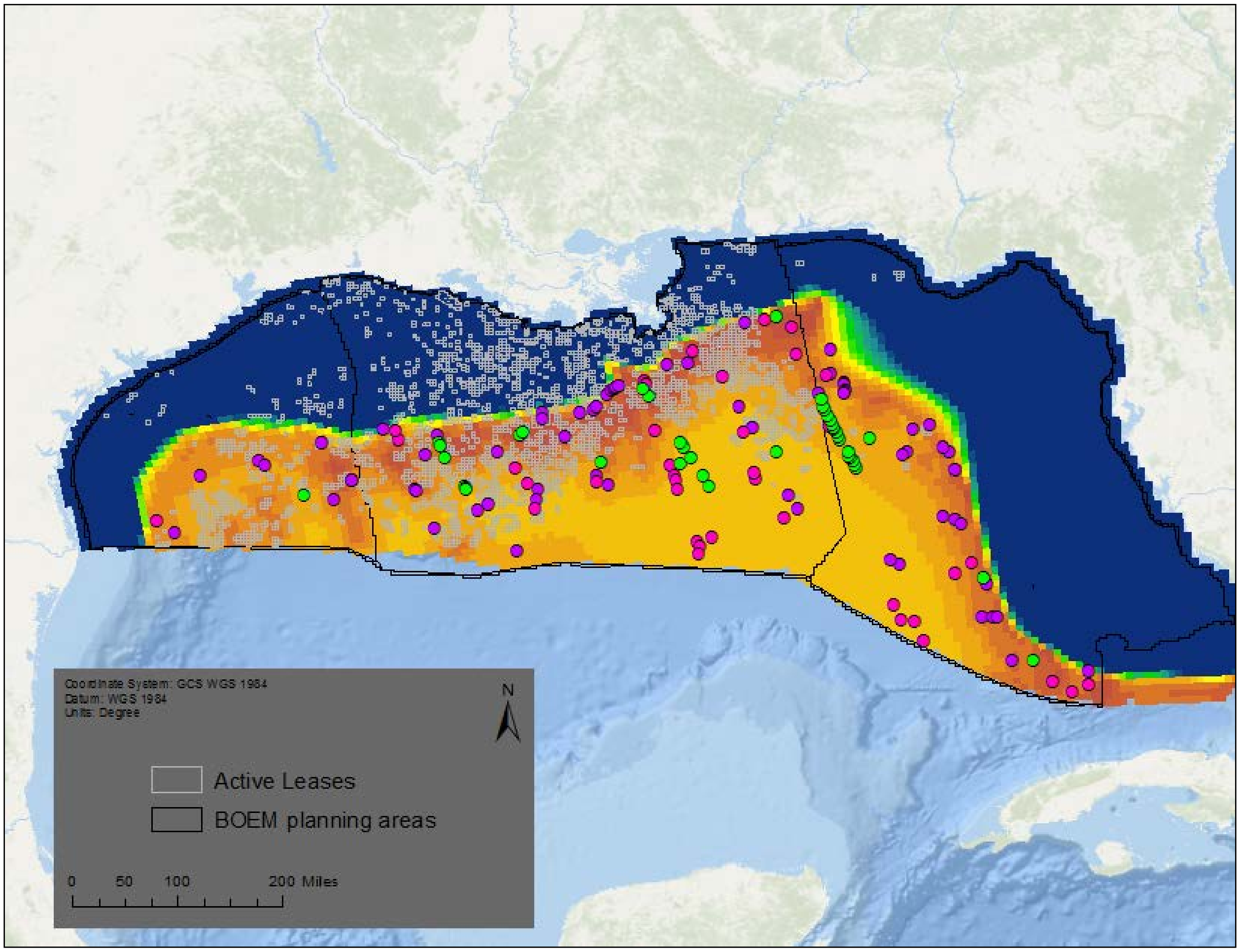

Figure 21. Sperm whale sightings (circles with different colors representing different season trips) overlaying Roberts et al. (2016b) mean abundance in the Gulf of Mexico (2003-2004 Southeast Fisheries Science Center Survey Data).

6.2.2.2 Life History Information

The social organization of sperm whales, as with most other mammals, is characterized by females remaining in the geographic area in which they were born and males dispersing more broadly. Females group together and raise young. For female sperm whales, remaining in the region of birth can include very large oceanic ranges the whales need to successfully forage and nurse young whales. Male sperm whales are mostly solitary and disperse more widely and can mate with multiple female populations throughout a lifetime.

Female and immature sperm whales of both sexes are found in more temperate and tropical waters throughout the year. Maturing males will leave the female groups and form loose aggregations of bachelor schools. As the males grow older, they separate from the bachelor schools and remain solitary most of the year (Best 1979). Adult males visit female groups of whales only to breed. Large males have been sighted on occasion and are believed to enter the Gulf of Mexico for short periods to breed. Therefore, the Gulf of Mexico population is comprised of the year-round presence of females, calves, and juvenile whales. The proportion of females to males in the Gulf of Mexico is 72:28 (Engelhaupt et al. 2009). Calves make up about 11 percent of the population in the Gulf of Mexico (Jochens et al. 2008).

Female sperm whales attain sexual maturity at a mean age of eight or nine years. Mature females ovulate April through August in the Northern Hemisphere. Maturation in males usually begins in this same age interval as females, but males have a prolonged puberty and attain sexual maturity at between age 12 and 20. Males may require another 10 years to become large enough to successfully compete for breeding rights (Kasuya 1991). During this season of ovulating females, one or more large mature bulls temporarily join each breeding school. In the North Atlantic Ocean, the peak breeding season for sperm whales occurs during the spring (March/April to June), although some mating activity continues throughout the summer (NMFS 2015c). In the South Atlantic Ocean, the peak breeding season is presumed to occur in the austral spring. During mating seasons, mature males in their late twenties and older rove among groups of females. Because females within a group often become reproductively active at the same time, the male need not remain with them for an entire season to achieve maximal breeding success (Best and Butterworth 1980) and their association with a female group can be as brief as several hours. Gestation lasts well over a year, with credible estimates of the normal duration ranging from 15 months to over 18 months. A single calf is born at a length of about 13 feet (four meters). Female sperm whales rarely become pregnant after the age of 40 (Whitehead and Mesnick 2003). It is thought that females assist each other in the care of offspring, guarding of young at the surface while mothers dive (Whitehead 1996). Females even have been observed nursing calves other than their own (Reeves and Whitehead 1997). Calves are nursed for two to three years (in some cases, up to 13 years), and the calving interval is estimated to be about four to seven years (Kasuya 1991).

The age distribution of the sperm whale population is unknown, but they are believed to live at least 60 years (Rice 1989). Potential sources of natural mortality in sperm whales include killer whale predation and disease (Lambertsen 1997; Whitt et al. 2015). Sperm whales may also be “harassed” by pilot whales (*Globicephala spp*.) and false killer whales (*Pseudorca crassidens*), but most “attacks” by these species are probably unsuccessful (Palacios and Mate 1996; Weller et al. 1996). Very little is known about the role of disease in the natural mortality of sperm whales (Lambertsen 1997). Several naturally occurring diseases that are likely to be lethal have been identified in sperm whales: myocardial infarction associated with coronary atherosclerosis, gastric ulceration associated with parasitic nematode infection**,** the papilloma virus, (Lambertsen 1997) and *Brucella* and *Morbillivirus* (West et al. 2015). There were 37 individual sperm whale strandings reported in the Gulf of Mexico from 2000-2016 in Texas, Louisiana, Alabama and Florida (NOAA National Marine Mammal Health and Stranding Response Database unpublished data). At least seven of those reported were calves. Using data from 2003-2007, Williams *et al.* (2011) suggested that the rate of recovery of sperm whale carcasses in the Gulf of Mexico was 3.4 percent.

Cephalopods (i.e., squid, octopi, cuttlefishes, and nautili) are the main component of sperm whale diets. The ommastrephids, onychoteuthids, cranchids, and enoploteuthids are the cephalopod families that are numerically important in the diet of sperm whales in the Gulf of Mexico (Davis et al. 2002). Other populations, especially mature males in higher latitudes, are known to feed on significant quantities of large demersal and mesopelagic sharks, skates, and bony fishes (Clarke 1962; Clarke 1979). Sperm whales consume about 3.0 to 3.5 percent of their body weight per day (Lockyer 1981). Sperm whales undergo deep foraging dives to find prey, spending approximately 75percent of their day in the foraging dive cycle (Watwood et al. 2006). Descent rates are approximately 1.7 meters per second and nearly vertical (Goold and Jones 1995). Dive depth may be dependent upon temporal variations in prey location in the water column. Typical foraging dives last 40 minutes to depths of about 1,300 feet (400 meters), followed by approximately eight minutes of resting at the surface (Gordon 1987; Papastavrou et al. 1989). Nonetheless, dives of over two hours and deeper than 3.3 kilometers (2 miles) have been recorded (Clarke 1976); individuals may spend extended periods of time at the surface to recover.

The highly asymmetrical, disproportionately large head of the sperm whale is an adaptation to produce acoustic signals (Cranford 1992; Norris et al. 1972). Recordings of sperm whale vocalizations reveal that they produce a variety of sounds, such as clicks, gunshots, chirps, creaks, short trumpets, pips, squeals, and clangs (Goold 1999). Sperm whales locate prey by echolocation clicks while in a deep dive pattern, and also produce vocalizations while resting at the surface. The function of vocalizations is relatively well-studied (Goold and Jones 1995; Weilgart and Whitehead 1997). Long series of monotonous, regularly spaced clicks and closely spaced clicks are produced for echolocation and are associated with feeding and prey capture (Goold and Jones 1995; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). However, clicks are also used in short patterns (codas) during social behavior and intragroup interactions (Gero et al. 2015; Gero et al. 2016; Weilgart and Whitehead 1993). Sperm whales show regional differences in coda patterns (Gero et al. 2016; Weilgart and Whitehead 1997). Clicks may also aid in intra-specific communication. Clicks are heard most frequently when sperm whales are engaged in diving and foraging behavior (Miller et al. 2004; Whitehead and Weilgart 1991). Creaks (rapid sets of clicks) are heard most frequently when sperm whales are foraging and engaged in the deepest portion of their dives, with inter-click intervals and source levels being altered during these behaviors (Laplanche et al. 2005; Miller et al. 2004). When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals in a social unit and are considered to be primarily for intragroup communication (Rendell and Whitehead 2004; Weilgart and Whitehead 1997). Recent research in the South Pacific Ocean suggests that in breeding areas the majority of codas are produced by mature females (Marcoux et al. 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects, similar to those of killer whales (Pavan et al. 2000; Weilgart and Whitehead 1997). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean Sea and those in the Pacific Ocean (Weilgart and Whitehead 1997). Three coda types used by male sperm whales have recently been described from data collected over multiple years: these codas associated with dive cycles, socializing, and alarm (Frantzis and Alexiadou 2008).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measures of sperm whale hearing were conducted on a stranded neonate using the auditory brainstem response technique: the whale showed responses to pulses ranging from 2.5 to 60 kHz and highest sensitivity to frequencies between five to 20 kHz (Ridgway and Carder 2001). Other hearing information consists of indirect data. For example, the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high-frequency to ultrasonic hearing (Ketten 1992). The sperm whale may also possess better low-frequency than other odontocetes, although not as low as many baleen whales (Ketten 1992). Reactions to anthropogenic sounds can provide indirect evidence of hearing capability, and several studies have made note of changes seen in sperm whale behavior in conjunction with these sounds. For example, sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echo sounders and submarine sonar (Watkins et al. 1985; Watkins and Schevill 1975). In the Caribbean, Watkins et al. (1985) observed that sperm whales exposed to 3.25 to 8.4 kHz pulses (presumed to be from submarine sonar) interrupted their activities and left the area. Similar reactions were observed from artificial sound generated by banging on a boat hull (Watkins et al. 1985). André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signals did not ultimately exhibit any general avoidance reactions: when resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al. 1997). Thode et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel's propeller (110 dB re: 1 μPa^2 between 250 Hz and 1 kHz) interrupted sperm whale acoustic activity and resulted in the animals converging on the vessel.

A sperm whale was tagged for a controlled exposure experiment during a behavioral response study in southern California and did not appear to demonstrate obvious behavioral changes in dive pattern or production of clicks (Miller et al. 2012; Sivle et al. 2012; Southall et al. 2011).

Clicks produced by sperm whales (and presumably heard by them) are in the range of about 0.1 to 20 kHz (Goold and Jones 1995; Watkins 1977; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997), up to 30 kHz, often with most of the energy in the two to four kHz range (Watkins 1980). Clicks have source levels estimated at 171 dB re: 1 μPa (Levenson 1974). The clicks of neonate sperm whales are very different from typical clicks of adults in that they are of low directionality, long duration, and low frequency (between 300 Hz and 1.7 kHz) with estimated source levels between 140 to 162 dB re: 1 μPa at 1 m (rms) (Madsen et al. 2003).

Sound production and reception by sperm whales are better understood than in most cetaceans. Sperm whales produce broadband clicks in the frequency range of 100 Hz to 20 kHz that can be extremely loud for a biological source (200 to 236 dB re: 1 μPa at 1 m [rms]), although lower source level energy has been suggested at around 171 dB re: 1 μPa at 1 m (rms) (Goold and

Jones 1995; Møhl et al. 2003; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). Another class of sound, "squeals," are produced with frequencies of 100 Hz to 20 kHz (e.g., Weir et al. 2007).

6.2.2.3 Status and Population Dynamics

The best estimate of the current worldwide abundance of sperm whale is estimated to be between 300,000 and 450,000 individuals (Whitehead 2002). The abundance of sperm whales in the Atlantic Ocean is estimated at 90,000 to 134,000 individuals and 763 resident whales in the northern Gulf of Mexico, according to the latest stock assessment report (NMFS 2015c). Roberts et al. (2016a) used a habitat-based distribution model and estimated 2,128 sperm whales in the Gulf of Mexico. On a global scale, no genetic differences have been found in the nuclear DNA (nDNA) (bi-parentally inherited) between individuals sampled in different ocean basins with some differences found in mitochondrial DNA (mtDNA) (maternally-inherited) sequences (Lyrholm et al. 1999). In general, results tend to find low genetic differentiation of nDNA among sperm whales in different ocean basins and little differentiation of mtDNA within ocean basin stocks, with the exception of some semi-enclosed basins such as the Mediterranean Sea and Gulf of Mexico (Bond 1999; Engelhaupt 2004; Lyrholm and Gyllensten 1998; Lyrholm et al. 1999; Mesnick et al. 1999; Richard et al. 1996). Based on over 2,473 tissue samples and 1,038 mtDNA sequences from a global consortium of investigators, 28 haplotypes have been identified worldwide, defined by 24 variable sites (Mesnick et al. 2005). Three common haplotypes dominated the sequencing and made up 82 percent of the total. This dominance by a few haplotypes indicates broad reproductive mixing of genetic material. Mitochondrial DNA evidence in the Gulf of Mexico suggests population structuring based on genetic material inherited from mothers. Regional structuring is also supported by satellite tracking data suggesting that most females establish home ranges within the Gulf of Mexico basin, and their site fidelity has resulted in maternally related groups of females and young whales in this region.

6.2.2.4 Threats

Continued threats to sperm whale populations include vessel strikes, entanglement in fishing gear, competition for resources due to overfishing, pollution, loss of prey and habitat, and sound. NMFS' Recovery Plan for Sperm Whales (NMFS 2010b) identified four main categories of threats to the recovery of sperm whales in the Atlantic Ocean: (1) vessel interactions, (2) incidental capture in fishing gear, (3) habitat degradation, and (4) military operations. Loss of habitat can occur from multiple stressors including climate change, contaminant pollution and sound (Waring et al. 2016). Sound threats can include seismic surveys or propeller cavitation from large vessels, and this is heightened in areas of oil and gas activities or where shipping activity is high.

Vessels affect sperm whales via collisions and vessel sound. Sperm whales have been recorded spending periods of up to ten minutes "rafting" at the surface between deep dives (Watwood et al. 2006). This could make them exceptionally vulnerable to ship strikes. Studies on the behavior of sperm whales around whale watching boats suggest sperm whales change their diving and acoustic behavior in response to boats, but following frequent exposure, they become increasingly tolerant or habituated to the presence of vessels (Gordon et al. 1992; Markowitz et al. 2011).

Incidental entrapment and entanglement in fishing gear, especially gillnets set in deep water for pelagic fish (e.g., sharks, billfish, tuna), is of potential concern. In U.S. East coast waters, two incidents involving sperm whales were reported between 1990 and 1995, both on Georges Bank. In 1990, a whale was found entangled and was released in "injured" condition. In 1995, another was found, also injured, and released while still carrying gear (Waring et al. 1997). Based on observer data, mortality of sperm whales from the drift gillnet fishery between 1989 and 1995 ranged from zero to 4.4 (CV 1.77) per year (Waring et al. 1997). A single nonlethal interaction between sperm whales and the longline fishery has been recorded in the Gulf of Mexico. A stranded sperm whale has been documented with signs of human interaction (NOAA National Marine Mammal Health and Stranding database unpublished data 2002-2012).

The accumulation of stable pollutants (e.g. heavy metals, polycholorobiphenyls [PCBs], chlorinated pesticides [DDT, DDE, etc.], and polycyclic aromatic hydrocarbons [PAHs]) is of concern for sperm whales. The potential impact of coastal pollution may be an issue for this species in portions of its habitat, though little is known regarding the effect pollutants may have on individuals. Because sperm whales feed at high trophic levels and store the chemicals in their blubber, they are susceptible to chemical pollution. Sperm whales could potentially pass these chemicals to their offspring in their milk (Whitehead 2003). A population sensitivity analysis for the Gulf of Mexico sperm whales showed that if toxins, such as those found in oil spills, reduce the survivorship rate of the mature female sperm whales by as little as 2.2 percent, or the survivorship rate of mothers by 4.8 percent, the growth rate of the population would drop to a level that would result in a decline in the size of that population (Chiquet et al. 2013). The DWH oil spill and response impacted the Gulf of Mexico sperm whale population. The effects on sperm whales are described in greater detail in Section 8.8.1.1, as well as in the Final PDARP (found at http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan). Oil spills and response activities continue to threaten sperm whales.

Marine debris may be ingested by sperm whales as is the case with many marine animals. Debris entrained in the deep scattering layer where sperm whales feed could be mistaken for prey and incidentally ingested. Man-made sound and offshore energy development may also be adversely affecting habitat quality. Because of their apparent role as important predators of mesopelagic squid and fish, changing the abundance of sperm whales should affect the distribution and abundance of other marine species. Conversely, changes in the abundance of mesopelagic squid and fish from recently developed targeted fisheries could affect the distribution of sperm whales.

Sperm whales are potentially affected by military operations in a number of ways. Whales can be struck by vessels and disturbed by sonar and other anthropogenic sounds. Sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins 1985; Watkins and Schevill 1975). They also stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995).

6.2.3 Gulf of Mexico Bryde's Whales

The subspecies of Bryde's whales in the Gulf of Mexico are genetically distinct from other Bryde's whales worldwide (including the subspecies of *B. e. edeni* and *B. e. brydei*). Gulf of Mexico Bryde's whales were listed as endangered under the ESA on April 15, 2019.

6.2.3.1 Species Description and Distribution

Bryde's whales are found in tropical and subtropical waters worldwide and the smaller species are typically found in coastal and continental shelf waters. The Gulf of Mexico subspecies of Bryde's whale is the only known baleen whale to inhabit the Gulf of Mexico year-round. These whales are consistently found in the northeastern Gulf of Mexico in the De Soto Canyon area between the 100 meter and 300 meter depth contours (Figure 22). Consequently, LaBrecque et al. (2015) designated this area as a Biologically Important Area (BIA). There have also been sightings at at deeper depths in this region and west of Pensacola, Florida; for this reason, the area predominantly inhabited by the species is probably better described out to the 400 meter depth contour and to Mobile Bay, Alabama, to provide some buffer around the deeper water sightings and to include all sighting locations in the northeastern Gulf of Mexico, respectively (Rosel 2016). Whaling records indicate the historical distribution of Bryde's whales in the Gulf of Mexico was much broader than it is currently and included the north-central and southern Gulf of Mexico.

The current area where Gulf of Mexico Bryde's whales are expected to be found and their density based on best available information is shown in Figure 23. There have been sightings of unidentified baleen whales outside the eastern Gulf, and there have also been a couple of rare confirmed sightings of Bryde's whales outside that area, such as in the central and western Gulf, one of which was observed off the coast of Texas during the 2018 GoMAPPS survey effort (https://www.boem.gov/GOMMAPPS/; pers. Comm. L. Garrison, April 9, 2019).

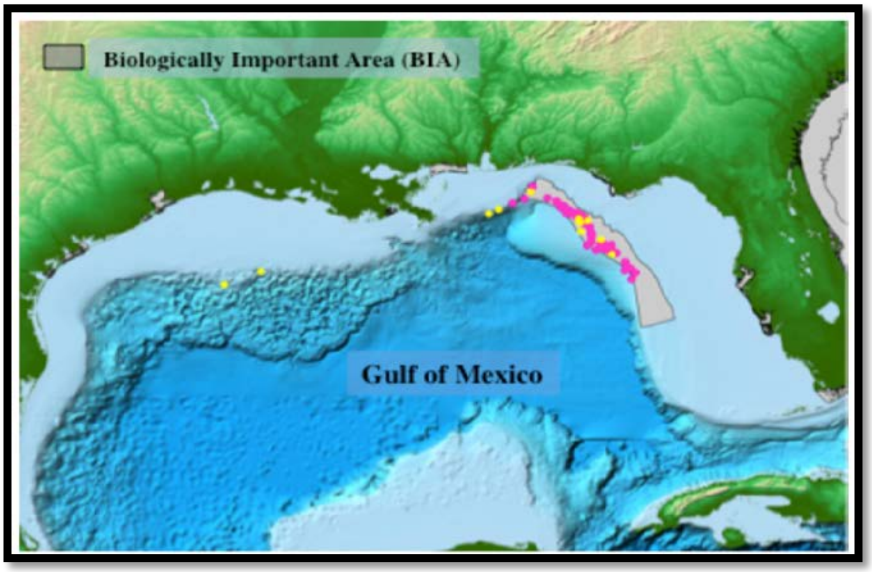

Figure 22. Sightings of Bryde's whales (pink) and unidentified balaenopterid whales (yellow) during NMFS shipboard and aerial surveys between 1989 and 2015 in the northern Gulf of Mexico, with respect to the Biologically Important BIA (LaBrecque et al. 2015; Rosel 2016).

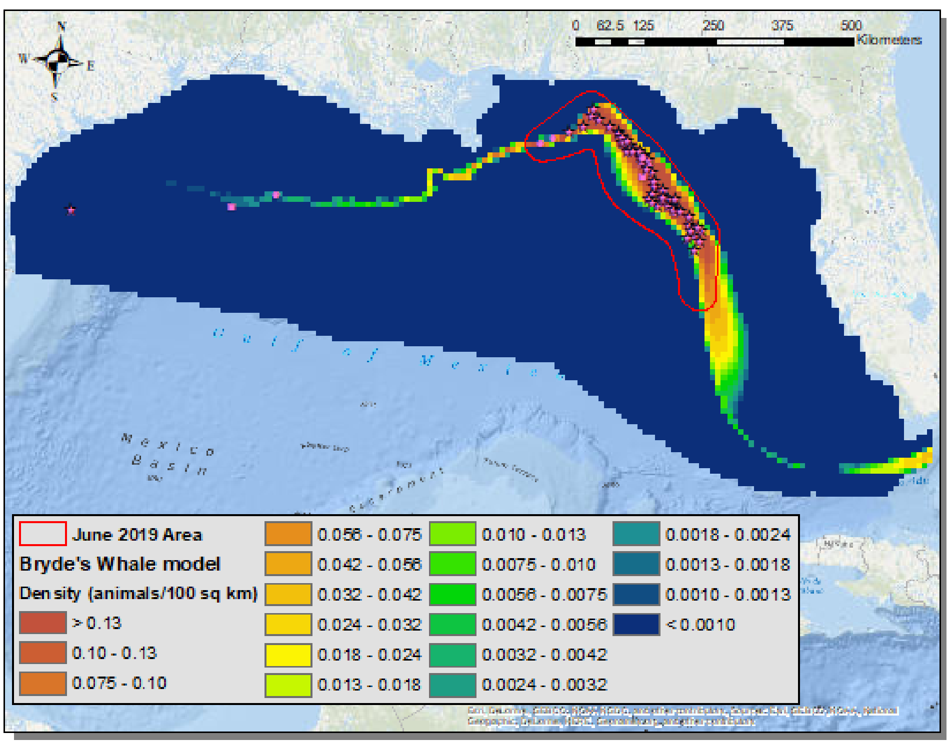

Figure 23. 2019 Area Defined by the Southeast Fisheries Science Center for where the Gulf of Mexico Bryde's whale are expected (red polygon), which accounts for daily migration patterns and 10 km strip width of visual surveys, and with sightings (pink spots) overlaying Bryde's whale habitat-based density models for the Gulf of Mexico (Roberts et al. 2016a).

Bryde's whales are baleen whales that typically grow to lengths of 40 to 55 feet (13 to 16.5 meters). The species has a large, falcate dorsal fin, a streamlined body shape, and a pointed, flat rostrum. There are three ridges on the dorsal surface of the rostrum that distinguish it from other similar-looking species, such as the sei whale (Rosel 2016). Bryde's whales have a counter-shaded color that is fairly uniformly-dark dorsally and light to pinkish ventrally.

Information available from the status review (Rosel 2016), the proposed listing, and available literature were used to summarize the life history, population dynamics, and status of the species as follows.

6.2.3.2 Life History Information

Little is known about the Gulf of Mexico Bryde's whale subspecies' life history compared to Bryde's whales more generally and worldwide. The life expectancy of Bryde's whales is unknown. Other stocks of this species have a gestation period of 11 to 12 months, and give birth to a single calf, which is nursed for six to 12 months. Age of sexual maturity is not known for Gulf of Mexico Bryde's whales specifically, but Bryde's whales are thought to be sexually mature at eight to 13 years. Peak breeding and calving probably occurs in the fall. Females breed every second year. Bryde's whales exhibit a typical diel dive pattern, with deep dives in the daytime, and shallow dives at night. Bryde's whales generally feed on schooling fishes (e.g., anchovy, sardine, mackerel, and herring) and small crustaceans (Rosel 2016).

Bryde's whales, unlike other baleen whales, are not known to make long foraging migrations (Figueiredo et al. 2014). The Gulf of Mexico subspecies is a year-round resident of the Gulf of Mexico. Bryde's whales are known to dive to over 200 meters depth to feed on small fish or crustaceans and their occurrence is thought to be determined by prey abundance (Kerosky et al. 2012). They are observed in small groups, pairs or solitary and reportedly seem curious about ships (Lodi et al. 2015; Rosel 2016; Tershy 1992).

According to Rice (1998), adult *B. e. edeni* rarely exceed 37 feet (11.5 meters) total length and adult *B. e. brydei* reach approximately 46 to 49 feet (14 to15 meters). Rosel and Wilcox (2014) summarized body length information in the Gulf of Mexico from strandings and concluded that they may have a size range intermediate to the currently recognized subspecies. This is similar to Bryde's whales off the coast of South Africa where inshore males are estimated to attain maturity at 40 to 41 feet (12.2 to 12.5 meters) compared to 42 to 45 ft (12.8 to 13.7 meters) for offshore males, while inshore females reach sexual maturity at 39 to 41 feet (11.9 to 12.5 meters) compared to 42 to 43 feet (12.8 to 13.1 meters) for offshore females (Best 2001).

Bryde's whales produce low-frequency tonal and broadband calls for communication, navigation, and reproduction (Richardson et al. 1995b). Like other balaenopterids, Bryde's whales have distinctive calls depending on geographic regions that may be useful for delineating subspecies or populations (Figueiredo 2014; Rosel 2016; Širović et al. 2014). Based on data presented in Širović et al. (2014) and Rice et al. (2014), the calls by the Gulf of Mexico Bryde's whale are consistent with, but different from those previously reported for Bryde's whales worldwide. These unique acoustic signatures support the genetic analyses identifying the Gulf of Mexico Bryde's whale as an evolutionary distinct unit (Rosel and Wilcox 2014). While no data exist on the hearing abilities of Bryde’s whale, as with other marine mammals we assume they hear best in the frequency range in which they produce calls.

6.2.3.3 Status and Population Dynamics

The Gulf of Mexico Bryde’s whale population is very small; the most recent estimate from 2009 places the population size at 33 individuals (Waring 2016). A second habitat-based density estimate by Roberts et al. (2016a) that incorporated visual survey data from 1992 to 2009 estimated 44 individuals (Rosel 2016). Given the best available scientific information and allowing for the uncertainty of Bryde's whale occurrence in non-U.S. waters of the Gulf of Mexico, most likely less than 100 individuals exist (Rosel 2016). There is no population trend information available for the Gulf of Mexico Bryde’s whale.

Genetic diversity within the Gulf of Mexico Bryde’s whale population is very low. Genetic analysis of Bryde’s whale samples from the Gulf of Mexico found only two mitochondrial DNA control region haplotypes in the first 375 base pairs of the control region (compared to five haplotypes for North Atlantic right whales and 51 in fin whales across the same control region sequence) (Rosel and Wilcox 2014). Examination of 42 nuclear microsatellite loci found that 25 (60 percent) were monomorphic, meaning no genetic variability was seen for the 21 Gulf of Mexico Bryde’s whales sampled (Rosel 2016).

Phylogenetic reconstruction using the control region and all published Bryde’s whale sequences reveal that the Gulf of Mexico Bryde’s whale’s haplotypes are evolutionarily distinct from the other two recognized subspecies of Bryde’s whale as the two subspecies are from each other. In addition, the Gulf of Mexico Bryde’s whale is more genetically differentiated from the two recognized subspecies than is the sei whale, which is an entirely different species (Rosel and Wilcox 2014).

6.2.3.4 Threats

Historically, some commercial whaling targeted sperm whales in the Gulf of Mexico. Bryde’s whales were not specifically targeted by whalers, but “finback whales” caught between the mid-1700s and late 1800s were likely Bryde’s whales (Reeves et al. 2011). Since then, there has not been whaling for sperm whales in the Gulf of Mexico. Sound from shipping traffic and seismic surveys in the region can impact Gulf of Mexico Bryde’s whales’ ability to communicate. Vessel traffic from commercial shipping and the oil and gas industry poses a risk of vessel strike for Gulf of Mexico Bryde’s whales. Of the six reported Bryde’s whale strandings on the Gulf Coasts of Louisiana and Florida since 2005, at least one was attributed to blunt force trauma by ship strike (NOAA National Marine Mammal Health and Stranding Response Database unpublished data). Further, carcass-recovery rates are low for cetaceans in the Gulf of Mexico (Williams et al. 2011). Entanglement from fishing gear is also a threat, and several fisheries operate within the range of the species. The DWH oil spill and response heavily impacted the Gulf of Mexico Bryde's whale population (Trustees 2016). Oil spills and response to spills continue to be a serious threat. Because the Gulf of Mexico Bryde's whale population is small and has low levels of genetic diversity, it is highly susceptible to further perturbations.

The Bryde's whale status review identified 27 possible threats to Gulf of Mexico Bryde's whales, with the following four being the most significant: (1) sound, (2) vessel collisions; (3) energy exploration; (4) oil spills and oil spill response.

1. Sound from shipping traffic and oil and gas exploration and development activities are of particular concern since they produce a large amount of low frequency sound (less than 100 Hz) that falls within the hearing range of the species. Similar to other baleen whales, it is likely that Gulf of Mexico Bryde's whales rely on their hearing to perform critical life functions (i.e., communication, navigation, mate finding, food location, predator avoidance, etc.).
2. The northern Gulf of Mexico is an area with considerably high amount of ship traffic, which increases the risk of vessel-whale collisions. Vessel traffic from commercial shipping lanes cuts through known Bryde's whale habitat. The Bryde's whales' dive behavior contributes to their risk of collision. Tracking information indicates they spend the majority of the night within 15 meters of the surface. The risk of vessel strike is significant, given the location of commercial shipping lanes, the difficulty of sighting a whale at the surface at night, and the low ability of large ships to change course quickly enough to avoid a whale.
3. The Gulf of Mexico is highly industrialized due to expansive energy exploration and production that requires drilling rigs, platforms, cables, pipelines, and ship support. Habitat in the north-central and western Gulf of Mexico, which includes the Gulf of Mexico Bryde's whale's historical range, has been significantly modified by the presence of thousands of oil and gas platforms. The GOMESA (2006) prohibits lease sales through June 30, 2022, in the EPA, which overlaps with the area where Bryde's whale are found. BOEM has not projected any new lease sales in the EPA in their projection of activities to be covered by this opinion. However, if new leases are offered after the GOMESA moratorium expires, Bryde's whales could be exposed to increased threats associated with energy exploration and development.
4. Exposure to spilled oil and dispersants used for oil spill response can result in lethal or sub-lethal effects to baleen whales. The DWH oil spill is an example of the significant impacts a spill can have on the Gulf of Mexico Bryde's whale. Although the DWH platform was not located within the BIA, the Bryde's whales were still significantly impacted by the spill, with an estimated 17 percent of the population killed, 22 percent of females exhibiting reproductive failure, and 18 percent of the population suffering adverse health effects (Trustees 2016).

6.2.4 Sea Turtles

6.2.4.1 Threats to Five Species of Sea Turtles

The five species of sea turtles that may be adversely affected by the proposed action (green, hawksbill, Kemp's ridley, leatherback, and loggerhead) travel widely throughout the South Atlantic, Gulf of Mexico and the Caribbean. These species are highly migratory and therefore could occur within the action area. This section will address threats to all species of sea turtles followed by information on the status and unique threats for each species.

Fisheries

Incidental bycatch in commercial fisheries is identified as a major contributor to past declines, and threat to future recovery, for all of the sea turtle species (NMFS and USFWS 1991b; NMFS and USFWS 1993; NMFS and USFWS 2008a; NMFS et al. 2011a; USFWS and NMFS 1992). Domestic fisheries often capture, injure, and kill sea turtles at various life stages. Sea turtles in the pelagic environment are exposed to U.S. Atlantic pelagic longline fisheries. Sea turtles in the benthic environment in waters off the coastal United States are exposed to a suite of other fisheries in federal and state waters. These fishing methods include trawls, gillnets, purse seines, hook-and-line gear (including bottom longlines and vertical lines [e.g., bandit gear, handlines, and rod-reel]), pound nets, and trap fisheries. Refer to the Environmental Baseline section of this opinion for more specific information regarding federal and state managed fisheries affecting sea turtles within the action area). The Southeast U.S. shrimp fisheries have historically been the largest fishery threat to benthic sea turtles in the southeastern United States, and continue to interact with and kill large numbers of sea turtles each year.

In addition to domestic fisheries, sea turtles are subject to direct as well as incidental capture in numerous foreign fisheries, further impeding the ability of sea turtles to survive and recover on a global scale. For example, oceanic-stage sea turtles, especially loggerheads and leatherbacks, that circumnavigate the Atlantic are susceptible to international longline fisheries including the Azorean, Spanish, and various other fleets (Aguilar et al. 1994; Bolten et al. 1994; Crouse 1999). Bottom longlines and gillnet fishing is known to occur in many foreign waters, including (but not limited to) the northwest Atlantic, western Mediterranean, South America, West Africa, Central America, and the Caribbean. Shrimp trawl fisheries are also occurring off the shores of numerous foreign countries and pose a significant threat to sea turtles similar to the impacts seen in U.S. waters. Many unreported takes or incomplete records by foreign fleets make it difficult to characterize the total impact that international fishing pressure is having on listed sea turtles. Nevertheless, international fisheries represent a continuing threat to sea turtle survival and recovery throughout their respective ranges.

Non-Fishery In-Water Activities

There are also many non-fishery impacts affecting the status of sea turtle species, both in the ocean and on land. In nearshore waters of the United States, the construction and maintenance of federal navigation channels has been identified as a source of sea turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly and can entrain and kill sea turtles (NMFS 1997). Sea turtles entering coastal or inshore areas have also been affected by entrainment in the cooling-water systems of electrical generating plants. Other nearshore threats include harassment and/or injury resulting from private and commercial vessel operations, military detonations and training exercises, in-water construction activities, and scientific research activities.

Vessel Strikes

Where there is overlap between vessel traffic and sea turtle habitat, there is threat of vessel strike to sea turtles. High levels of vessel traffic in nearshore areas along the U.S. Atlantic and Gulf of Mexico coasts result in frequent injury and mortality of sea turtles. From 1997 to 2005, nearly 15 percent of all stranded loggerheads in this region were documented as having sustained some type of propeller or collision injury, although it is not known what proportion of these injuries were sustained ante-mortem versus post mortem. According to Reneker et al. (2017), examination of stranded turtles from Mississippi in 2017 showed trauma, primarily from vessel strikes, to be the second largest factor for mortality. In one study from Virginia, Barco et al. (2016) found that all 15 dead loggerhead turtles encountered with signs of acute vessel interaction were apparently normal and healthy prior to human-induced mortality. The incidence of propeller wounds of stranded turtles from the U.S. Atlantic and Gulf of Mexico doubled from about ten percent in the late 1980s to about 20 percent in 2004. Singel et al. (2007) reported a tripling of boat strike injuries in Florida from the 1980’s to 2005. Over this time period, in Florida alone over 4,000 (~500 live; ~3500 dead) sea turtle strandings were documented with propeller wounds, which represents 30 percent of all sea turtle strandings for the state (Singel et al. 2007). These studies suggest that the threat of vessel strikes to sea turtles may be increasing over time as vessel traffic continues to increase in the southeastern U.S. and throughout the world.

Coastal Development and Erosion Control

Coastal development can deter or interfere with nesting, affect nesting success, and degrade nesting habitats for sea turtles. Structural impacts to nesting habitat include the construction of buildings and pilings, beach armoring and renourishment, and sand extraction (Bouchard et al. 1998; Lutcavage et al. 1997a). These factors may decrease the amount of nesting area available to females and change the natural behaviors of both adults and hatchlings, directly or indirectly, through loss of beach habitat or changing thermal profiles and increasing erosion, respectively (Ackerman 1997; Witherington et al. 2003; Witherington et al. 2007). In addition, coastal development is usually accompanied by artificial lighting which can alter the behavior of nesting adults (Witherington 1992) and is often fatal to emerging hatchlings that are drawn away from the water (Witherington and Bjorndal 1991). In-water erosion control structures such as breakwaters, groins, and jetties can impact nesting females and hatchling as they approach and leave the surf zone or head out to sea by creating physical blockage, concentrating predators, creating longshore currents, and disruption of wave patterns.

Environmental Contamination

Multiple municipal, industrial, and household sources, as well as atmospheric transport, introduce various pollutants such as pesticides, hydrocarbons, organochlorides (e.g., dichlorodiphenyltrichloroethane [DDT], PCBs, and perfluorinated chemicals [PFCs]), and others that may cause adverse health effects to sea turtles (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993). Acute exposure to hydrocarbons from petroleum products released into the environment via oil spills and other discharges may directly injure individuals through skin contact with oils (Geraci 1990), inhalation at the water's surface, and ingestion of compounds while feeding (Matkin and Saulitis 1997). Hydrocarbons also have the potential to impact prey populations, and therefore may affect listed species indirectly by reducing food availability in the action area. Oil spills and spill response activities continue to be a threat to sea turtle populations in the Gulf of Mexico.

Juvenile sea turtles include oceanic juveniles (younger juveniles using surface-pelagic habitats) and nearshore benthic-stage juveniles (neritic stage defined by older juveniles using nearshore benthic habitats). Most reports of oiled juveniles are oceanic stage juveniles from convergence zones, ocean areas where currents meet to form collection points for material at or near the surface of the water. These oceanic juveniles spend a greater proportion of their time at the surface than adults; thus, their risk of exposure to floating oil slicks would be increased. In convergence zones off the east coast of Florida, tar was found in the mouths, esophagi, or stomachs of 65 out of 103 post-hatchling loggerheads (Loehefener et al. 1989). In another study (Witherington 1994), 34 percent of post-hatchlings at "weed lines" off the Florida coast had tar in their mouths or esophagi, and over half had tar caked in their jaws. Lutz (1989) reported that hatchlings have been found apparently starved to death, their beaks and esophagi blocked with tarballs.

The April 20, 2010, explosion of the DWH oil rig affected sea turtles in the Gulf of Mexico. There is an on-going assessment of the long-term effects of the spill on Gulf of Mexico marine life, including sea turtle populations. Following the spill, juvenile Kemp's ridley, green, and loggerhead sea turtles were found in *Sargassum* algae mats in the convergence zones, where currents meet and oil collected. Sea turtles found in these areas were often coated in oil and/or had ingested oil.

The Trustees involved with the Natural Resources Damage Assessment conducted a thorough assessment of the effects of the spill and response activities on sea turtles. Assessment activities included boat-based rescues, veterinary assessments, aerial surveys, satellite tracking of live sea turtles, recovery of stranded sea turtles, and movements and/or monitoring of sea turtle nests and nesting females. Oil collected from the rescued turtles was confirmed as DWH oil. They concluded that sea turtles were adversely effected by exposure to DWH oil and response activities (Trustees 2016).

"The Trustees estimated that between 4,900 and up to 7,600 large juvenile and adult sea turtles (Kemp's ridleys, loggerheads, and hardshelled sea turtles not identified to species), and between 55,000 and 160,000 small juvenile sea turtles (Kemp's ridleys, green turtles, loggerheads, hawksbills, and hardshelled sea turtles not identified to species) were killed by the DWH oil spill. Nearly 35,000 hatchling sea turtles (loggerheads, Kemp's ridleys, and green turtles) were also injured by response activities." (Trustees 2016)

The DWH event impacted sea turtles at the population level and shifted the baseline for sea turtles. To read more on the full assessment and the nature and magnitude of effects from the DWH oil spill, please refer to the PDARP and Final PEIS at http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan.

Oil spills and spill response activities continue to be a threat to sea turtle populations in the Gulf of Mexico.

Marine debris is a continuing problem for sea turtles. Sea turtles living in the pelagic environment commonly eat or become entangled in marine debris (e.g., tar balls, plastic bags/pellets, balloons, and ghost fishing gear) as they feed along oceanographic fronts where debris and their natural food items converge. This is especially problematic for sea turtles that spend all or significant portions of their life cycle in the pelagic environment (i.e., leatherbacks, juvenile loggerheads, and juvenile green turtles).

Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. NOAA's climate information portal provides basic background information on these and other measured or anticipated effects (see http://www.climate.gov).

Climate change impacts on sea turtles currently cannot be predicted with any degree of certainty; however, significant impacts to the hatchling sex ratios of sea turtles may result (NMFS and USFWS 2007d). In sea turtles, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25°-35°C (Ackerman 1997). Increases in global temperature could potentially skew future sex ratios toward higher numbers of females (NMFS and USFWS 2007d).

The effects from increased temperatures may be intensified on developed nesting beaches where shoreline armoring and construction have denuded vegetation. Erosion control structures could potentially result in the permanent loss of nesting beach habitat or deter nesting females (NRC

1990a). These impacts will be exacerbated by sea level rise. If females nest on the seaward side of the erosion control structures, nests may be exposed to repeated tidal overwash (NMFS and USFWS 2007d). Sea level rise from global climate change is also a potential problem for areas with low-lying beaches where sand depth is a limiting factor, as the sea may inundate nesting sites and decrease available nesting habitat (Baker et al. 2006; Daniels et al. 1993; Fish et al. 2005). The loss of habitat as a result of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006; Baker et al. 2006).

Other changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution, etc.) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish, etc.) which could ultimately affect the primary foraging areas of sea turtles.

Other Threats

Predation by various land predators is a threat to developing nests and emerging hatchlings. The major predators of sea turtle nests are mammals, including raccoons, dogs, pigs, skunks, and badgers. Emergent hatchlings are preyed upon by these mammals as well as ghost crabs, laughing gulls, and the exotic South American fire ant (*Solenopsis invicta*). In addition to predation, direct harvest of eggs and adults from beaches in foreign countries continues to be a problem for various sea turtle species throughout their ranges (NMFS and USFWS 2008c).

Diseases, toxic blooms from algae and other microorganisms, and cold stunning events are additional sources of mortality that can range from local and limited to wide-scale and impacting hundreds or thousands of animals.

Sea Turtle Hearing

Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 Hz to 2.0 kHz, with a range of maximum sensitivity between 100 to 800 Hz (Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (Piniak 2012) found green sea turtle juveniles capable of hearing underwater sounds at frequencies of 50 Hz to 1,600 kHz (maximum sensitivity at 200 to 400 Hz). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Based upon auditory brainstem responses green sea turtles have been measured to hear in the 50 Hz to 1.6 kHz range (Dow et al. 2008), with greatest response at 300 Hz (Yudhana et al. 2010); a value verified by Moein Bartol and Ketten (2006). Other studies have found greatest sensitivities are 200 to 400 Hz for the green sea turtle with a range of 100 to 500 Hz (Moein Bartol and Ketten 2006; Ridgway et al. 1969) and around 250 Hz or below for juveniles (Bartol et al. 1999). However, Dow et al. (2008) found best sensitivity between 50 and 400 Hz.

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 to 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3 kHz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3.0 to 4.0 kHz (Patterson 1966).

6.2.5 Green Turtles (North Atlantic and South Atlantic Distinct Population Segments)

The green sea turtle was listed as threatened under the ESA on July 28, 1978, except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered. Of the 11 green sea turtle DPSs that were listed on May 6, 2016, only the North Atlantic DPS and South Atlantic DPS occur within the action area. Three of the green sea turtle DPSs were listed as endangered and the other eight including the North Atlantic DPS and South Atlantic DPS were listed as threatened.

6.2.5.1 Species Description and Distribution

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (one meter). Green sea turtles have a smooth carapace with four pairs of lateral (or costal) scutes and a single pair of elongated prefrontal scales between the eyes. They typically have a black dorsal surface and a white ventral surface, although the carapace of green sea turtles in the Atlantic Ocean has been known to change in color from solid black to a variety of shades of grey, green, or brown and black in starburst or irregular patterns (Lagueux 2001).

With the exception of post-hatchlings, green sea turtles live in nearshore tropical and subtropical waters where they generally feed on marine algae and seagrasses. They have specific foraging grounds and may make large migrations between these forage sites and natal beaches for nesting (Hays et al. 2001). Green sea turtles nest on sandy beaches of mainland shores, barrier islands, coral islands, and volcanic islands in more than 80 countries worldwide (Hirth and USFWS 1997). The two largest nesting populations are found at Tortuguero, on the Caribbean coast of Costa Rica, and Raine Island, on the Pacific coast of Australia along the Great Barrier Reef.

Differences in mitochondrial DNA properties of green sea turtles from different nesting regions indicate there are genetic subpopulations (Bowen et al. 1992; Fitzsimmons et al. 2006). Despite the genetic differences, sea turtles from separate nesting origins are commonly found mixed together on foraging grounds throughout the species' range. Within U.S. waters individuals from both the North Atlantic and South Atlantic DPSs can be found on foraging grounds. While there are currently no in-depth studies available to determine the percent of North Atlantic and South Atlantic DPS individuals in any given location, two small-scale studies provide an insight into the degree of mixing on the foraging grounds. An analysis of cold-stunned green turtles in St. Joseph Bay, Florida (northern Gulf of Mexico) found approximately four percent of individuals came from nesting stocks in the South Atlantic DPS (specifically Suriname, Aves Island, Brazil, Ascension Island, and Guinea Bissau) (Foley et al. 2007). On the Atlantic coast of Florida, a study on the foraging grounds off Hutchinson Island found that approximately five percent of the turtles sampled came from the Aves Island/Suriname nesting assemblage, which is part of the South Atlantic DPS (Bass and Witzell 2000). All of the individuals in both studies were benthic juveniles. Available information on green turtle migratory behavior indicates that long distance dispersal is only seen for juvenile turtles. This suggests that larger adult-sized turtles return to forage within the region of their natal rookeries, thereby limiting the potential for gene flow across larger scales (Monzón-Argüello et al. 2010). While all of the mainland U.S. nesting individuals are part of the North Atlantic DPS, the U.S. Caribbean nesting assemblages are split between the North and South Atlantic DPSs. Nesters in Puerto Rico are part of the North Atlantic DPS, while those in the U.S. Virgin Islands are part of the South Atlantic DPS. We do not currently have information on what percent of individuals on the U.S. Caribbean foraging grounds come from which DPS.

In U.S. Atlantic and Gulf of Mexico waters, green sea turtles are distributed throughout inshore and nearshore waters from Texas to Massachusetts. Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984; Hildebrand 1982; Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957; Carr 1984), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system in Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman and Ehrhart 1992; Wershoven and Wershoven 1992). The summer developmental habitat for green sea turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus 1997). Additional important foraging areas in the western Atlantic include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, scattered areas along Colombia and Brazil (Hirth 1971), and the northwestern coast of the Yucatán Peninsula.

The complete nesting range of green sea turtles within the southeastern United States includes sandy beaches between Texas and North Carolina, as well as the U.S. Virgin Islands and Puerto Rico (Dow et al. 2007; NMFS and USFWS 1991a). Figure 24 depicts abundance estimates and location of nests. Still, the vast majority of green sea turtle nesting within the southeastern United States occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 1995). Principal U.S. nesting areas for green sea turtles are in eastern Florida, predominantly Brevard south through Broward counties. For more information on green sea turtle nesting in other ocean basins, refer to the 1991 publication, *Recovery Plan for the Atlantic Green Turtle* (NMFS and USFWS 1991a) or the 2007 publication, *Green Sea Turtle Five-Year Status Review* (NMFS and USFWS 2007b).

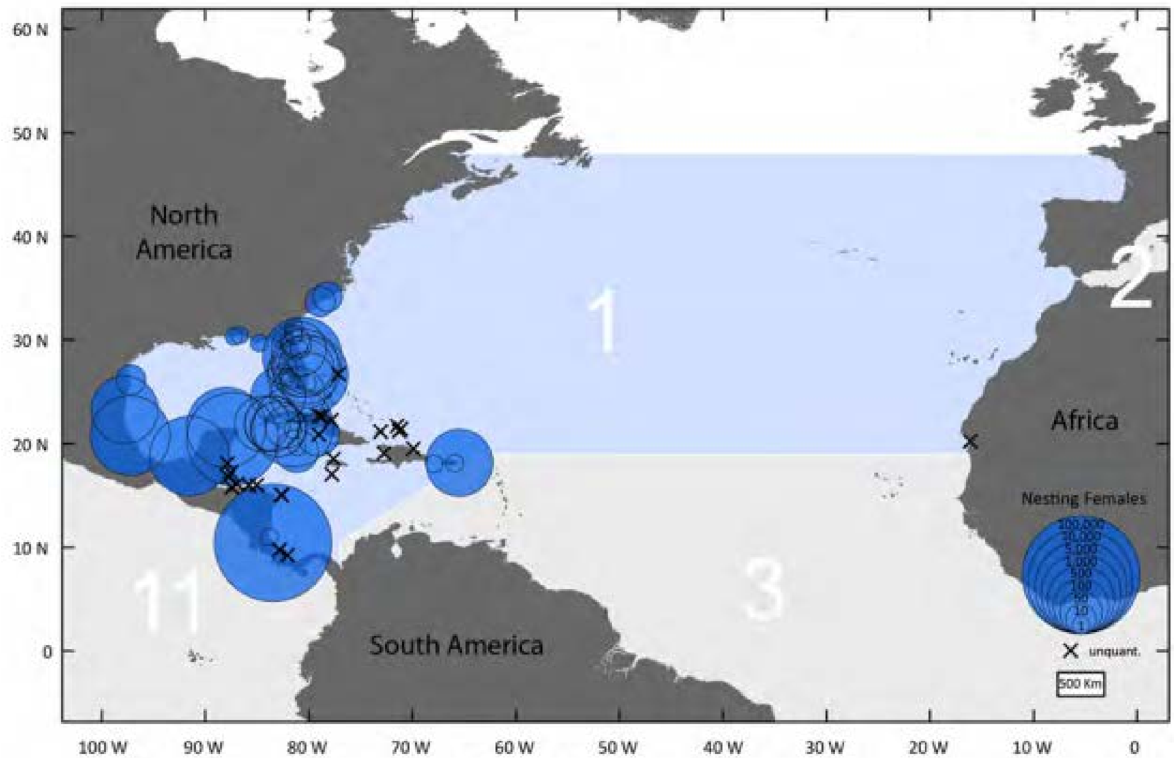

Figure 24. Geographic range of the North Atlantic distinct population segment green turtle, with location and abundance of nesting females. An 'x' signifies nesting sites lacking abundance information and the size of the circle depicts estimated abundance. Figure from (Seminoff et al. 2015).

6.2.5.2 Life History Information

Green sea turtles reproduce sexually, and mating occurs in the waters off nesting beaches. Mature females return to their natal beaches (i.e., the same beaches where they were born) to lay eggs (Balazs 1982; Frazer and Ehrhart 1985) every two to four years while males are known to reproduce every year (Balazs 1983). In the southeastern United States, females generally nest between June and September, and peak nesting occurs in June and July (Witherington and Ehrhart 1989). During the nesting season, females nest at approximately two-week intervals, laying an average of three to four clutches (Johnson and Ehrhart 1996). Clutch size often varies among subpopulations, but mean clutch size is approximately 110 to 115 eggs. In Florida, green sea turtle nests contain an average of 136 eggs (Witherington and Ehrhart 1989). Eggs incubate for approximately two months before hatching. Hatchling green sea turtles are approximately two inches (five centimeters) in length and weigh approximately 0.9 ounces (25 grams). Survivorship at any particular nesting site is greatly influenced by the level of anthropogenic stressors, with the more pristine and less disturbed nesting sites (e.g., along the Great Barrier Reef in Australia) showing higher survivorship values than nesting sites known to be highly disturbed (e.g., Nicaragua (Campbell and Lagueux 2005; Chaloupka and Limpus 2005)).

After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. his early oceanic phase remains one of the most poorly understood aspects of green sea turtle life history (NMFS and USFWS 2007c). Green sea turtles exhibit particularly slow growth rates of about 0.4 to two inches (one to five centimeters) per year (Green 1993; McDonald-Dutton and Dutton 1998), which may be attributed to their largely herbivorous, low-net energy diet (Bjorndal 1982). At approximately eight to 10 inches (20 to 25 centimteres) carapace length, juveniles leave the pelagic environment and enter nearshore developmental habitats such as protected lagoons and open coastal areas rich in sea grass and marine algae. Growth studies using skeletochronology indicate that green sea turtles in the western Atlantic shift from the oceanic phase to nearshore developmental habitats after approximately five to six years (Bresette et al. 2006; Zug and Glor 1998). Within the developmental habitats, juveniles begin the switch to a more herbivorous diet, and by adulthood feed almost exclusively on seagrasses and algae (Rebel 1974), although some populations are known to also feed heavily on invertebrates (Carballo et al. 2002). Green sea turtles mature slowly, requiring 20 to 50 years to reach sexual maturity (Chaloupka and Musick 1997; Hirth and USFWS 1997).

While in coastal habitats, green sea turtles exhibit site fidelity to specific foraging and nesting grounds, and it is clear they are capable of "homing in" on these sites if displaced (Hart et al. 2013; McMichael et al. 2003). Reproductive migrations of Florida green sea turtles have been identified through flipper tagging and/or satellite telemetry. Based on these studies, the majority of adult female Florida green sea turtles reside in nearshore foraging areas throughout the Florida Keys and in the waters southwest of Cape Sable, with some post-nesting turtles also residing in Bahamian waters as well (Hart et al. 2013; NMFS and USFWS 2007c).

6.2.5.3 Status and Population Dynamics

Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at seventy-three nesting sites (Figure 24), and available data indicate an increasing trend in nesting. The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts 79 percent of nesting females for the DPS (Seminoff et al. 2015).

For the North Atlantic DPS, the available data indicate an increasing trend in nesting. There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. Modeling by Chaloupka et al. (2008a) using data sets of 25 years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9 percent, and the Tortuguero, Costa Rica, population growing at 4.9 percent.

The North Atlantic DPS has a globally unique haplotype, which was a factor in defining the discreteness of the population for the DPS. Evidence from mitochondrial DNA studies indicates that there are at least four independent nesting subpopulations in Florida, Cuba, Mexico and Costa Rica (Seminoff et al. 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016).

The South Atlantic DPS nesting data is poor with only occasional or incomplete surveys. Therefore according to the listing rule (80 FR 15271), for 37 of the 51 identified nesting areas of this DPS, we were not able to estimate nesting female abundance, even for relatively large nesting sites such as French Guiana. Of the nesting sites for which an estimate could be derived, three account for the bulk of the nesting: Poilão, Guinea-Bissau (29,016 nesting females); Ascension Island, UK (13,417 nesting females); and the Galibi Reserve, Suriname (9,406 nesting females). There are two sites with >10,000 nesting females (Poilão and Ascension Island); one site with 5,001-10,000 nesting females (Suriname); three sites with 1,001-5,000 nesting females, Trindade Island, Brazil (2,016); Aves Island, Venezuela (2,833); and Matapica Reserve, Suriname (3,661). There are three sites with 501-1,001 nesting females, three sites with 101-500, two sites with 51-100, and 37 unquantified sites. Poilão accounts for almost 46 percent of the total number of nesting females (80 FR 15271). A minimum estimate based on information from the listing rule would be approximately 66,351 nesting females.

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Green turtles from the North Atlantic DPS originate from the boundary of South and Central America (7.5°N, 77°W) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48°N, 77°W) in the north. The range of the DPS then extends due east along latitudes 48°N and 19°N to the western coasts of Europe and Africa (Figure 24). Nesting occurs primarily in Costa Rica, Mexico, Florida and Cuba.

In the continental United States, green sea turtle nesting occurs along the Atlantic coast, primarily along the central and southeast coast of Florida where an estimated 200-1,100 females nest each year (Meylan et al. 1994; Weishampel et al. 2003). Occasional nesting has also been documented along the Gulf Coast of Florida (Meylan et al. 1995); in Texas, Georgia and in North Carolina (seaturtle.org accessed on June 19, 2017).

In Florida, index beaches were established to standardize data collection methods and effort on key nesting beaches. Since establishment of the index beaches in 1989, the pattern of green sea turtle nesting has generally shown biennial peaks in abundance with a positive trend during the ten years of regular monitoring (Figure 25). According to data collected from Florida's index nesting beach survey from 1989 to 2016, green sea turtle nest counts across Florida have increased approximately 100-fold from a low of 267 in the early 1990s to a high of 27,975 in 2015. Green turtle nesting tends to follow a biennial pattern of fluctuation (Figure 25). Modeling by Chaloupka et al. (2008b) using data sets of 25 years or more has resulted in an estimate of the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of

13.9 percent. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green sea turtle generation, up to 50 years.

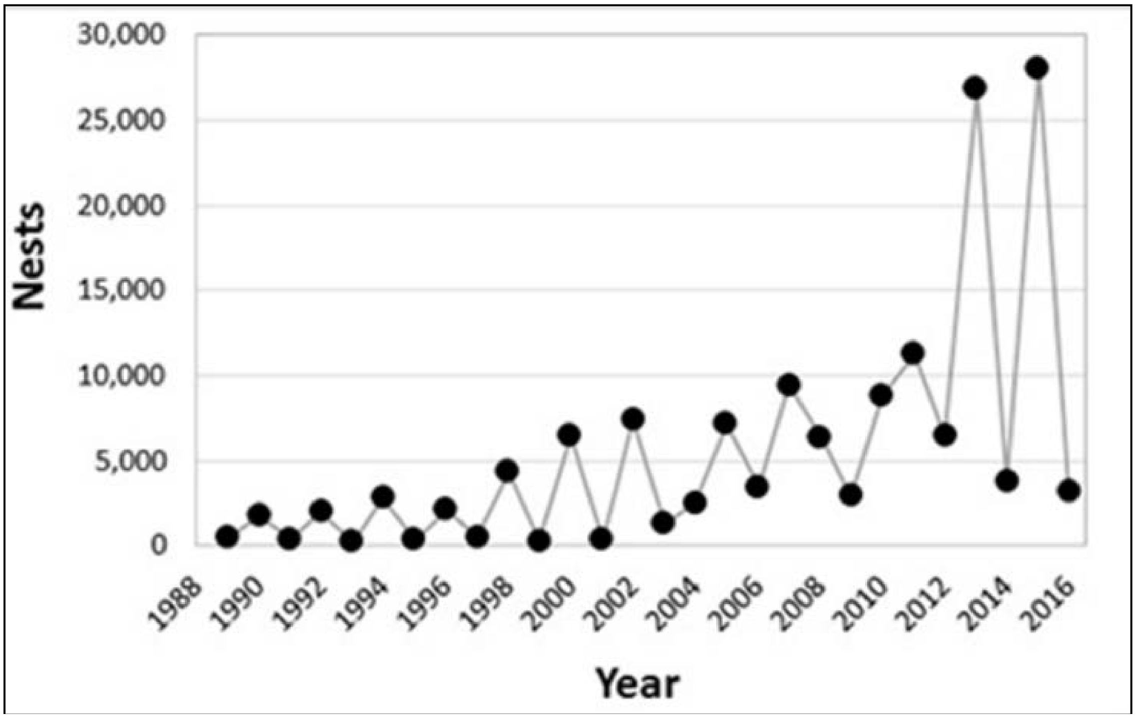

Figure 25. Green sea turtle nesting at Florida index beaches since 1989. Figure from http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/ Accessed June 15, 2017.

6.2.5.4 Threats

The principal cause of past declines and extirpations of green sea turtle assemblages has been the overexploitation of the species for food and other products. Although intentional take of green sea turtles and their eggs is not extensive within the southeastern United States, green sea turtles that nest and forage in the region may spend large portions of their life history outside the region and outside U.S. jurisdiction, where exploitation is still a threat. While the threats of pollution, habitat loss through coastal development or stabilization, destruction of nesting habitat from storm events, beachfront lighting, poaching, global climate change, fisheries interactions, natural predation, disease and fisheries bycatch continue, the green turtle appears to be somewhat resilient to future perturbations. We discussed some of these in section 6.2.4.1 as relevant to all sea turtle species, and will discuss the species-specific threats below.

In addition to anthropogenic threats, green sea turtles are susceptible to natural mortality from Fibropapillomatosis (FP) disease. FP results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) of turtles (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). These tumors range in size from 0.04 inches (0.1 centimeters) to greater than 11.81 inches (30 centimterers) in diameter and may affect swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). Presently, scientists are unsure of the exact mechanism causing this disease, though it is believed to be related to both an infectious agent, such as a virus (Herbst et al. 1995), and environmental conditions (e.g., habitat degradation, pollution, low wave energy, and shallow water (Foley et al. 2005; Jones et al. 2015). Presently, FP is cosmopolitan, but it has been found to affect large numbers of animals in specific areas, including Hawaii and Florida (Herbst 1994; Jacobson 1990; Jacobson et al. 1991).

Cold-stunning is another natural threat to green sea turtles. Although it is not considered a major source of mortality in most cases, as temperatures fall below 46.4 and 50°F (8 and 10°C) turtles may lose their ability to swim and dive, often floating to the surface. The rate of cooling that precipitates cold-stunning appears to be the primary threat, rather than the water temperature itself (Milton and Lutz 2003). Sea turtles that overwinter in inshore waters are most susceptible to cold-stunning because temperature changes are most rapid in shallow water (Witherington and Ehrhart 1989). During January 2010, an unusually large cold-stunning event in the southeastern United States resulted in around 4,600 sea turtles, mostly greens, found cold-stunned, with hundreds found dead or dying (Avens et al. 2012). Several large cold-stunning events occurred in the western Gulf of Mexico in early 2010, early 2011, late 2013 to early 2014, and late 2014 to early 2015 resulting in 464, 1,683, 1,300, and nearly 700 green sea turtles found cold-stunned in Texas, respectively. Some were found dead or died after stranding, while approximately two-thirds were rehabilitated and released (Shaver et al. 2015).

Whereas oil spill impacts are discussed generally for all species, specific impacts of the DWH spill on green sea turtles are considered here. Impacts to green sea turtles occurred to offshore small juveniles only. A total of 154,000 small juvenile greens (36.6 percent of the total small juvenile sea turtle exposures to oil from the spill) were estimated to have been exposed to oil. A large number of small juveniles were removed from the population, as 57,300 small juveniles greens are estimated to have died as a result of the exposure. A total of four nests (580 eggs) were also translocated during response efforts, with 455 hatchlings released (the fate of which is unknown) (DWH Trustees 2015). Additional unquantified effects may have included inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred.

While green turtles regularly use the northern Gulf of Mexico, they have a widespread distribution throughout the entire Gulf of Mexico, Caribbean, and Atlantic, and the proportion of the population using the northern Gulf of Mexico at any given time is relatively low. Although it is known that adverse impacts occurred and numbers of animals in the Gulf of Mexico were reduced as a result of the 2010 DWH oil spill, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event, as well as the impacts being primarily to smaller juveniles (lower reproductive value than adults and large juveniles), reduces the impact to the overall population. It is unclear what impact these losses may have caused on a population level, but it is not expected to have had a large impact on the population trajectory moving forward. However, recovery of green turtle numbers equivalent to what was lost in the northern Gulf of Mexico as a result of the spill will likely take decades of sustained efforts to reduce the existing threats and enhance survivorship of multiple life stages (DWH Trustees 2015).

6.2.6 Kemp's Ridley Turtles

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Internationally, the Kemp's ridley is considered the most endangered sea turtle (Groombridge 1982; TEWG 2000; Zwinenberg 1977).

6.2.6.1 Species Description and Distribution

The Kemp's ridley sea turtle is the smallest of all sea turtles. Adults generally weigh less than 100 pounds (45 kilograms) and have a carapace length of around 2.1 feet (65 centimeters). Adult Kemp's ridley shells are almost as wide as they are long. Coloration changes significantly during development from the grey-black dorsum and plastron of hatchlings, a grey-black dorsum with a yellowish-white plastron as post-pelagic juveniles, and then to the lighter grey-olive carapace and cream-white or yellowish plastron of adults. There are two pairs of prefrontal scales on the head, five vertebral scutes, usually five pairs of costal scutes, and generally 12 pairs of marginal scutes on the carapace. In each bridge adjoining the plastron to the carapace, there are four scutes, each of which is perforated by a pore.

Kemp's ridley habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 feet (37 meters) deep, although they can also be found in deeper offshore waters. These areas support the primary prey species of the Kemp's ridley sea turtle, which consist of swimming crabs, but may also include fish, jellyfish, and an array of mollusks.

The primary range of Kemp's ridley sea turtles is within the Gulf of Mexico basin, though they also occur in coastal and offshore waters of the U.S. Atlantic Ocean and occasionally in the Mediterranean Sea which may be due to migration expansion or increased hatchling production (Tomas and Raga 2008). Juvenile Kemp's ridley sea turtles, possibly carried by oceanic currents, have been recorded as far north as Nova Scotia. Historic records indicate a nesting range from Mustang Island, Texas, in the north to Veracruz, Mexico, in the south. Nesting occurs mainly on beaches in the Gulf of Mexico in large aggregations called arribadas[26]. Kemp's ridley sea turtles have also recently been nesting along the Atlantic Coast of the United States, with nests recorded from beaches in Florida, Georgia, and the Carolinas. In 2012, the first Kemp's ridley sea turtle nest was recorded in Virginia. The Kemp's ridley nesting population was exponentially

[26] Arribada is the Spanish word for "arrival" and is the term used for massive synchronized nesting within the genus *Lepidochelys.*

increasing (NMFS et al. 2011a), however since 2009 there has been concern over the slowing of recovery (Gallaway et al. 2016a; Gallaway et al. 2016b; Plotkin 2016).

6.2.6.2 Life History Information

Kemp's ridley sea turtles share a general life history pattern similar to other sea turtles. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. After 45 to 58 days of embryonic development, the hatchlings emerge and swim offshore into deeper, ocean water where they feed and grow until returning at a larger size. Hatchlings generally range from 1.65 to 1.89 inches (42 to 48 millimeters) straight carapace length, 1.26 to 1.73 inches (32 to 44 millimeters) in width, and 0.3 0.4 pounds (15 to 20 grams) in weight. Their return to nearshore coastal habitats typically occurs around two years of age (Ogren 1989), although the time spent in the oceanic zone may vary from one to four years or perhaps more (TEWG 2000). Juvenile Kemp's ridley sea turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops.

The average rates of growth may vary by location, but generally fall within 2.2 to 2.9 ± 2.4 inches per year (5.5 to 7.5 ± 6.2 centimterers per year (Schmid and Barichivich 2006; Schmid and Woodhead 2000)). Age to sexual maturity ranges greatly from five to 16 years, though NMFS et al. (2011a) determined the best estimate of age to maturity for Kemp's ridley sea turtles was 12 years. It is unlikely that most adults grow very much after maturity. While some sea turtles nest annually, the weighted mean remigration rate for Kemp's ridley sea turtles is approximately two years. Nesting generally occurs from April to July and females lay approximately 2.5 nests per season with each nest containing approximately 100 eggs (Márquez M. 1994).

6.2.6.3 Status and Population Dynamics

Of the seven species of sea turtles in the world, the Kemp's ridley has declined to the lowest population level. Most of the population of adult females nest on the beaches of Rancho Nuevo, Mexico (Pritchard 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand 1963). By the mid-1980s, however, nesting numbers from Rancho Nuevo and adjacent Mexican beaches were below 1,000, with a low of 702 nests in 1985. Yet, nesting steadily increased through the 1990s, and then accelerated during the first decade of the 21st century (Figure 26), which indicates the species is recovering. It is worth noting that when the Bi-National Kemp's Ridley Sea Turtle Population Restoration Project was initiated in 1978, only Rancho Nuevo nests were recorded. In 1988, nesting data from southern beaches at Playa Dos and Barra del Tordo were added. In 1989, data from the northern beaches of Barra Ostionales and Tepehuajes were added, and most recently in 1996, data from La Pesca and Altamira beaches were recorded. Nesting at Rancho Nuevo accounts for just over 81 percent of all recorded Kemp's ridley nests in Mexico. Following a significant, unexplained one-year decline in 2010, Kemp's ridley nests in

Mexico reached a record high of 21,797 in 2012 (NPS 2013). In 2013, there was a second significant decline, with 16,385 nests recorded. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from three primary nesting beaches in Mexico (NMFS 2015b).

The number of nests in Texas (mainly Padre Island) has increased over the past two decades, with one nest observed in 1985, four in 1995, 50 in 2005, 197 in 2009, 209 in 2012 and 119 in 2014 (NMFS 2015b). Figure 27 shows a trajectory for the animals that nest in Texas similar to those that nest in Mexico.

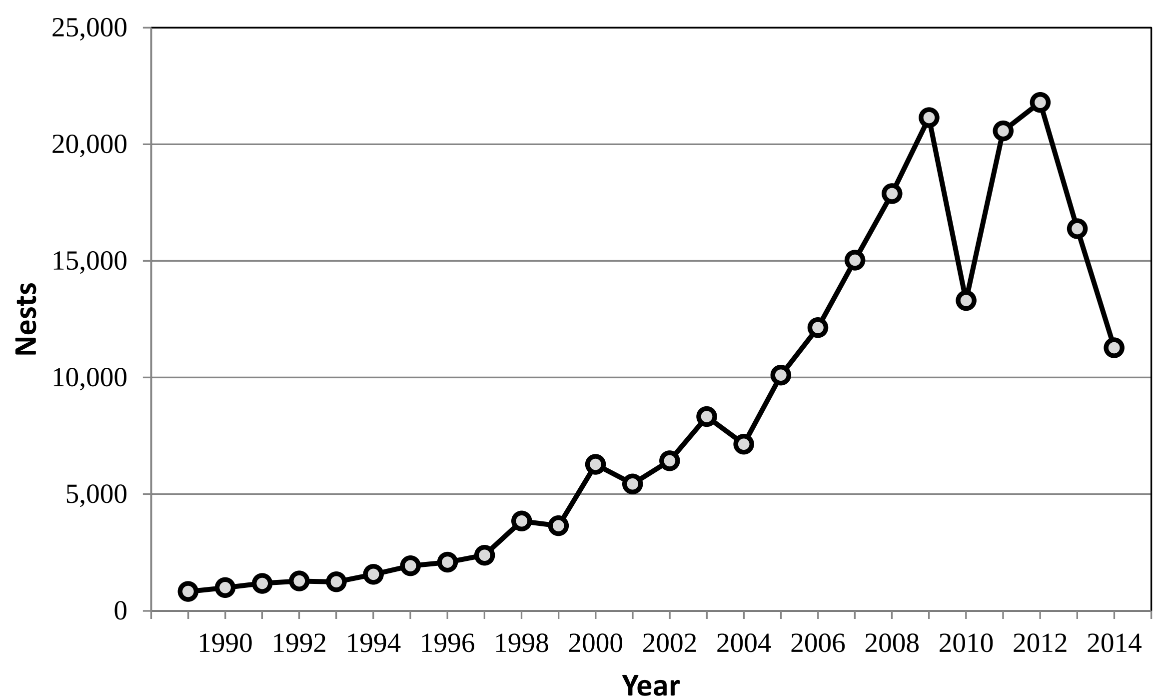

Figure 26. Kemp's ridley nest totals from Mexican beaches (Gladys Porter Zoo nesting database 2014).

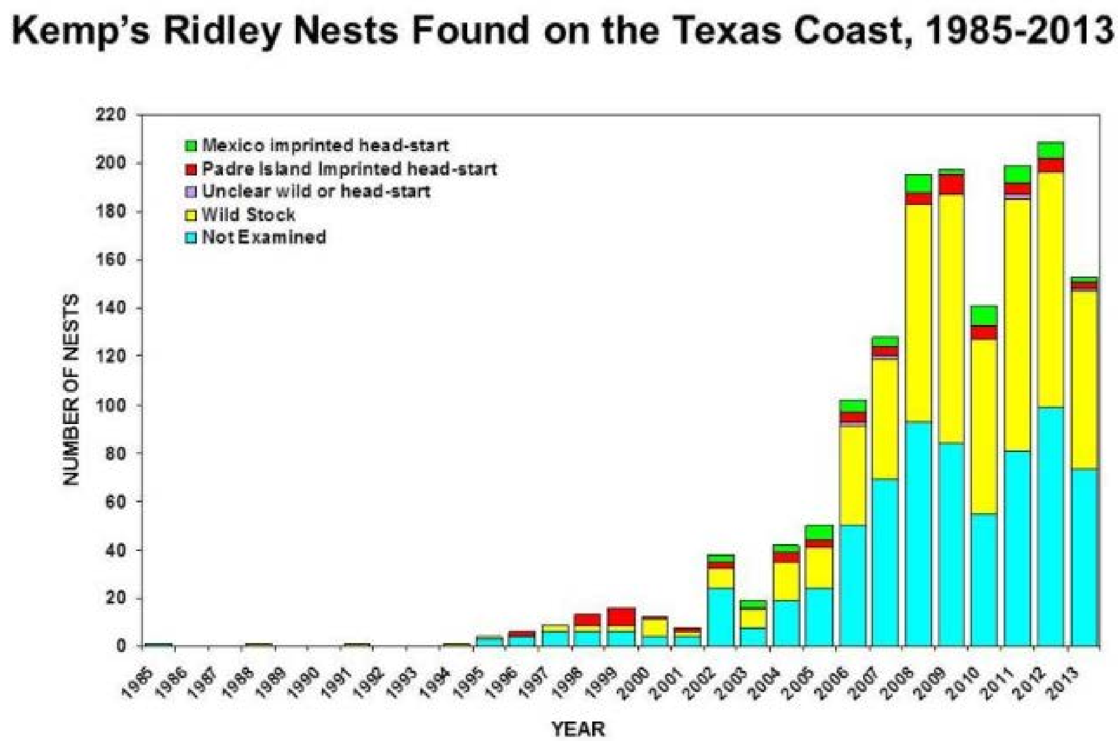

Figure 27. Number of Kemp's ridley nests on Texas beaches (NPS 2013).

Heppell et al. (2005) predicted in a population model that the population is expected to increase at least 12 to 16 percent per year and that the population could attain at least 10,000 females nesting on Mexico beaches by 2015. NMFS et al. (2011a) produced an updated model that predicted the population to increase 19 percent per year and attain at least 10,000 females nesting on Mexico beaches by 2011. Approximately 25,000 nests would be needed for an estimate of 10,000 nesters on the beach, based on an average 2.5 nests/nesting female. While counts did not reach 25,000 nests by 2012, it is clear that the population is steadily increasing. The recent increases in Kemp's ridley sea turtle nesting seen in the last two decades is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of turtle exclusion devices, reduced trawling effort in Mexico and the United States, and possibly other changes in vital rates (TEWG 1998; TEWG 2000). The species limited range as well as low global abundance makes it particularly vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty.

Genetic variability in Kemp's ridley turtles is considered to be high, as measured by heterozygosis at microsatellite loci (NMFS 2011a). Additional analysis of the mitochondrial DNA taken from samples of Kemp's ridley turtles at Padre Island, Texas, showed six distinct haplotypes, with one found at both Padre Island and Rancho Nuevo (Dutton et al. 2006).

6.2.6.4 Threats

Kemp's ridley sea turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. Of the five sea turtle species in the Gulf of Mexico, Kemp's ridley sea turtles are the most vulnerable to threats, especially threats that cause population-level impacts such as the DWH oil spill and response, due to their already low numbers and location of nesting habitat. We discussed some of these threats in section 6.2.4.1 as relevant to all sea turtle species. The remainder of this section will expand on a few of the aforementioned threats and how they may specifically impact Kemp's ridley sea turtles.

As Kemp's ridley sea turtles continue to recover and nesting arribadas are increasingly established, bacterial and fungal pathogens in nests are also likely to increase. Bacterial and fungal pathogen impacts have been well documented in the large arribadas of the olive ridley at Nancite in Costa Rica (Mo 1988). In some years, and on some sections of the beach, the hatching success can be as low as five percent (Mo 1988). As the Kemp's ridley nest density at Rancho Nuevo and adjacent beaches continues to increase, appropriate monitoring of emergence success will be necessary to determine if there are any density-dependent effects.

NMFS has documented (via the Sea Turtle Stranding and Salvage Network data, http://www.sefsc.noaa.gov/species/turtles/strandings.htm) elevated sea turtle strandings in the Northern Gulf of Mexico. In the first three weeks of June 2010, over 120 sea turtle strandings were reported from Mississippi and Alabama waters, none of which exhibited any signs of external oiling to indicate effects associated with the DWH oil spill event. A total of 644 sea turtle strandings were reported in 2010 from Louisiana, Mississippi, and Alabama waters, 561 (87 percent) of which were Kemp's ridley sea turtles. During March through May of 2011, 267 sea turtle strandings were reported from Mississippi and Alabama waters alone. A total of 525 sea turtle strandings were reported in 2011 from Louisiana, Mississippi, and Alabama waters, with the majority (455) occurring from March through July, 390 (86 percent) of which were Kemp's ridley sea turtles. During 2012, a total of 428 sea turtles were reported from Louisiana, Mississippi, and Alabama waters, though the data are incomplete. Of these reported strandings, 301 (70 percent) were Kemp's ridley sea turtles. These stranding numbers are significantly greater than reported in past years; Louisiana, Mississippi, and Alabama waters reported 42 and 73 sea turtle strandings for 2008 and 2009, respectively. It should be noted that stranding coverage has increased considerably due to the DWH oil spill event.

Nonetheless, considering that strandings typically represent only a small fraction of actual mortality, these stranding events potentially represent a serious impact to the recovery and survival of the local sea turtle populations. While a definitive cause for these strandings has not been identified, necropsy results indicate a significant number of stranded turtles from these events likely perished due to forced submergence, which is commonly associated with fishery interactions (Stacy 2015). Yet, available information indicates fishery effort was extremely limited during the stranding events. It is notable that in both 2010 and 2011 approximately 85 percent of all Louisiana, Mississippi, and Alabama stranded sea turtles were Kemp's ridleys; however, this could simply be a function of the species' preference for shallow, inshore waters coupled with increased population abundance as reflected in recent Kemp's ridley nesting increases.

In response to these strandings, and due to speculation that fishery interactions may be the cause, fishery observer effort was shifted to evaluate the inshore skimmer trawl fishery during the summer of 2012. During May-July of that year, observers reported 24 sea turtle interactions in the skimmer trawl fishery, all but one of which were identified as Kemp's ridleys (one sea turtle was an unidentified hardshell turtle). Encountered sea turtles were all very small, juvenile specimens ranging from 7.6 yo 19.0 inches (19.4 to 48.3 centimeters) curved carapace length (CCL), and all sea turtles were released alive. The small average size of encountered Kemp's ridleys introduces a potential conservation issue, as over 50 percent of these reported sea turtles could potentially pass through the maximum four-inch bar spacing of TEDs currently required in the shrimp fishery. Due to this issue, a proposed 2012 rule to require TEDs in the skimmer trawl fishery (77 FR 27411) was not implemented. Given the nesting trends and habitat utilization of Kemp's ridley sea turtles, it is likely that fishery interactions in the Northern Gulf of Mexico may continue to be an issue of concern for the species, and one that may potentially slow the rate of recovery for Kemp's ridley sea turtles.

While oil spill impacts are discussed generally for all species in Section 7.4.4 specific impacts of the DWH oil spill event on Kemp's ridley sea turtles are considered here. Kemp's ridleys experienced the greatest negative impact stemming from the DWH oil spill event of any sea turtle species. Impacts to Kemp's ridley sea turtles occurred to offshore small juveniles, as well as large juveniles and adults. Loss of hatchling production resulting from injury to adult turtles was also estimated for this species. Injuries to adult turtles of other species, such as loggerheads, certainly would have resulted in unrealized nests and hatchlings to those species as well. Yet, the calculation of unrealized nests and hatchlings was limited to Kemp's ridleys for several reasons. All Kemp's ridleys in the Gulf belong to the same population (NMFS et al. 2011a), so total population abundance could be calculated based on numbers of hatchlings because all individuals that enter the population could reasonably be expected to inhabit the northern Gulf of Mexico throughout their lives (DWH Trustees 2015).

A total of 217,000 small juvenile Kemp's ridleys (51.5 percent of the total small juvenile sea turtle exposures to oil from the spill) were estimated to have been exposed to oil. That means approximately half of all small juvenile Kemp's ridleys from the total population estimate of 430,000 oceanic small juveniles were exposed to oil. Furthermore, a large number of small juveniles were removed from the population, as up to 90,300 small juveniles Kemp's ridleys are estimated to have died as a direct result of the exposure. Therefore, as much as 20 percent of the small oceanic juveniles of this species were killed during that year. Impacts to large juveniles (greater than three years old) and adults were also high. An estimated 21,990 such individuals were exposed to oil (about 22 percent of the total estimated population for those age classes); of those, 3,110 mortalities were estimated (or three percent of the population for those age classes). The loss of near-reproductive and reproductive-stage females would have contributed to some extent to the decline in total nesting abundance observed between 2011 and 2014. The estimated number of unrealized Kemp's ridley nests is between 1,300 and 2,000, which translates to between approximately 65,000 and 95,000 unrealized hatchlings (DWH Trustees 2015). This is a minimum estimate, however, because the sublethal effects of the DWH oil spill event on turtles, their prey, and their habitats might have delayed or reduced reproduction in subsequent years, which may have contributed substantially to additional nesting deficits observed following the DWH oil spill event. These sublethal effects could have slowed growth and maturation rates, increased remigration intervals, and decreased clutch frequency (number of nests per female per nesting season). The nature of the DWH oil spill event effect on reduced Kemp's ridley nesting abundance and associated hatchling production after 2010 requires further evaluation. It is clear that the DWH oil spill event resulted in large losses to the Kemp's ridley population across various age classes, and likely had an important population-level effect on the species. Still, we do not have a clear understanding of those impacts on the population trajectory for the species into the future.

6.2.7 Hawksbill Turtles

The hawksbill sea turtle was listed as endangered throughout its entire range on June 2, 1970 under the Endangered Species Conservation Act of 1969, a precursor to the ESA. Critical habitat was designated on June 2, 1998, in coastal waters surrounding Mona and Monito Islands in Puerto Rico.

6.2.7.1 Species Description and Distribution

Hawksbill sea turtles are small to medium-sized (99 to 150 pounds on average [45 to 68 kilograms]) although females nesting in the Caribbean are known to weigh up to 176 pounds (80 kilograms) (Pritchard et al. 1983). The carapace is usually serrated and has a "tortoise-shell" coloring, ranging from dark to golden brown, with streaks of orange, red, and/or black. The plastron of a hawksbill turtle is typically yellow. The head is elongated and tapers to a point, with a beak-like mouth that gives the species its name. The shape of the mouth allows the hawksbill turtle to reach into holes and crevices of coral reefs to find sponges, their primary adult food source, and other invertebrates. The shells of hatchlings are 1.7 inches (42 millimeters) long, are mostly brown, and somewhat heart-shaped (Eckert 1995; Hillis and Mackay 1989; Van Dam and Sarti 1989).

Hawksbill sea turtles have a circumtropical distribution and usually occur between latitudes 30°N and 30°S in the Atlantic, Pacific, and Indian Oceans. In the western Atlantic, hawksbills are widely distributed throughout the Caribbean Sea, off the coasts of Florida and Texas in the continental United States, in the Greater and Lesser Antilles, and along the mainland of Central America south to Brazil (Amos 1989; Groombridge and Luxmoore 1989; Lund 1985; Meylan and Donnelly 1999; NMFS and USFWS 1998a; Plotkin and Amos 1988; Plotkin and Amos 1990). They are highly migratory and use a wide range of habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Adult hawksbill sea turtles are capable of migrating long distances between nesting beaches and foraging areas. For instance, a female hawksbill sea turtle tagged at Buck Island Reef National Monument (BIRNM) was later identified 1,160 miles (1,866 kilometers) away in the Miskito Cays in Nicaragua (Spotila 2004).

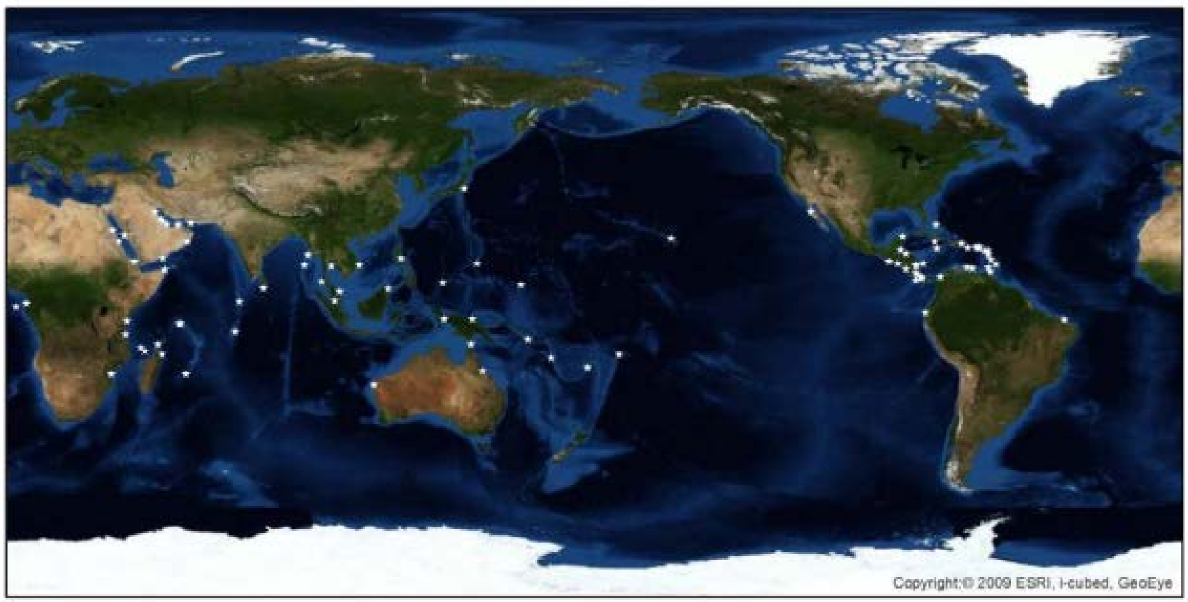

Figure 28. Hawksbill Sea Turtle Global Nesting Distribution. Figure from (NMFS and USFWS 2013a).

Hawksbill sea turtles nest on sandy beaches throughout the tropics and subtropics (Figure 28). Nesting occurs in at least 70 countries, although much of it now only occurs at low densities compared to that of other sea turtle species (NMFS and USFWS 2007b). Surveys at eighty eight nesting sites worldwide indicate that 22,004 to 29,035 females nest annually (NMFS and USFWS 2013a). Nesting sites in the Atlantic and Caribbean have an estimated total number of nesting females annually across 33 sites at 4,867 (i.e., midpoint of range from 3,626 to 6,108) (NMFS and USFWS 2013a). Meylan and Donnelly (1999) believe that the widely dispersed nesting areas and low nest densities is likely a result of overexploitation of previously large colonies that have since been depleted over time. The most significant nesting within the United States occurs in Puerto Rico and the U.S. Virgin Islands, specifically on Mona Island and BIRNM, respectively. Although nesting within the continental United States is typically rare, it can occur along the southeast coast of Florida and the Florida Keys. The largest hawksbill nesting population in the western Atlantic occurs in the Yucatán Peninsula of Mexico, where several thousand nests are recorded annually in the states of Campeche, Yucatán, and Quintana Roo (Garduño-Andrade et al. 1999; Spotila 2004). Hawksbill nesting has also been documented in American Samoa and Guam. More information on nesting in other ocean basins may be found in the five-year status review for the species (NMFS and USFWS 2013a).

Mitochondrial DNA studies show that reproductive populations are effectively isolated over ecological time scales (Bass et al. 1996). Substantial efforts have been made to determine the nesting population origins of hawksbill sea turtles assembled in foraging grounds, and genetic research has shown that hawksbills of multiple nesting origins commonly mix in foraging areas (Bowen and Witzell 1996). Since hawksbill sea turtles nest primarily on the beaches where they were born, if a nesting population is decimated, it might not be replenished by sea turtles from other nesting rookeries (Bass et al. 1996).

6.2.7.2 Life History Information

Hawksbill sea turtles exhibit slow growth rates although they are known to vary within and among populations from a low of 0.4 to 1.2 inches (one to three centimeters) per year, measured in the Indo-Pacific (Chaloupka and Limpus 1997; Mortimer et al. 2003; Mortimer et al. 2002; Whiting 2000), to a high of two inches (five centimeters) or more per year, measured at some sites in the Caribbean (Díez and Dam 2002; León and Díez 1999). Differences in growth rates are likely due to differences in diet and/or density of sea turtles at foraging sites and overall time spent foraging (Bjorndal and Bolten 2000; Chaloupka et al. 2004). Consistent with slow growth, age to maturity for the species is also long, taking between 20 and 40 years, depending on the region (Chaloupka and Musick 1997; Limpus and Miller 2000). Hawksbills in the western Atlantic are known to mature faster (i.e., 20 or more years) than sea turtles found in the Indo-Pacific (i.e., 30 to 40 years) (Boulan 1983; Boulon 1994; Díez and Dam 2002; Limpus and Miller 2000). Males are typically mature when their length reaches 27 inches (69 centimeters), while females are typically mature at 30 iches (75 centimeters) (Eckert et al. 1992; Limpus 1992).

Female hawksbills return to the beaches where they were born (natal beaches) every two to three years to nest (van Dam et al. 1991; Witzell 1983) and generally lay three to five nests per season (Richardson et al. 1999a). Compared with other sea turtles, the number of eggs per nest (clutch) for hawksbills can be quite high. The largest clutches recorded for any sea turtle belong to hawksbills [approximately 250 eggs per nest, (Hirth and Abdel Latif 1980)], though nests in the U.S. Caribbean and Florida more typically contain approximately 140 eggs (USFWS hawksbill fact sheet, http://www.fws.gov/northflorida/SeaTurtles/Turtle percent20Factsheets/hawksbill-sea-turtle.htm). Eggs incubate for approximately 60 days before hatching (USFWS hawksbill fact sheet). Hatchling hawksbill sea turtles typically measure one to two iches(2.5 to five centimeters) in length and weigh approximately 0.5 ounces (15 grams).

Hawksbills may undertake developmental migrations (migrations as immatures) and reproductive migrations that involve travel over many tens to thousands of miles (Meylan

1999a). Post-hatchlings (oceanic stage juveniles) are believed to live in the open ocean, taking shelter in floating algal mats and drift lines of flotsam and jetsam in the Atlantic and Pacific oceans (Musick and Limpus 1997) before returning to more coastal foraging grounds. In the Caribbean, hawksbills are known to almost exclusively feed on sponges (Meylan 1988; van Dam and Díez 1997), although at times they have been seen foraging on other food items, notably corallimorphs and zooanthids (León and Díez 2000; Mayor et al. 1998; van Dam and Díez 1997).

Reproductive females undertake periodic (usually non-annual) migrations to their natal beaches to nest and exhibit a high degree of fidelity to their nest sites. Movements of reproductive males are less certain, but are presumed to involve migrations to nesting beaches or to courtship stations along the migratory corridor. Hawksbills show a high fidelity to their foraging areas as well (van Dam and Díez 1998). Foraging sites are typically areas associated with coral reefs, although hawksbills are also found around rocky outcrops and high energy shoals which are optimum sites for sponge growth. They can also inhabit seagrass pastures in mangrove-fringed bays and estuaries, particularly along the eastern shore of continents where coral reefs are absent (Bjorndal 1997; van Dam and Díez 1998).

6.2.7.3 Status and Population Dynamics

There are currently no reliable estimates of population abundance and trends for non-nesting hawksbills at the time of this consultation; therefore, nesting beach data is currently the primary information source for evaluating trends in global abundance. In general, hawksbills are doing better in the Atlantic and Indian Ocean than in the Pacific Ocean, where despite greater overall abundance, a greater proportion of the nesting sites are declining.

From 1980 to 2003, the number of nests at three primary Mexico nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS and USFWS 2013a).

In the United States, hawksbills typically laid about 500 to 1,000 nests on Mona Island, Puerto Rico in the past (Diez and van Dam 2007), but after declining, the numbers appear to be increasing in Puerto Rico (NMFS and USFWS 2013a) and Buck Island US Virgin Islands confirmed 86 nests in 2014 (Pollock 2015). Another 56 to 150 nests are typically laid on Buck Island off St. Croix (Meylan 1999b; Mortimer and Donnelly 2008). Nesting also occurs to a lesser extent on beaches on Culebra Island and Vieques Island in Puerto Rico, the mainland of Puerto Rico, and additional beaches on St. Croix, St. John, and St. Thomas, U.S. Virgin Islands.

With respect to regional trends, nesting populations in the Atlantic (especially in the Insular Caribbean and Western Caribbean Mainland) are generally doing better than those in the Indo-Pacific regions. For instance, nine of the ten sites that showed recent increases are located in the Caribbean. Buck Island and St. Croix’s East End beaches support two remnant populations of between 17 to 30 nesting females per season (Hillis and Mackay 1989; Mackay 2006). The

BIRNM had 86 confirmed hawksbill nests in 2014 (Pollock 2015). While the proportion of hawksbills nesting on Buck Island represents a small proportion of the total hawksbill nesting occurring in the greater Caribbean region, Mortimer and Donnelly (2008) report an increasing trend in nesting at that site based on data collected from 2001 to 2006. The conservation measures implemented when BIRNM was expanded in 2001 most likely explains this increase.

6.2.7.4 Threats

Hawksbills are currently subjected to the same suite of threats on both nesting beaches and in the marine environment that affect other sea turtles (e.g., interaction with federal and state fisheries, coastal construction, oil spills, climate change affecting sex ratios). We discussed some of these in section 6.2.4.1 as relevant to all sea turtle species. There are also specific threats that are of special emphasis, or are unique, for hawksbill sea turtles discussed in further detail below.

The historical decline of the species is primarily attributed to centuries of exploitation for the beautifully patterned shell, which made it a highly attractive species to target (Parsons 1972). The fact that reproductive females exhibit a high fidelity for nest sites and the tendency of hawksbills to nest at regular intervals within a season made them an easy target for capture on nesting beaches. The shells from hundreds of thousands of sea turtles in the western Caribbean region were imported into the United Kingdom and France during the nineteenth and early twentieth centuries (Parsons 1972). Additionally, hundreds of thousands of sea turtles contributed to the region’s trade with Japan prior to 1993 when a zero quota was imposed (Milliken and Tokunaga 1987), as cited in Brautigram and Eckert (2006).

The continuing demand for the hawksbills’ shells as well as other products derived from the species (e.g., leather, oil, perfume, and cosmetics) represents an ongoing threat to its recovery. The British Virgin Islands, Cayman Islands, Cuba, Haiti, and the Turks and Caicos Islands (United Kingdom) all permit some form of legal take of hawksbill sea turtles. In the northern Caribbean, hawksbills continue to be harvested for their shells, which are often carved into hair clips, combs, jewelry, and other trinkets (Márquez M 1990; Stapleton and Stapleton 2006). Additionally, hawksbills are harvested for their eggs and meat, while whole, stuffed sea turtles are sold as curios in the tourist trade. Hawksbill sea turtle products are openly available in the Dominican Republic and Jamaica, despite a prohibition on harvesting hawksbills and their eggs (Fleming 2001). Up to 500 hawksbills per year from two harvest sites within Cuba were legally captured each year until 2008 when the Cuban government placed a voluntary moratorium on the sea-turtle fishery (Carillo et al. 1999; Mortimer and Donnelly 2008). While current nesting trends are unknown, the number of nesting females is suspected to be declining in some areas (Carillo et al. 1999; Moncada et al. 1999). International trade in the shell of this species is prohibited between countries that have signed CITES, but illegal trade still occurs and remains an ongoing threat to hawksbill survival and recovery throughout its range.

Due to their preference to feed on sponges associated with coral reefs, hawksbill sea turtles are particularly sensitive to losses of coral reef communities. Coral reefs are vulnerable to destruction and degradation caused by human activities (e.g., nutrient pollution, sedimentation, contaminant spills, vessel groundings and anchoring, recreational uses) and are also highly sensitive to the effects of climate change (e.g., higher incidences of disease and coral bleaching) (Crabbe 2008; Wilkinson 2004). Because continued loss of coral reef communities (especially in the greater Caribbean region) is expected to impact hawksbill foraging, it represents a major threat to the recovery of the species.

6.2.8 Leatherback Turtles

The leatherback sea turtle was listed as endangered throughout its entire range on June 2, 1970, under the Endangered Species Conservation Act of 1969.

6.2.8.1 Species Description and Distribution

The leatherback is the largest sea turtle in the world, with a curved carapace length often exceeding five feet (150 centimeters) and front flippers that can span almost nine feet (270 centimeters) (NMFS and USFWS 1998b). Mature males and females can reach lengths of over six fee (two meters) and weigh close to 2,000 pounds (900 kilograms). The leatherback does not have a bony shell. Instead, its shell is approximately 1.5 inches (four centimeters) thick and consists of a leathery, oil-saturated connective tissue overlaying loosely interlocking dermal bones. The ridged shell and large flippers help the leatherback during its long-distance trips in search of food.

Unlike other sea turtles, leatherbacks have several unique traits that enable them to live in cold water. For example, leatherbacks have a countercurrent circulatory system[27] (Greer et al. 1973), a thick layer of insulating fat (Davenport et al. 1990; Goff and Lien 1988), gigantothermy[28] (Paladino et al. 1990), and they can increase their body temperature through increased metabolic activity (Bostrom and Jones 2007; Southwood et al. 2005). These adaptations allow leatherbacks to be comfortable in a wide range of temperatures, which helps them to travel further than any other sea turtle species (NMFS and USFWS 1995b). For example, a leatherback may swim more than 6,000 miles (10,000 kilometers) in a single year (Benson et al. 2007a; Benson et al. 2011; Eckert 2006; Eckert et al. 2006). They search for food between latitudes 71°N and 47°S, in all oceans, and travel extensively to and from their tropical nesting beaches.

While leatherbacks will look for food in coastal waters, they appear to prefer the open ocean at all life stages (Heppell et al. 2003b). Leatherbacks have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied prey such as jellyfish and salps. A leatherback's

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[27] Countercurrent circulation is a highly efficient means of minimizing heat loss through the skin's surface because heat is recycled. For example, a countercurrent circulation system often has an artery containing warm blood from the heart surrounded by a bundle of veins containing cool blood from the body's surface. As the warm blood flows away from the heart, it passes much of its heat to the colder blood returning to the heart via the veins. This conserves heat by recirculating it back to the body's core.

[28] "Gigantothermy" refers to a condition when an animal has relatively high volume compared to its surface area, and as a result, it loses less heat.

mouth and throat also have backward-pointing spines that help retain jelly-like prey. Leatherbacks' favorite prey (e.g., medusae, siphonophores, and salps) occur commonly in temperate and northern or sub-arctic latitudes and likely has a strong influence on leatherback distribution in these areas (Plotkin 1995). Leatherbacks are known to be deep divers, with recorded depths in excess of a half-mile (Eckert et al. 1989), but they may also come into shallow waters to locate prey items. In the Atlantic Ocean, they are found as far north as the North Sea, Barents Sea, Newfoundland, and Labrador and as far south as Argentina and the Cape of Good Hope, South Africa (NMFS USFWS 2013). In the U.S., important nesting areas include Florida, St. Croix U.S. Virgin Islands, and Puerto Rico. Other islands of the Caribbean south to Brazil and Venezuela are also important nesting areas in the western Atlantic (NMFS USFWS 2013). Figure 29 displays subpopulation nesting areas and ranges.

Genetic analyses using microsatellite markers along with mitochondrial DNA and tagging data indicate there are seven groups or breeding populations in the Atlantic Ocean: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG 2007). General differences in migration patterns and foraging grounds may occur between the seven nesting assemblages, although data to support this is limited in most cases.

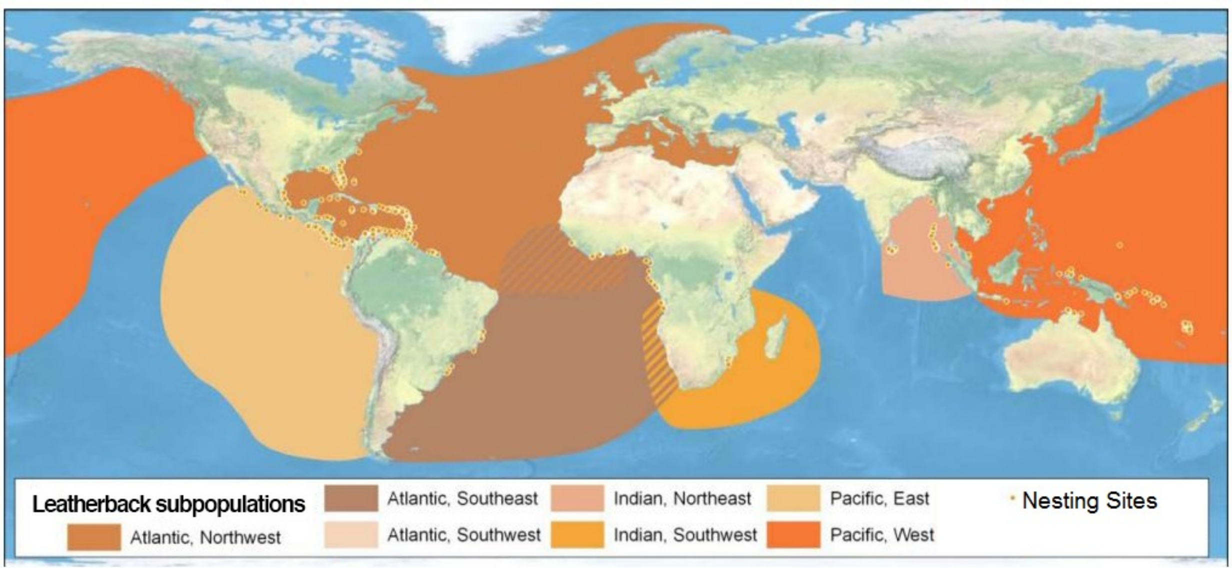


Figure 29. Map identifying the range of the endangered leatherback sea turtle. Adapted from (Wallace et al. 2010).

6.2.8.2 Life History Information

The leatherback life cycle is broken into several stages: (1) egg/hatchling, (2) post-hatchling, (3) juvenile, (4) subadult, and (5) adult. Leatherbacks are a long-lived species that delay age of maturity, have low and variable survival in the egg and juvenile stages, and have relatively high and constant annual survival in the subadult and adult life stages (Chaloupka 2002; Crouse 1999; Heppell et al. 1999; Heppell et al. 2003b; Spotila et al. 1996; Spotila et al. 2000). While a robust estimate of the leatherback sea turtle's life span does not exist, the current best estimate for the maximum age is 43 (Avens et al. 2009). It is still unclear when leatherbacks first become sexually mature. Age at maturity has been difficult to ascertain, with estimates ranging from five to 29 years (Avens et al. 2009; Spotila et al. 1996). Using skeletochronological data, Avens et al. (2009) estimated that leatherbacks in the western North Atlantic may not reach maturity until 29 years of age, which is longer than earlier estimates of two to three years by Pritchard and Trebbau (1984), of three to six years by Rhodin (1985), of 13 to 14 years for females by Zug and Parham (1996), and 12 to 14 years for leatherbacks nesting in the U.S. Virgin Islands by Dutton et al. (2005). A more recent study that examined leatherback growth rates estimated an age at maturity of 16.1 years (Jones et al. 2011).

The average size of reproductively active females in the Atlantic is generally 5 to 5.5 ft (150 to 162 centimeters) CCL (Benson et al. 2007a; Hirth et al. 1993; Starbird and Suarez 1994). Still, females as small as 3.5 to 4 feet (105 to 125 centimeters) CCL have been observed nesting at various sites (Stewart et al. 2007). In the Atlantic Ocean, equatorial waters appear to be a barrier between breeding populations. In the northwestern Atlantic Ocean, post-nesting female migrations appear to be restricted to north of the Equator but the migration routes vary (Eckert et al. 2012; Saba 2013 as cited in NMFS USFWS 2013). Genetic studies support the satellite telemetry data indicating a strong difference in migration and foraging fidelity between the breeding populations in the northern and southern hemispheres of the Atlantic Ocean (Dutton et al. 2013b; Stewart et al. 2013 as cited in NMFS USFWS 2013).

Female leatherbacks typically nest on sandy, tropical beaches at intervals of one to seven years (Garcia M. and Sarti 2000; McDonald and Dutton 1996; Spotila et al. 2000). Unlike other sea turtle species, female leatherbacks do not always nest at the same beach year after year; some females may even nest at different beaches during the same year (Dutton et al. 2005; Eckert et al. 1989; Keinath and Musick 1993; Steyermark et al. 1996). Individual female leatherbacks have been observed with fertility spans as long as 25 years (Hughes 1996). Females usually lay up to 10 nests during the three to six month nesting season (March through July in the United States), typically eight to 12 days apart, with 100 eggs or more per nest (Eckert et al. 2012; Eckert et al. 1989; Maharaj 2004; Matos ; Stewart and Johnson 2006; Tucker 1988). Yet, up to approximately 30 percent of the eggs may be infertile (Eckert et al. 1989; Maharaj 2004; Matos ; MTN 1984; Stewart and Johnson 2006; Tucker 1988). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately 50 percent worldwide (Eckert et al. 2012). Eggs hatch after 60 to 65 days, and the hatchlings have white striping along the ridges of their backs and on the edges of the flippers. Leatherback hatchlings weigh approximately 1.5 to 2 ounces (40 to 50 grams), and are approximately two to three inches (51 to 76 millimeters) in length, with fore flippers as long as their bodies. Hatchlings grow rapidly with reported growth rates for leatherbacks from 2.5 to 27.6 inches (six to 70 centimeters) in length, estimated at 12.6 inches (32 centimeters) per year (Jones et al. 2011).

In the Atlantic, the sex ratio appears to be skewed toward females. The Turtle Expert Working Group (TEWG) reports that nearshore and onshore strandings data from the U.S. Atlantic and Gulf of Mexico coasts indicate that 60 percent of strandings were females (TEWG 2007). Those data also show that the proportion of females among adults (57 percent) and juveniles (61 percent) was also skewed toward females in these areas (TEWG 2007). James et al. (2007) collected size and sex data from large subadult and adult leatherbacks off Nova Scotia and also concluded a bias toward females at a rate of 1.86:1.

The survival and mortality rates for leatherbacks are difficult to estimate and vary by location. For example, the annual mortality rate for leatherbacks that nested at Playa Grande, Costa Rica, was estimated to be 34.6 percent in 1993 to 1994 and 34.0 percent in 1994 to 1995 (Spotila et al. 2000). In contrast, leatherbacks nesting in French Guiana and St. Croix had estimated annual survival rates of 91 percent (Rivalan et al. 2005) and 89 percent (Dutton et al. 2005), respectively. For the St. Croix population, the average annual juvenile survival rate was estimated to be approximately 63 percent and the total survival rate from hatchling to first year of reproduction for a female was estimated to be between 0.4 percent and two percent (assuming age at first reproduction is between nine and 13 years (Eguchi et al. 2006)). Spotila et al. (1996) estimated first-year survival rates for leatherbacks at 6.25 percent.

Migratory routes of leatherbacks are not entirely known; however, recent information from satellite tags have documented long travels between nesting beaches and foraging areas in the Atlantic and Pacific Ocean basins (Benson et al. 2007a; Benson et al. 2011; Eckert 2006; Eckert et al. 2006; Ferraroli et al. 2004; Hays et al. 2004; James et al. 2005a). Leatherbacks nesting in Central America and Mexico travel thousands of miles through tropical and temperate waters of the South Pacific (Eckert and Sarti 1997; Shillinger et al. 2008). Data from satellite tagged leatherbacks suggest that they may be traveling in search of seasonal aggregations of jellyfish (Benson et al. 2007b; Bowlby et al. 1994; Graham 2009; Shenker 1984; Starbird et al. 1993; Suchman and Brodeur 2005).

6.2.8.3 Status and Population Dynamics

The status of the Atlantic leatherback population has been less clear than the Pacific population, which has shown dramatic declines at many nesting sites (Santidrián-Tomillo et al. 2007; Sarti Martínez et al. 2007; Spotila et al. 2000). This uncertainty has been a result of inconsistent beach and aerial surveys, cycles of erosion, and reformation of nesting beaches in the Guianas (representing the largest nesting area). Leatherbacks also show a lesser degree of nest-site fidelity than occurs with the hardshell sea turtle species. Coordinated efforts of data collection and analyses by the leatherback TEWG have helped to clarify the understanding of the Atlantic population status (TEWG 2007).

Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean. Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherbacks must consume large quantities to support their body weight. Leatherbacks weigh about 33 percent more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (James et al. 2005b; Wallace et al. 2006). Sea turtles must meet an energy threshold before returning to nesting beaches. Therefore, their remigration intervals (the time between nesting) are dependent upon foraging success and duration (Hays 2000; Price et al. 2004).

The Southern Caribbean/Guianas stock is the largest known Atlantic leatherback nesting aggregation (TEWG 2007). Using nesting females as a proxy for population, the TEWG (2007) determined that the Southern Caribbean/Guianas stock had demonstrated a long-term, positive population growth rate.

Nesting data for the Northern Caribbean stock is available from Puerto Rico, St. Croix (U.S. Virgin Islands), and the British Virgin Islands (Tortola). In Puerto Rico, the primary nesting beaches are at Fajardo and on the island of Culebra. At the primary nesting beach on St. Croix, the Sandy Point National Wildlife Refuge, nesting has varied from a few hundred nests to a high of 1,008 in 2001, and the average annual growth rate has been approximately 1.1 percent from 1986 to 2004 (TEWG 2007). Nesting in Tortola is limited, but has been increasing from zero to six nests per year in the late 1980s to 35 to 65 per year in the 2000s, with an annual growth rate of approximately 1.2 percent between 1994 and 2004 (TEWG 2007).

The Florida nesting stock nests primarily along the east coast of Florida. This stock is of growing importance, with total nests between 600 and 700 per year in the 2000s following nesting totals fewer than 100 nests per year in the 1980s (Florida Fish and Wildlife Conservation Commission data available at http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/). Using data from the index nesting beach surveys, the TEWG (TEWG 2007) estimated a significant annual nesting growth rate of 1.17 percent between 1989 and 2005. FWC Index Nesting Beach Survey Data indicates biennial peaks in nesting abundance beginning in 2007 (Figure 30). A similar pattern was also observed statewide (Table 28). This up-and-down pattern is thought to be a result of the cyclical nature of leatherback nesting, similar to the biennial cycle of green turtle nesting. Overall, the trend shows growth on Florida's east coast beaches.

Table 28. Number of leatherback sea turtle nests in Florida.

Nests Recorded	2010	2011	2012	2013	2016
Index Nesting Beaches	552	625	515	322	319
Statewide	1,334	1,653	1,712	896	1,054

Data from *http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/*.

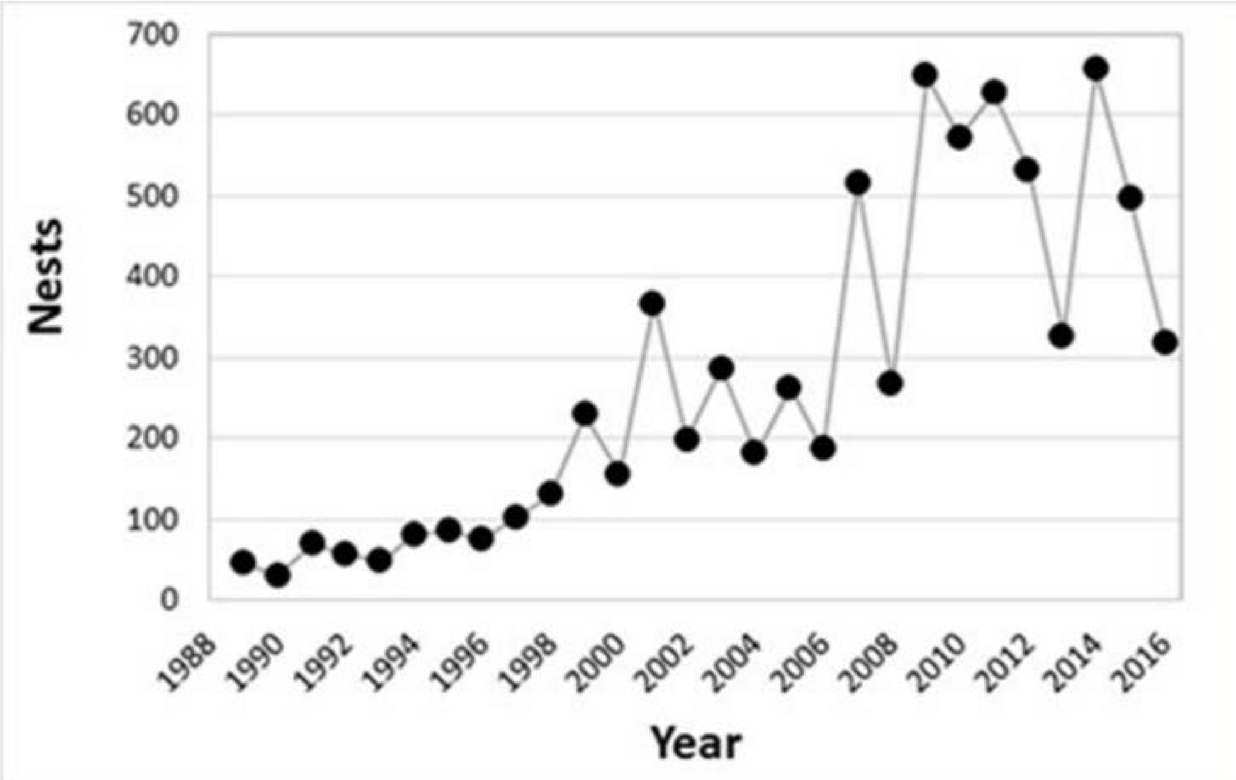


Figure 30. Leatherback sea turtle nesting at Florida index beaches since 1989 to 2016. Figure from http://myfwc.com/research/wildlife/sea-turtles/nesting/beach-survey-totals/ accessed June 19, 2017.

Because the available nesting information is inconsistent, it is difficult to estimate the total population size for Atlantic leatherbacks. Spotila et al. (1996) characterized the entire Western Atlantic population as stable at best and estimated a population of 18,800 nesting females. Spotila et al. (1996) further estimated that the adult female leatherback population for the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa, was about 27,600 (considering both nesting and interesting females), with an estimated range of 20,082 to 35,133. This is consistent with the estimate of 34,000 to 95,000 total adults (20,000 to 56,000 adult females; 10,000 to 21,000 nesting females) determined by the TEWG (2007). The latest review by NMFS and USFWS (2013d) suggests the leatherback nesting population is stable in most nesting regions of the Atlantic Ocean.

6.2.8.4 Threats

Leatherbacks face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease. We discussed some of these in section 6.2.4.1 as relevant to all sea turtle species. This section will expand on a few of the aforementioned threats and how they may specifically impact leatherback sea turtles.

Of all sea turtle species, leatherbacks seem to be the most vulnerable to entanglement in fishing gear, especially gillnet and pot/trap lines. This may be because of their body type (large size, long pectoral flippers, and lack of a hard shell), their attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface, their method of locomotion, and/or perhaps their attraction to the lightsticks used to attract target species in longline fisheries. From 1990 to 2000, 92 entangled leatherbacks were reported from New York through Maine and many other stranded individuals exhibited evidence of prior entanglement (Dwyer 2004). Zug and Parham (1996) point out that a combination of the loss of long-lived adults in fishery-related mortalities and a lack of recruitment from intense egg harvesting in some areas has caused a sharp decline in leatherback sea turtle populations and represents a significant threat to survival and recovery of the species worldwide.

Leatherback sea turtles may also be more susceptible to marine debris ingestion than other sea turtle species due to their predominantly pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding and migratory purposes (Lutcavage et al. 1997a; Shoop and Kenney 1992). The stomach contents of leatherback sea turtles revealed that a substantial percentage (33.8 percent or 138 of 408 cases examined) contained some form of plastic debris (Mrosovsky et al. 2009). Blocking of the gut by plastic to an extent that could have caused death was evident in 8.7 percent of all leatherbacks that ingested plastic (Mrosovsky et al. 2009). Mrosovsky et al. (2009) also note that in a number of cases, the ingestion of plastic may not cause death outright, but could cause the animal to absorb fewer nutrients from food, eat less in general, etc. – factors which could cause other adverse effects. The presence of plastic in the digestive tract suggests that leatherbacks might not be able to distinguish between prey items and forms of debris such a plastic bags (Mrosovsky et al. 2009). Balazs (1985) speculated that the plastic object might resemble a food item by its shape, color, size, or even movement as it drifts about, and therefore induce a feeding response in leatherbacks.

As discussed in Section 7.1, global climate change can be expected to have various impacts on all sea turtles, including leatherbacks. Global climate change is likely to also influence the distribution and abundance of jellyfish, the primary prey item of leatherbacks (NMFS and USFWS 2007e). Several studies have shown leatherback distribution is influenced by jellyfish abundance (e.g., Houghton et al. 2006; Witt et al. 2007; Witt et al. 2006); however, more studies need to be done to monitor how changes to prey items affect distribution and foraging success of leatherbacks so population-level effects can be determined.

6.2.9 Loggerhead Turtles (Northwest Atlantic Ocean Distinct Population Segment)

The loggerhead sea turtle was listed as a threatened species throughout its global range on July 28, 1978. NMFS and USFWS published a final rule designating nine DPSs for loggerhead sea turtles on September 22, 2011, which became effective October 24, 2011. The Northwest Atlantic (NWA) DPS is the only one that occurs within the action area and therefore is the only one considered in this opinion.

6.2.9.1 Species Description and Distribution

Loggerheads are large sea turtles. Adults in the southeast United States average about three feet (92 centimeters) long, measured as a SCL, and weigh approximately 255 pounds (116 kilograms) (Ehrhart and Yoder 1978). Adult and subadult loggerhead sea turtles typically have a light yellow plastron and a reddish brown carapace covered by non-overlapping scutes that meet along seam lines. They typically have 11 or 12 pairs of marginal scutes, five pairs of costals, five vertebrals, and a nuchal (precentral) scute that is in contact with the first pair of costal scutes (Dodd 1988).

The loggerhead sea turtle inhabits continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans (Dodd 1988). Habitat uses within these areas vary by life stage. Juveniles are omnivorous and forage on crabs, mollusks, jellyfish, and vegetation at or near the surface (Dodd 1988). Subadult and adult loggerheads are primarily found in coastal waters and eat benthic invertebrates such as mollusks and decapod crustaceans in hard-bottom habitats.

The majority of loggerhead nesting occurs at the western rims of the Atlantic and Indian Oceans concentrated in the north and south temperate zones and subtropics (NRC 1990b). For the NWA DPS, most nesting occurs along the East coast of the United States, from southern Virginia to Alabama. Additional nesting beaches for this DPS are found along the northern and western Gulf of Mexico, eastern Yucatán Peninsula, at Cay Sal Bank in the eastern Bahamas (Addison 1997; Addison and Morford 1996), off the southwestern coast of Cuba (Gavilan 2001), and along the coasts of Central America, Colombia, Venezuela, and the eastern Caribbean Islands.

Non-nesting, adult female loggerheads are reported throughout the U.S. Atlantic, Gulf of Mexico, and Caribbean Sea. Little is known about the distribution of adult males who are seasonally abundant near nesting beaches.

The recovery plan for the Northwest Atlantic population of loggerhead sea turtles concluded that there is no genetic distinction between loggerheads nesting on adjacent beaches along the Florida Peninsula (NMFS and USFWS 2008c). It also concluded that specific boundaries for subpopulations could not be designated based on genetic differences alone. Thus, the recovery plan uses a combination of geographic distribution of nesting densities, geographic separation, and geopolitical boundaries, in addition to genetic differences, to identify recovery units. The recovery units are as follows: (1) the Northern Recovery Unit (Florida/Georgia border north through southern Virginia), (2) the Peninsular Florida Recovery Unit (Florida/Georgia border through Pinellas County, Florida), (3) the Dry Tortugas Recovery Unit (islands located west of Key West, Florida), (4) the Northern Gulf of Mexico Recovery Unit (Franklin County, Florida, through Texas), and (5) the Greater Caribbean Recovery Unit (Mexico through French Guiana, the Bahamas, Lesser Antilles, and Greater Antilles) (NMFS and USFWS 2008b). The recovery plan concluded that all recovery units are essential to the recovery of the species. Although the recovery plan was written prior to the listing of the NWA DPS, the recovery units for what was then termed the Northwest Atlantic population apply to the NWA DPS.

6.2.9.2 Life History Information

The Northwest Atlantic Loggerhead Recovery Team defined the following eight life stages for the loggerhead life cycle, which include the ecosystems those stages generally use: (1) egg (terrestrial zone), (2) hatchling stage (terrestrial zone), (3) hatchling swim frenzy and transitional stage (neritic zone[29]), (4) juvenile stage (oceanic zone), (5) juvenile stage (neritic zone), (6) adult stage (oceanic zone), (7) adult stage (neritic zone), and (8) nesting female (terrestrial zone) (NMFS and USFWS 2008). Loggerheads are long-lived animals. They reach sexual maturity between 20 and 38 years of age, although age of maturity varies widely among populations (Frazer and Ehrhart 1985; NMFS 2001). The annual mating season occurs from late March to early June, and female turtles lay eggs throughout the summer months. Females deposit an average of 4.1 nests within a nesting season (Murphy and Hopkins 1984), but an individual female only nests every 3.7 years on average (Tucker 2010). Each nest contains an average of 100 to 126 eggs (Dodd 1988) which incubate for 42 to 75 days before hatching (NMFS and USFWS 2008b). Loggerhead hatchlings are 1.5 to two inches long and weigh about 0.7 ounces (20 grams).

As post-hatchlings, loggerheads hatched on U.S. beaches enter the "oceanic juvenile" life stage, migrating offshore and becoming associated with *Sargassum* habitats, driftlines, and other convergence zones (Carr 1986; Conant et al. 2009; Witherington 2002). Oceanic juveniles grow at rates of one to two inches (2.9 to 5.4 centimeters) per year (Bjorndal et al. 2003; Snover 2002) over a period as long as seven to 12 years (Bolten et al. 1998) before moving to more coastal habitats. Studies have suggested that not all loggerhead sea turtles follow the model of circumnavigating the North Atlantic Gyre as pelagic juveniles, followed by permanent settlement into benthic environments (Bolten and Witherington 2003; Laurent et al. 1998). These studies suggest some turtles may either remain in the oceanic habitat in the North Atlantic longer than hypothesized, or they move back and forth between oceanic and coastal habitats interchangeably (Witzell 2002). Stranding records indicate that when immature loggerheads reach 15 to 24 inches (40 to 60 centimeters) SCL, they begin to reside in coastal inshore waters of the continental shelf throughout the U.S. Atlantic and Gulf of Mexico (Witzell 2002).

After departing the oceanic zone, neritic juvenile loggerheads in the Northwest Atlantic inhabit continental shelf waters from Cape Cod Bay, Massachusetts, south through Florida, the Bahamas, Cuba, and the Gulf of Mexico. Estuarine waters of the United States, including areas such as Long Island Sound, Chesapeake Bay, Pamlico and Core Sounds, Mosquito and Indian River Lagoons, Biscayne Bay, Florida Bay, and numerous embayments fringing the Gulf of Mexico,

[29] Neritic refers to the nearshore marine environment from the surface to the sea floor where water depths do not exceed 200 meters.

comprise important inshore habitat. Along the Atlantic and Gulf of Mexico shoreline, essentially all shelf waters are inhabited by loggerheads (Conant et al. 2009).

Like juveniles, non-nesting adult loggerheads also use the neritic zone. However, these adult loggerheads do not use the relatively enclosed shallow-water estuarine habitats with limited ocean access as frequently as juveniles. Areas such as Pamlico Sound, North Carolina, and the Indian River Lagoon, Florida, are regularly used by juveniles but not by adult loggerheads. Adult loggerheads do tend to use estuarine areas with more open ocean access, such as the Chesapeake Bay in the U.S. mid-Atlantic. Shallow-water habitats with large expanses of open ocean access, such as Florida Bay, provide year-round resident foraging areas for significant numbers of male and female adult loggerheads (Conant et al. 2009).

Offshore, adults primarily inhabit continental shelf waters, from New York south through Florida, the Bahamas, Cuba, and the Gulf of Mexico. Seasonal use of mid-Atlantic shelf waters, especially offshore New Jersey, Delaware, and Virginia during summer months, and offshore shelf waters, such as Onslow Bay (off the North Carolina coast), during winter months has also been documented (Hawkes et al. 2014; Hawkes et al. 2007). Satellite telemetry has identified the shelf waters along the west Florida coast, the Bahamas, Cuba, and the Yucatán Peninsula as important resident areas for adult female loggerheads that nest in Florida (Foley et al. 2008a; Girard et al. 2009; Hart et al. 2012). The southern edge of the Grand Bahama Bank is important habitat for loggerheads nesting on the Cay Sal Bank in The Bahamas, but nesting females are also resident in the bights of Eleuthera, Long Island, and Ragged Islands. They also reside in Florida Bay in the United States. Moncada et al. (2010) report the recapture in Cuban waters of five adult female loggerheads originally flipper-tagged in Quintana Roo, Mexico, indicating that Cuban shelf waters likely also provide foraging habitat for adult females that nest in Mexico.

6.2.9.3 Status and Population Dynamics

A number of stock assessments and similar reviews (Conant et al. 2009; Heppell et al. 2003a; NMFS-SEFSC 2001; NMFS-SEFSC 2009a; NMFS and USFWS 2008b; TEWG 1998; TEWG 2000; TEWG 2009) have examined the stock status of loggerheads in the Atlantic Ocean, but none have been able to develop a reliable estimate of absolute population size.

Numbers of nests and nesting females can vary widely from year to year. Nesting beach surveys, though, can provide a reliable assessment of trends in the adult female population, due to the strong nest site fidelity of female loggerhead sea turtles, as long as such studies are sufficiently long and survey effort and methods are standardized (e.g., (NMFS and USFWS 2008b). NMFS and USFWS (NMFS and USFWS 2008b) concluded that the lack of change in two important demographic parameters of loggerheads, remigration interval and clutch frequency, indicate that time series on numbers of nests can provide reliable information on trends in the female population.

Peninsular Florida Recovery Unit

The Peninsular Florida Recovery Unit is the largest loggerhead nesting assemblage in the Northwest Atlantic. A near-complete nest census (all beaches including index nesting beaches) undertaken from 1989 to 2007 showed an average of 64,513 loggerhead nests per year, representing approximately 15,735 nesting females per year (NMFS and USFWS 2008b). The statewide estimated total for 2016 was 122,706 nests and 18,631 of those from Florida's Gulf coast (FWRI nesting database).

Since the start of the Florida Index Nesting Beach Survey program in 1989, counts of loggerhead nests on Florida beaches have ranged from a minimum of 28,876 in 2007 to a maximum of 65,807 nests in 2016 (note: these numbers do not represent Florida's total annual nest counts because they are collected only on a subset of beaches and only during a 109-day time window) (FFWCC 2018). Following a 52 percent increase between 1989 and 1998, nest counts declined sharply (53 percent) over nearly a decade (1998-2007). However, annual nest counts showed a strong increase (65 percent) since then (2007-2017) (FFWCC 2018). Index beaches in the Florida Panhandle, which are not part of the set of core beaches, had the second highest loggerhead nest counts in 2017 since these surveys to detect trends began in that area in 1997. Based on the currently available information, NMFS categorizes the loggerhead Northwest Atlantic DPS population trend as being stable (NMFS 2017h).

In addition to the total nest count estimates, the Florida Fish and Wildlife Research Institute uses an index nesting beach survey method. The index survey uses standardized data-collection criteria to measure seasonal nesting and allow accurate comparisons between beaches and between years. This provides a better tool for understanding the nesting trends (Figure 31). FWRI performed a detailed analysis of the long-term loggerhead index nesting data (1989 to 2013) (http://myfwc.com/research/wildlife/sea-turtles/nesting/). Over that time period, three distinct trends were identified. From 1989 to 1998, there was a 30 percent increase that was then followed by a sharp decline over the subsequent decade. Large increases in loggerhead nesting occurred since then. FWRI examined the trend from the 1998 nesting high through 2013 and found the decade-long post-1998 decline had reversed and there was no longer a demonstrable trend. Looking at the data from 1989 through 2016, FWRI concluded that there was an overall positive change in the nest countsbut that change was not statistically significant (http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trend/ accessed on June 13, 2017).

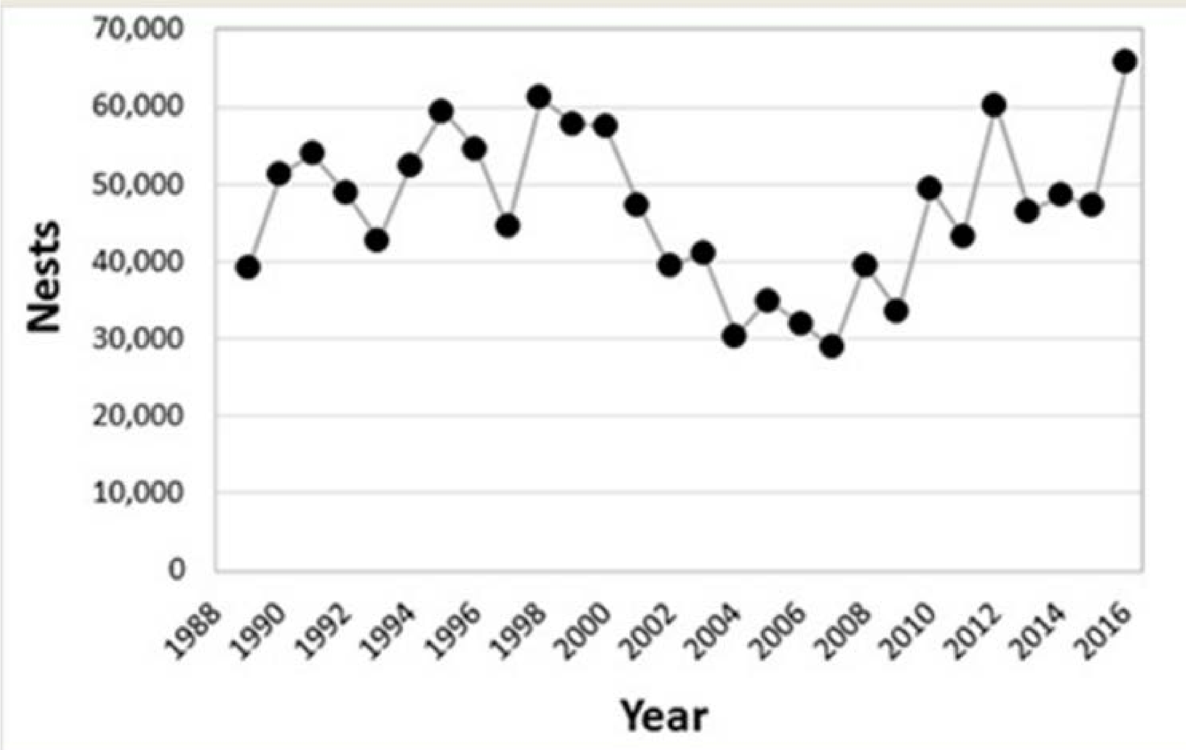


Figure 31. Loggerhead sea turtle nesting at Florida index beaches since 1989. Survey effort remained nearly identical. (Figure from Florida Fish and Wildlife Conservation Commission website on June 13, 2017- http://myfwc.com/research/wildlife/sea-turtles/nesting/).

Northern Recovery Unit

Annual nest totals from beaches within the Northern Recovery Unit averaged 5,215 nests from 1989 to 2008, a period of near-complete surveys of NRU nesting beaches (Georgia Department of Natural Resources [GADNR] unpublished data, North Carolina Wildlife Resources Commission [NCWRC] unpublished data, South Carolina Department of Natural Resources [SCDNR] unpublished data), and represent approximately 1,272 nesting females per year, assuming 4.1 nests per female (Murphy and Hopkins 1984). The loggerhead nesting trend from daily beach surveys showed a significant decline of 1.3 percent annually from 1989 to 2008. Nest totals from aerial surveys conducted by SCDNR showed a 1.9 percent annual decline in nesting in South Carolina from 1980 to 2008. Overall, there is strong statistical data to suggest the Northern Recovery Unite had experienced a long-term decline over that period of time.

Data since that analysis (Table 29) are showing improved nesting numbers and a departure from the declining trend. Georgia nesting has rebounded to show the first statistically significant increasing trend since comprehensive nesting surveys began in 1989 (Mark Dodd, GADNR press release). South Carolina and North Carolina nesting have also begun to show a shift away from the declining trend of the past.

Table 29. Total number of loggerhead nests in the northern recovery unit.

Nests Recorded	2008	2009	2010	2011	2012	2013	2014
Georgia	1,649	998	1,760	1,992	2,241	2,289	1,196
South Carolina	4,500	2,182	3,141	4,015	4,615	5,193	2,083
North Carolina	841	302	856	950	1,074	1,260	542
Total	6,990	3,472	5,757	6,957	7,930	8,742	3,821

Data from each states' department of natural resources nesting datasets.

South Carolina also conducts an index beach nesting survey similar to the one described for Florida. Although the survey only includes a subset of nesting, the standardized effort and locations allow for a better representation of the nesting trend over time. Increases in nesting were seen for the period from 2009 to 2012, with 2012 showing the highest index nesting total since the start of the program (Figure 32).

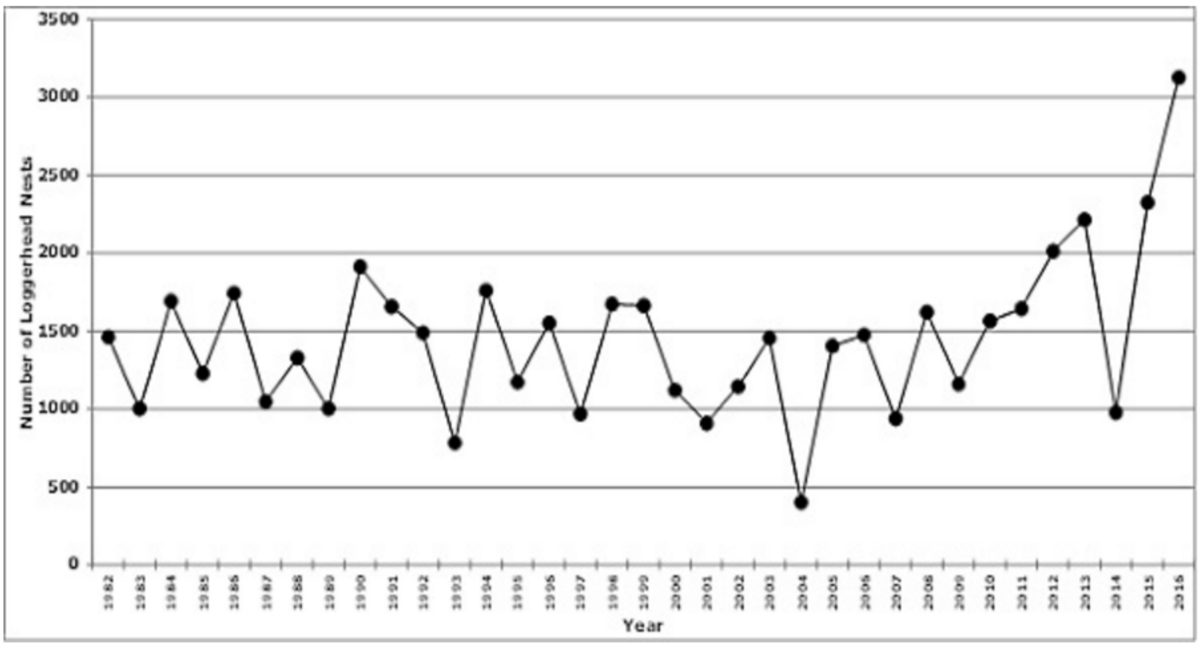


Figure 32. South Carolina index nesting beach counts for loggerhead sea turtles (from the South Caroloina Department of Natural Resources website on June 13, 2017, http://www.dnr.sc.gov/seaturtle/nest.htm)

Other NW Atlantic DPS Recovery Units

The remaining three recovery units—Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean—are much smaller nesting assemblages, but they are still considered essential to the continued existence of the species. Nesting surveys for the Dry Tortugas are conducted as part of Florida's statewide survey program. Survey effort was relatively stable during the nine-year period from 1995 to 2004, although the 2002 year was missed. Nest counts ranged from 168 to 270, with a mean of 246, but there was no detectable trend during this period (NMFS and USFWS 2008b). Nest counts for the Northern Gulf of Mexico are focused on index beaches rather than all beaches where nesting occurs. Analysis of the 12-year dataset (1997 to 2008) of index nesting beaches in the area shows a statistically significant declining trend of 4.7 percent annually. Nesting on the Florida Panhandle index beaches, which represents the majority of Northern Gulf of Mexico nesting, had shown a large increase in 2008, but then declined again in 2009 and 2010 before rising back to a level similar to the 2003 to 2007 average in 2011. Nesting survey effort has been inconsistent among the greater Caribbean nesting beaches, and no trend can be determined for this subpopulation (NMFS and USFWS 2008b). Zurita et al. (Zurita et al. 2003) found a statistically significant increase in the number of nests on seven of the beaches on Quintana Roo, Mexico from 1987 to 2001, where survey effort was consistent during the period. Nonetheless, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS and USFWS 2008b).

In-water Trends

Nesting data are the best current indicator of sea turtle population trends, but in-water data also provide some insight. In-water research suggests the abundance of neritic juvenile loggerheads is steady or increasing. Although Ehrhart et al. (2007) found no significant regression-line trend in a long-term dataset, researchers have observed notable increases in catch per unit effort (Arendt et al. 2009; Ehrhart et al. 2007; Epperly et al. 2007). Researchers believe that this increase in catch per unit effort is likely linked to an increase in juvenile abundance, although it is unclear whether this increase in abundance represents a true population increase among juveniles or merely a shift in spatial occurrence. Bjorndal et al. (2005), cited in NMFS and USFWS (NMFS and USFWS 2008b), caution about extrapolating localized in-water trends to the broader population and relating localized trends in neritic sites to population trends at nesting beaches. The apparent overall increase in the abundance of neritic loggerheads in the southeastern United States may be due to increased abundance of the largest oceanic/neritic juveniles (historically referred to as small benthic juveniles), which could indicate a relatively large number of individuals around the same age may mature in the near future (TEWG 2009). In-water studies throughout the eastern United States, however, indicate a substantial decrease in the abundance of the smallest oceanic/neritic juvenile loggerheads, a pattern corroborated by stranding data (TEWG 2009).

Population Estimate

The NMFS Southeast Fishery Science Center developed a preliminary stage/age demographic model to help determine the estimated impacts of mortality reductions on loggerhead sea turtle population dynamics (NMFS-SEFSC 2009a). The model uses the range of published information for the various parameters including mortality by stage, stage duration (years in a stage), and fecundity parameters such as eggs per nest, nests per nesting female, hatchling emergence success, sex ratio, and remigration interval. Resulting trajectories of model runs for each individual recovery unit, and the western North Atlantic population as a whole, were found to be very similar. The model run estimates, from the adult female population size for the western North Atlantic (from the 2004-2008 time frame), suggest the adult female population size approximately 20,000 to 40,000 individuals, with a low likelihood of being up to 70,000 (NMFS-SEFSC 2009a). A less robust estimate for total benthic females in the western North Atlantic was also obtained, yielding approximately 30,000 to 300,000 individuals, up to less than one million (NMFS-SEFSC 2009a). A preliminary regional abundance survey of loggerheads within the northwestern Atlantic continental shelf for positively identified loggerhead in all strata estimated about 588,000 loggerheads (interquartile range of 382,000 to 817,000). When correcting for unidentified turtles in proportion to the ratio of identified turtles, the estimate increased to about 801,000 loggerheads (interquartile range of 521,000 to 1,111,000) (NEFSC 2011).

6.2.9.4 Threats

The threats faced by loggerhead sea turtles are well-summarized in the general discussion of threats in Section 6.2.4.1. Yet the impact of fishery interactions is a point of further emphasis for this species. The joint NMFS and USFWS Loggerhead Biological Review Team determined that the greatest threats to the NWA DPS of loggerheads result from cumulative fishery bycatch in neritic and oceanic habitats (Conant et al. 2009).

Regarding the impacts of pollution, loggerheads may be particularly affected by organochlorine contaminants; they have the highest organochlorine concentrations (Storelli et al. 2008) and metal loads (D'Ilio et al. 2011) in sampled tissues among the sea turtle species. It is thought that dietary preferences were likely to be the main differentiating factor among sea turtle species. Storelli et al. (2008) analyzed tissues from stranded loggerhead sea turtles and found that mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals, and porpoises (Law et al. 1991a).

Specific information regarding potential climate change impacts on loggerheads is also available. Modeling suggests an increase of two degrees Celsius in air temperature would result in a sex ratio of over 80 percent female offspring for loggerheads nesting near Southport, North Carolina. The same increase in air temperatures at nesting beaches in Cape Canaveral, Florida, would result in close to 100 percent female offspring. Such highly skewed sex ratios could undermine the reproductive capacity of the species. More ominously, an air temperature increase of three degeres Celsius is likely to exceed the thermal threshold of most nests, leading to egg mortality (Hawkes et al. 2007). Warmer sea surface temperatures have also been correlated with an earlier onset of loggerhead nesting in the spring (Hawkes et al. 2007; Weishampel et al. 2004), short inter-nesting intervals (Hays et al. 2002), and shorter nesting seasons (Pike et al. 2006).

6.2.10 Critical Habitat for the Northwest Atlantic Loggerhead Sea Turtles

As mentioned above, on September 22, 2011, NMFS and USFWS jointly published a Final Rule revising the loggerhead’s listing from a single, worldwide threatened species to nine DPSs, with one of those, the NWA DPS, present in the action area of this consultation. At the time the Final Listing Rule was developed, we lacked comprehensive data and information necessary to identify and describe physical or biological features (PBFs) of the terrestrial and marine habitats. As a result, we found designation of critical habitat to be “not determinable” (see 16 USC

§1533(b)(6)(C)(ii)) at the time. In the Final Rule, we stated that we would consider designating critical habitat in future rulemakings after a critical habitat review team was convened to assess and evaluate potential critical habitat areas for the DPSs in U.S. waters. The Services published a proposed rule (78 FR 43006) to designate critical habitat for the threatened Northwest Atlantic Ocean DPS on July 18, 2013, and a Final Rule was published on July 10, 2014 (79 FR 39855).

We designated 38 marine areas within the Northwest Atlantic Ocean DPS as critical habitat (Figure 33). Each of these areas consists of a single or a combination of the following habitat types: nearshore reproductive habitat (directly off USFWS-designated critical habitat nesting beaches out to 1 mile [1.6 km]), wintering habitat, breeding habitat, constricted migratory corridors, and *Sargassum* habitat.

Essential Features of Critical Habitat

Essential features are the physical and biological features of the habitat that are essential for the conservation of the species. In the Loggerhead Critical Habitat Rule, the essential features were described first with the PBFs of the habitat that provide the essential habitat function, and then the primary constituent elements (PCEs) that support the habitat functions (Table 30).

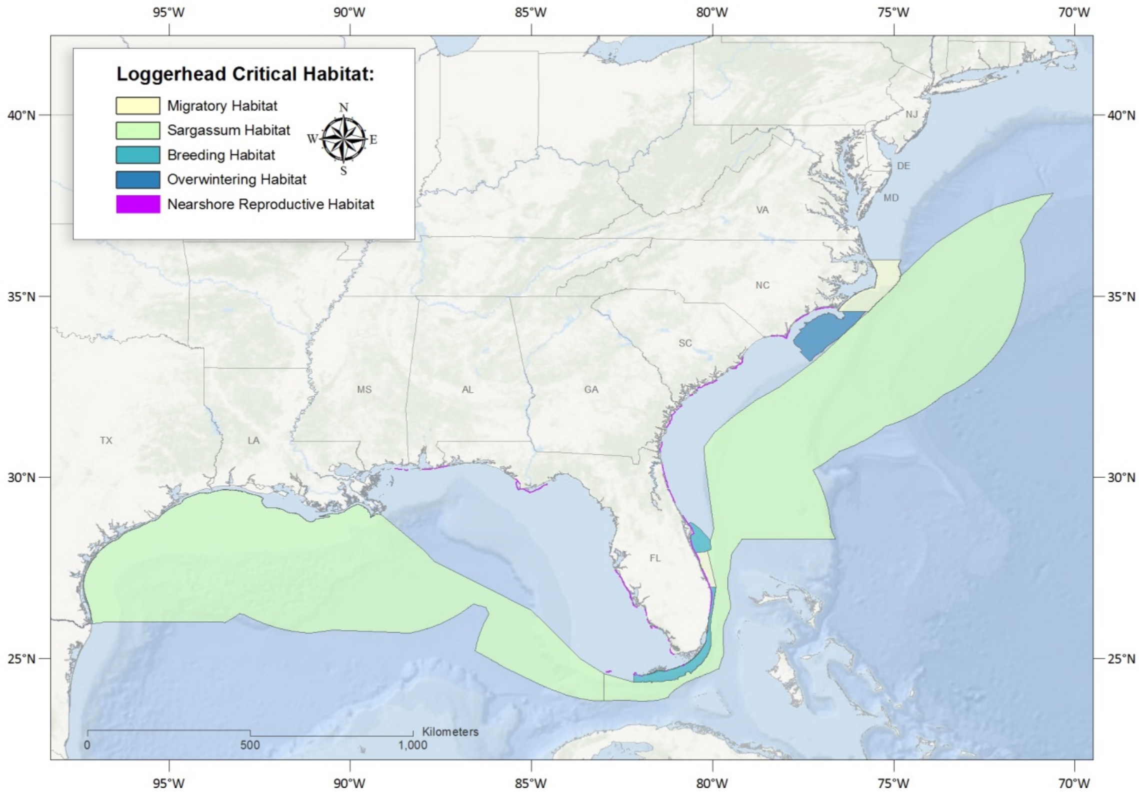


Figure 33. Distribution of critical habitat for the NWA DPS of loggerhead sea turtles.

Table 30. Description of Critical Habitat for the NWA DPS of Loggerhead Sea Turtles.

Habitat Type	Physical and Biological Feature(s)	Primary Constituent Elements	Unit Numbers
Nearshore Reproductive	Portion of nearshore waters adjacent to nesting beaches that are used by hatchlings to egress to the open-water environment as well as by nesting females to transit between beach and open water during the nesting season	• Waters directly off the highest density nesting beaches to 1 mile (1.6 km) offshore • Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water • Waters with minimal man-made structures that could promote predators (e.g., submerged offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents	LOGG-N-1 through LOGG-N-36

Habitat Type	Physical and Biological Feature(s)	Primary Constituent Elements	Unit Numbers
Winter	Warm water habitat south of Cape Hatteras near the western edge of the Gulf Stream used by concentration of juveniles and adults during the winter months	• Water temperatures above 10°C during colder months of November through April • Continental shelf waters in proximity to the western boundary of the Gulf Stream • Water depths between 20 and 100 meters	LOGG-N-1 LOGG-N-2
Breeding	Areas with high concentrations of both male and female adult individuals during the breeding season	• Concentrations of reproductive males and females • Proximity to primary Florida migratory corridor • Proximity to Florida nesting grounds	LOGG-N-17 LOGG-N-19
Constricted Migratory	High use migratory corridors that are constricted (limited in width) by land on one side and the edge of the continental shelf and Gulf Stream on the other side	• Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways • Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas	LOGG-N-1, LOGG-N-17, LOGG-N-18, LOGG-N-19

Habitat Type	Physical and Biological Feature(s)	Primary Constituent Elements	Unit Numbers
Sargassum	Developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially *Sargassum*	• Convergence zones, surface-water downwelling areas, and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads • *Sargassum* in concentrations that support adequate prey abundance and cover • Available prey and other material associated with *Sargassum* habitat such as, but not limited to, plants and cyanobacteria and animals endemic to the *Sargassum* community such as hydroids and copepods	LOGG-S-1 LOGG-S-2

Critical Habitat Unit(s) in the Proposed Action Area

The proposed action will occur within the Gulf of Mexico and overlap with loggerhead critical habitat units LOGG-N-31 through LOGG-N-36 and LOGG-S-02. Units LOGG-N-31 through LOGG-N-36 contain only nearshore reproductive habitat while LOGG-S-02 only contains *Sargassum* habitat. The location of each unit is described below, while the PBFs and PCEs of these habitat types are detailed in Table 3-6 above.

- LOGG-N-31—St. Joseph Peninsula, Cape San Blas, St. Vincent, St. George and Dog Islands, Gulf and Franklin Counties, Florida. The boundaries of this unit are from St. Joseph Bay to St. George Sound (crossing Indian, West, and East Passes) from the MHW line seaward 1.6 km (Figure 3-8).
- LOGG-N-32—Mexico Beach and St. Joe Beach, Bay and Gulf Counties, Florida. The boundaries of the unit are from the eastern boundary of Tyndall Air Force Base to Gulf County Canal in St. Joseph Bay from the MHW line seaward 1.6 km (Figure 3-8).
- LOGG-N-33—Gulf State Park to Florida/Alabama state line, Baldwin County, Alabama; FL/AL state line to Pensacola Pass, Escambia County, Florida. The boundaries of the unit are nearshore areas from the west boundary of Gulf State Park to the Pensacola Pass

(crossing Perido Pass and the Alabama/Florida border) from the MHW line and seaward to 1.6 km (Figure 3-9).

- LOGG-N-34—Mobile Bay Inlet to Little Lagoon Pass, Baldwin County, Alabama. The boundaries of the unit are nearshore areas from Mobile Bay Inlet to Little Lagoon Pass from the MHW line and seaward to 1.6 km (Figure 3-9).
- LOGG-N-35—Petit Bois Island, Jackson County, Mississippi. The boundaries of the unit are nearshore areas from Horn Island Pass to Petit Bois Pass from the MHW line and seaward to 1.6 km (Figure 3-9).
- LOGG-N-36—Horn Island, Jackson County, Mississippi. The boundaries of the unit are nearshore areas from Dog Keys Pass to the eastern most point of the ocean-facing island shore from the MHW line and seaward to 1.6 km (Figure 3-9).
- LOGG-S-2—Gulf of Mexico *Sargassum* (Figure 3-10). The northern and western boundaries of the unit follow the 10-meter depth contour starting at the mouth of South Pass of the Mississippi River proceeding west and south to the outer boundary of the U.S. EEZ. The southern boundary of the unit is the U.S. EEZ from the 10-meter depth contour off of Texas to the Gulf of Mexico-Atlantic border (83°W longitude). The eastern boundary follows the 10-meter depth contour from the mouth of South Pass of the Mississippi River at 28.97°N latitude, 89.15°W longitude, in a straight line to the northernmost boundary of the Loop Current (28°N latitude, 89°W longitude) and along the eastern edge of the Loop Current roughly following the velocity of 0.101-0.20 m/s as depicted by Love et al. (2013) using the Gulf of Mexico summer mean sea surface currents from 1993-2011, to the Gulf of Mexico-Atlantic border (24.58°N latitude, 83°W longitude).

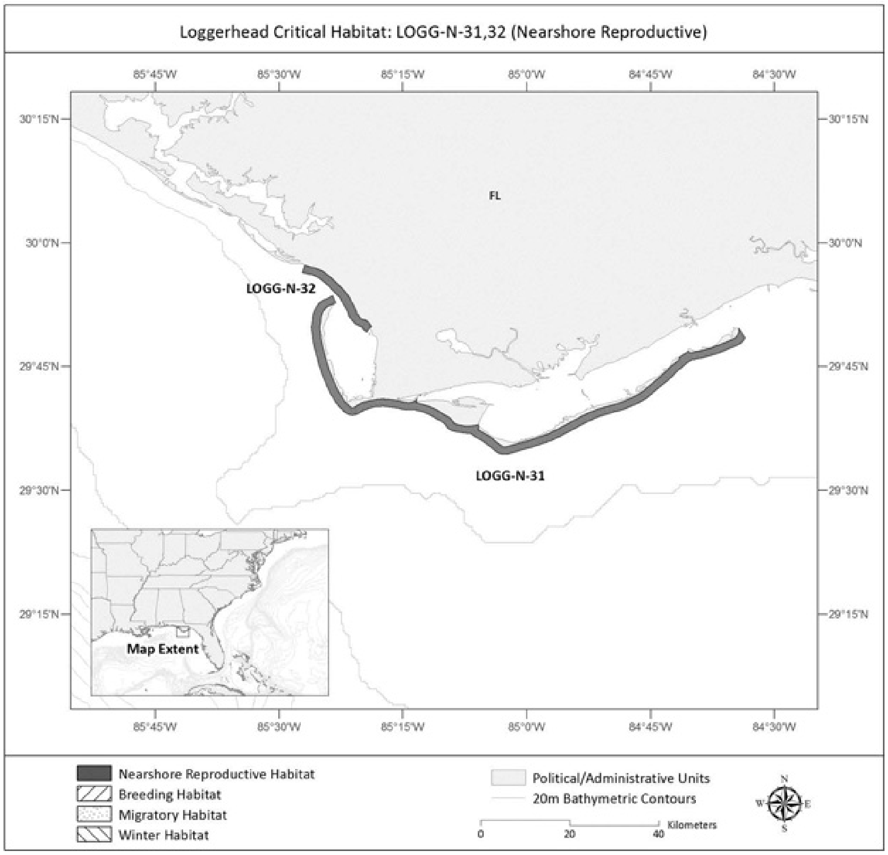


Figure 34. Nearshore reproductive habitat along the St. Joseph Peninsula, Florida (LOGG-N-31 and LOGG-N-32)

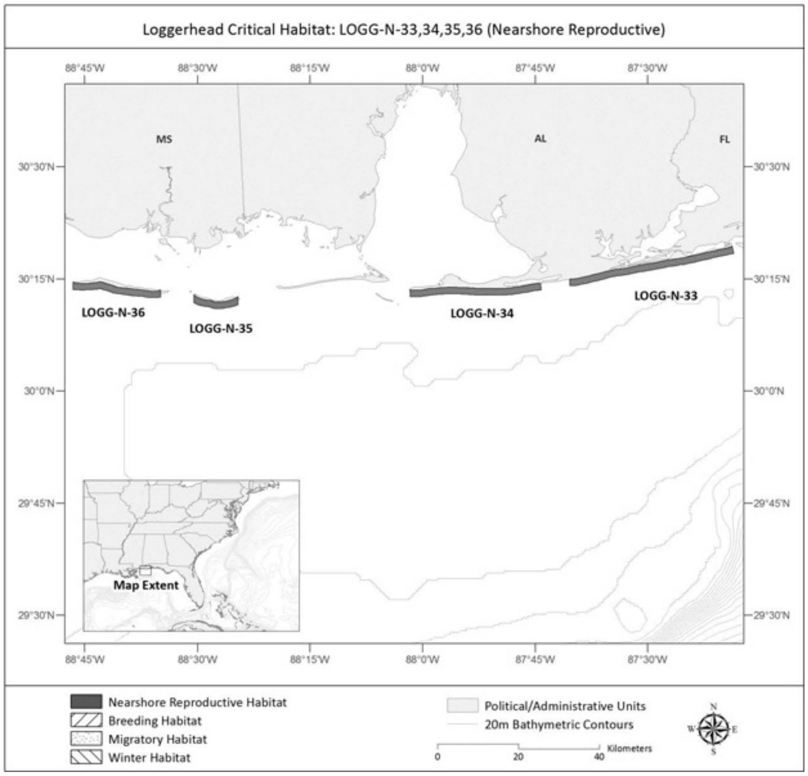


Figure 35. Nearshore reproductive habitat along the Northern Gulf Coast (LOGG-N-33 through LOGG-N-36)

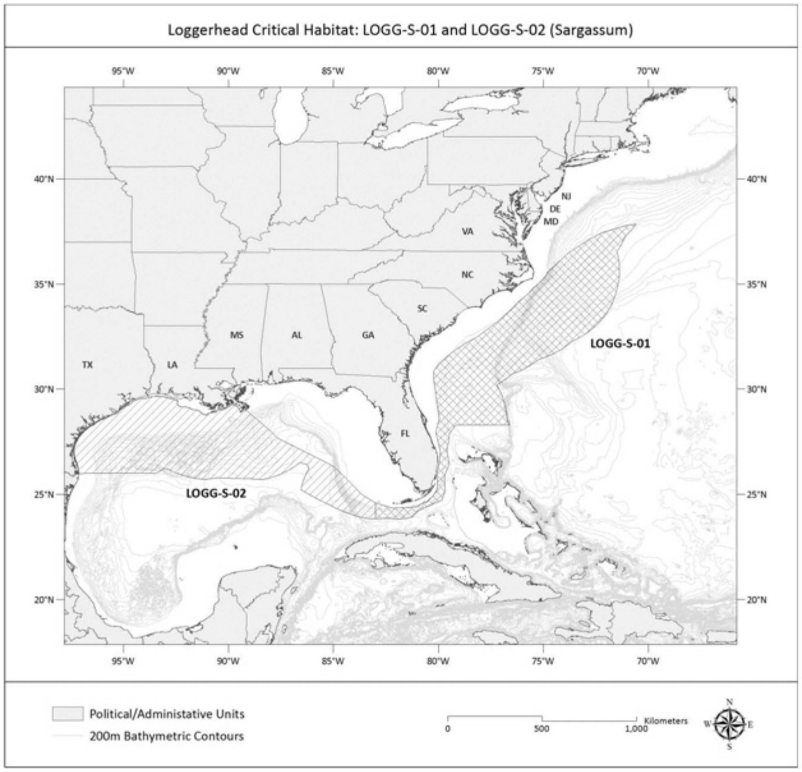


Figure 36. *Sargassum* critical habitat

Due to the recent designation, NMFS is currently unaware of any adverse impacts to the essential features of the designated critical habitat units (LOGG-N-31-36 and LOGG-S-2) for loggerheads. Activities that could affect the conservation value of this habitat would (1) obstruct the free transit of nesting females and hatchlings through the surf zone and outward to open waters, (2) promote notable increases in predatory species, (3) disrupt wave patterns necessary for hatchling orientation out to open waters, or (4) create excessive longshore currents which could sweep hatchling sea turtles off course as they attempt to reach open waters. Similarly, NMFS is not aware of any actions that have or are currently impacting *Sargassum* in critical habitat unit LOGG-S-2 since the designation. Projects that would pose threats to this unit would be those impacting (1) convergence zones, downwelling areas, and other locations where there are concentrated components of the *Sargassum* community; (2) the density or concentration of *Sargassum*; or (3) the prey community associated with *Sargassum* habitat.

Threats to Critical Habitat in the Proposed Action Area

Potential threats to loggerhead critical habitat in the proposed action area would include any activities that adversely impact the essential features. Such potential threats include:

<u>Offshore structures</u>

The construction of large-scale offshore structures such as breakwaters, groins, reefs, etc., have the potential to adversely impact the nearshore reproductive habitat of loggerhead critical habitat.

Offshore structures have the potential to adversely affect the essential features of this critical habitat type and thus reduce the habitat's functionality. Orientation cues used by hatchlings as they crawl, swim through the surf, and migrate offshore (collectively, the hatchling swim frenzy) are discussed in detail by Lohmann and Lohmann (2003) and include visual cues on the beach, wave orientation in the nearshore, and later magnetic field orientation as they proceed further toward open water. Any obstructions to swift egress from the beach and through the water to open ocean, whether via blockage or disorientation, as well as structures that aggregate potential predators to hatchlings, can affect the successful movement of hatchlings through nearshore habitat. Additionally, efficient movement offshore during the critical swim frenzy period can be adversely impacted by disruption of wave angles used for orientation to open water, and the formation of strong longshore currents resulting from artificial structures. Offshore structures also have the potential to adversely impact habitat functionality for nesting female loggerheads. During each approach to the nesting beach and return to sea after nesting, habitat suitable for transit between the beach and open waters is necessary. Nesting females typically favor beach approaches with few obstructions or physical impediments such as reefs or shallow water rocks, which may make the entrance to nearshore waters more difficult or cause injury (Salmon 2006).

Artificial lighting

The impacts of artificial lighting are discussed in section 4.2.1 because it relates to direct impacts to individual turtles. Nevertheless, the consistent presence of artificial lighting at nesting beaches can also be considered habitat alteration as it adversely impacts the essential habitat feature of allowing safe and efficient transit through the surf zone to and from open water. While onshore lighting is a threat best addressed through consultation with the USFWS, lighting in nearshore waters is an issue that NMFS addresses as an ongoing threat to loggerhead critical habitat.

Oil Spills

Large scale oil spills can adversely affect the *Sargassum* units of loggerhead critical habitat thereby reducing their ability to provide developmental and foraging habitat for young loggerheads. Surface oils can accumulate in mats of *Sargassum* and affect the prey community that loggerhead turtles rely on. Additionally, oil spill response activities such as the use of dispersants, *in situ* burning, containment booms, and skimmer operations could further affect the essential features of this habitat, by both affecting prey and modifying the concentration of the algal mats.

Seismic Activity

A recent study suggests that seismic airguns may lead to significant mortality of zooplankton, including copepods (McCauley et al. 2017), which can affect the *Sargassum* prey community that juvenile loggerheads rely on. Effects were found out to 1.2 km, the maximum distance that the sonar equipment used in the study was able to detect changes in abundance. McCauley et al.

(2017) note that for seismic activities to have a significant impact on zooplankton at an ecological scale, the spatial or temporal scale must be large in comparison to the ecosystem in question.

6.2.11 Gulf Sturgeon

Gulf sturgeon were listed as threatened effective October 30, 1991 (56 CFR §49653, September 30, 1991), after their stocks were greatly reduced or extirpated throughout much of their historic range by overfishing, dam construction, and habitat degradation. NMFS and the USFWS jointly manage Gulf sturgeon. In riverine habitats, USFWS is responsible for all consultations regarding Gulf sturgeon and critical habitat. In estuarine habitats, responsibility is divided based on the action agency involved. USFWS consults with the Department of Transportation, the USEPA, the USCG, and the Federal Emergency Management Agency; NMFS consults with the Department of Defense, U.S. Army Corps of Engineers, BOEM, and any other federal agencies not specifically mentioned at 50 CFR §226.214. In marine areas, NMFS is responsible for all consultations regarding Gulf sturgeon and critical habitat. In 2009, NMFS and USFWS conducted a 5-year review and found Gulf sturgeon continued to meet the definition of a threatened species (USFWS and NMFS 2009b).

6.2.11.1 Species Description and Distribution

The Gulf sturgeon is a subspecies of the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). Gulf sturgeon are nearly cylindrical fish with an extended snout, vertical mouth, five rows of scutes (bony plates surrounding the body), four chin barbels (slender, whisker-like feelers extending from the head used for touch and taste), and a heterocercal (upper lobe is longer than lower) caudal fin (tail fin). Adults range from 6-8 ft in length and weigh up to 200 lbs; females grow larger than males. Gulf sturgeon spawn in freshwater and then migrate to feed and grow in estuarine/marine (brackish/salt) waters. Large subadults and adults feed primarily on lancelets, brachiopods, amphipods and other crustaceans, polychaetes, and gastropods. Small Gulf sturgeons feed on benthic infauna such as amphipods, grass shrimp, isopods, oligochaetes, polychaetes, and chironomid and ceratopogonid larvae, found in the intertidal zone. Subadults of more than 5 kg and adults in the freshwater middle river reaches essentially fast during the summer and fall (Mason Jr. and Clugston 1993).

Historically, Gulf sturgeon occurred from the Mississippi River east to Tampa Bay. Sporadic occurrences were recorded as far west as the Rio Grande River in Texas and Mexico, and as far east and south as Florida Bay (Reynolds 1993; Wooley and Crateau 1985). The subspecies' present range extends from Lake Pontchartrain and the Pearl River system in Louisiana and Mississippi respectively, east to the Suwannee River in Florida (Figure 37).

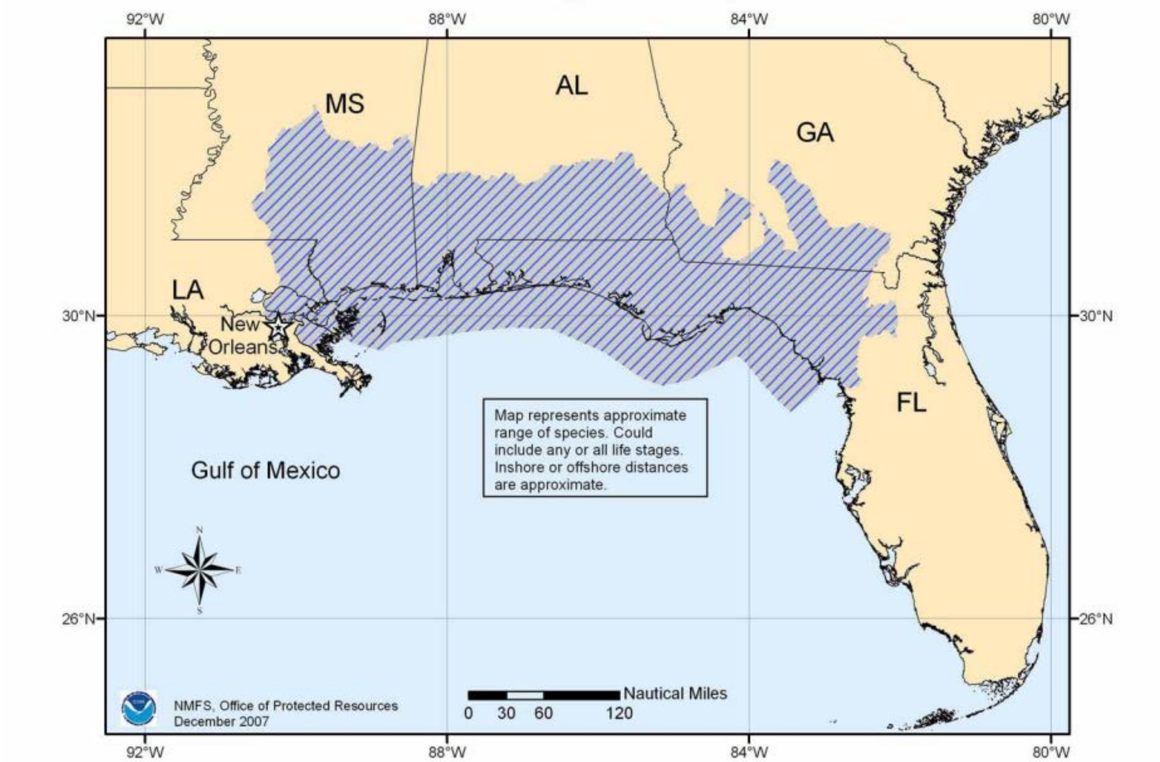


Figure 37. Gulf Sturgeon Distribution.

6.2.11.2 Life History

Gulf sturgeon are long-lived, with some individuals reaching at least 42 years in age (Huff 1975). Age at sexual maturity ranges from eight to 17 years for females and seven to 21 years for males (Huff 1975). Chapman and Carr (Chapman and Carr 1995) estimated that mature female Gulf sturgeon that weigh between 64 and 112 lb (29-51 kg) produce an average of 400,000 eggs. Spawning intervals range from one to five years for males, while females require longer intervals ranging from three to five years (Fox et al. 2000; Huff 1975).

Gulf sturgeon move from the Gulf of Mexico into coastal rivers in early spring (i.e., March through May). Fox et al (2000) found water temperatures at time of river entry differed significantly by reproductive stage and sex. Individuals enter the river system when water temperatures range between 11.2°C and 27.1°C. Spawning occurs in the upper reaches of rivers in the spring when water temperature is around 15°C to 20°C. While Sulak and Clugston (1999) suggest that sturgeon spawning activity is related to moon phase, other researchers have found little evidence of spawning associated with lunar cycles (Fox et al. 2000; Slack et al. 1999). Fertilization is external; females deposit their eggs on the river bottom and males fertilize them. Gulf sturgeon eggs are demersal, adhesive, and vary in color from gray to brown to black (Huff 1975; Vladykov and Greely 1963). Parauka et al. (1991) reported that hatching time for artificially spawned Gulf sturgeon ranged from 85.5 hours at 18.4°C to 54.4 hours at about 23°C. Published research on the life history of younger Gulf sturgeon is limited. After hatching, young-of-year individuals generally disperse downstream of spawning sites, though some may travel upstream as well (Clugston et al. 1995; Sulak and Clugston 1999), and move into estuarine feeding areas for the winter months.

Tagging studies confirm that Gulf sturgeon exhibit a high degree of river fidelity (Carr 1983). Of 4,100 fish tagged, 21 percent (860 of 4,100 fish) were later recaptured in the river of their initial collection, eight fish (0.2 percent) moved between river systems, and the remaining fish (78.8 percent) have not yet been recaptured (NMFS and USFWS 1995a). There is no information documenting the presence of spawning adults in non-natal rivers. However, there is some evidence of movements by both male and female Gulf sturgeon (n = 22) from natal rivers into non-natal rivers (Carr et al. 1996; Craft et al. 2001b; Fox et al. 2002; Ross et al. 2001; Wooley and Crateau 1985).

Gene flow is low in Gulf sturgeon stocks, with each stock exchanging less than one mature female per generation (Waldman and Wirgin 1998). Genetic studies confirm that Gulf sturgeon exhibit river-specific fidelity. Stabile et al. (Stabile et al. 1996) analyzed tissue taken from Gulf sturgeon in eight drainages along the Gulf of Mexico for genetic diversity and noted significant differences among Gulf sturgeon stocks, which suggests region-specific affinities and likely river-specific fidelity. Five regional or river-specific stocks (from west to east) have been identified: (1) Lake Pontchartrain and Pearl River, (2) Pascagoula River, (3) Escambia and Yellow Rivers, (4) Choctawhatchee River, and (5) Apalachicola, Ochlockonee, and Suwannee Rivers (Stabile et al. 1996).

After spawning, Gulf sturgeon move downstream to areas referred to as “summer resting” or “holding” areas. Adults and subadults are not distributed uniformly throughout the river, but instead show a preference for these discrete holding areas usually located in the lower and middle river reaches (Hightower et al. 2002). While it was suggested these holding areas were sought for cooler water temperatures (Carr et al. 1996; Chapman and Carr 1995), Hightower et al. (Hightower et al. 2002) found that water temperatures in holding areas where Gulf sturgeon were repeatedly found in the Choctawhatchee River were similar to temperatures where sturgeon were only occasionally found elsewhere in the river.

In the fall, movement from the rivers into the estuaries and associated bays begins in September (at water temperatures around 23°C) and continues through November (Foster and Clugston 1997; Huff 1975; Wooley and Crateau 1985). Because the adult and large subadult sturgeon have spent at least six months fasting or foraging sparingly on detritus (Mason and Clugston 1993) in the rivers, it is presumed they immediately begin foraging. Telemetry data indicate Gulf sturgeon are found in high concentrations near the mouths of their natal rivers with individual fish traveling relatively quickly between foraging areas where they spend an extended period of time (Edwards et al. 2007; Edwards et al. 2003).

Most subadult and adult Gulf sturgeon spend the cool winter months (October/November through March/ April) in the bays, estuaries, and the nearshore Gulf of Mexico (Clugston et al.

1995; Fox et al. 2002; Odenkirk 1989). Tagged fish have been located in well-oxygenated shallow water (less than 7 m) areas that support burrowing macro invertebrates (Craft et al. 2001b; Fox and Hightower 1998; Fox et al. 2002; Parauka et al. 2001; Rogillio et al. 2007; Ross et al. 2001; Ross et al. 2009a). These areas may include shallow shoals 5-7 ft (1.5-2.1 m), deep holes near passes (Craft et al. 2001b), unvegetated sand habitats such as sandbars, and intertidal and subtidal energy zones (Abele and Kim 1986; Menzel 1971; Ross et al. 2009a). Subadult and adult Gulf sturgeon overwintering in Choctawhatchee Bay (Florida) were generally found to occupy the sandy shoreline habitat at depths of 4-6 ft (2-3 m) (Fox et al. 2002; Parauka et al. 2001). These shifting, predominantly sandy, areas support a variety of potential prey items including estuarine crustaceans, small bivalve mollusks, ghost shrimp, small crabs, various polychaete worms, and lancelets (Abele and Kim 1986; AFS 1989; Menzel 1971). Preference for sandy habitat is supported by studies in other areas that have correlated Gulf sturgeon presence to sandy substrate (Fox et al. 2002).

Gulf sturgeon are described as opportunistic and indiscriminate benthivores that change their diets and foraging areas during different life stages. Their guts generally contain benthic marine invertebrates including amphiopods, lancelets, polychaetes, gastropods, shrimp, isopods, molluscs, and crustaceans (Carr et al. 1996; Fox et al. 2002; Huff 1975; Mason and Clugston 1993). Generally, Gulf sturgeon prey are burrowing species that feed on detritus and/or suspended particles, and inhabit sandy substrate. In the river, young-of-year sturgeon eat aquatic invertebrates and detritus (Mason and Clugston 1993; Sulak and Clugston 1999) and juveniles forage throughout the river on aquatic insects (e.g., mayflies and caddisflies), worms (oligochaete), and bivalves (Huff 1975; Mason and Clugston 1993). Adults forage sparingly in freshwater and depend almost entirely on estuarine and marine prey for their growth (Gu et al. 2001). Both adult and subadult Gulf sturgeon are known to lose up to 30 percent of their total body weight while in fresh water, and subsequently compensate the loss during winter feeding in marine areas (Carr 1983; Clugston et al. 1995; Heise et al. 1999; Morrow et al. 1998; Ross 2000; Sulak and Clugston 1999; Wooley and Crateau 1985).

6.2.11.3 Status and Population Dynamics

Abundance of Gulf sturgeon is measured at the riverine scale. Currently, seven rivers are known to support reproducing populations of Gulf sturgeon: Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, Apalachicola, and Suwannee. Gulf sturgeon abundance estimates by river and year for the seven known reproducing populations are presented in Table 31. Each of these estimates carries specific assumptions, and not all estimates were generated using data collected in similar fashion or modeled the same way. So direct comparison among systems must take those differences into consideration. The number of individuals within each riverine population is variable across their range, but generally over the last decade (USFWS and NMFS 2009b), populations in the eastern part of the range (Suwannee, Apalachicola Choctawhatchee) appear to be relatively stable in number or have a slightly increasing population trend. In the western portion of the range, populations in the Pearl and Pascagoula Rivers, have never been nearly as abundant as those to the east, and their current status, post-hurricanes Katrina and Rita, is unknown as comprehensive surveys have not occurred.

Table 31. Gulf Sturgeon Abundance Estimates by River and Year, with Confidence Intervals (CI) for the Seven Known Reproducing Populations (data from USFWS and NMFS (2009b) and Sulak et al. (2016)).

River	Year of data collection	Abundance Estimate	Lower Bound 95 percent CI	Upper Bound 95 percent CI	Source
Suwannee	2012-13	9,743	not reported	not reported	Sulak 2016
Apalachicola	2014	1,288*	1,081	1,607	Sulak 2016
Choctawhatchee	2008	2,800	not reported	not reported	USFWS 2009
Yellow	2010-11	1,036	724	1,348	Sulak 2016
Escambia	2015	373	253	548	Sulak 2016
Pascagoula	1997-2002	234	142	394	Sulak 2016
Pearl	1986-2007	224-376	168	603	Rogillio et al. 2001

*Reported as 503 juveniles and 785 adult/subadults.

6.2.11.4 Threats

The 1991 listing rule (56 FR 49653) for Gulf sturgeon cited the following impacts and threats: (1) Dams on the Pearl, Alabama, and Apalachicola Rivers; also on the North Bay arm of St. Andrew Bay; (2) Channel improvement and maintenance activities: dredging and de-snagging; (3) Water quality degradation, and (4) Contaminants.

In 2009, NMFS and USFWS conducted a 5-year review of the Gulf sturgeon and identified several new threats to the Gulf sturgeon (USFWS and NMFS 2009b). The following is a comprehensive list of threats to Gulf sturgeon, additional details can be found in the 5-year status review (USFWS and NMFS 2009b):

1. Pollution from industrial, agricultural, and municipal activities is believed responsible for a suite of physical, behavioral, and physiological impacts to sturgeon worldwide. Specific impacts of pollution and contamination on sturgeon have been identified to include muscle atrophy; abnormality of gonad, sperm, and egg development; morphogenesis of organs, tumors; and disruption of hormone production.
2. Chemicals and metals such as chlordane, dichlorodiphenyldichloroethylene, dichlorodiphenyltrichloroethane, dieldrin, polychlorinated biphenyls, cadmium, mercury, and selenium settle to the river bottom and are later incorporated into the food web as they are consumed by benthic feeders, such as sturgeon or macroinvertebrates.
3. Bycatch from fisheries may continue although all directed fisheries of Gulf sturgeon have been closed since 1990 (NMFS and USFWS 1995a). Although confirmed reports are rare, it is a common opinion among Gulf sturgeon researchers that bycatch mortality continues.

4. Dredging activities can pose significant impacts to aquatic ecosystems by: (1) direct removal/burial of organisms; (2) turbidity/siltation effects; (3) contaminant resuspension; (4) sound/disturbance; (5) alterations to hydrodynamic regime and physical habitat; and (6) loss of riparian habitat. Dredging operations may also destroy benthic feeding areas, disrupt spawning migrations, and resuspend fine sediments causing siltation over required substrate in spawning habitat. Because Gulf sturgeon are benthic omnivores, the modification of the benthos affects the quality, quantity, and availability of prey.
5. Collisions between jumping Gulf sturgeon and fast-moving boats on the Suwannee River and elsewhere are a relatively recent and new source of sturgeon mortality and pose a serious public safety issue as well. The Florida Fish and Wildlife Commission documented three collisions in the Suwannee River in 2008, and one incident in 2009.
6. Dams represent a significant impact to Gulf sturgeon by blocking passage to historical spawning habitats, which reduces the amount of available spawning habitat or entirely impede access to it. The ongoing operations of these dams also affect downstream habitat.
7. Global climate change may affect Gulf sturgeon by leading to accelerated changes in habitats utilized by Gulf sturgeon through saltwater intrusion, changes in water temperature, and extreme weather periods that could increase both droughts and floods.
8. Hurricanes have resulted in mortality of Gulf sturgeon in both Escambia Bay after Hurricane Ivan in 2004 (USFWS 2005) and Hurricane Katrina in 2005.
9. Red tide is the common name for a harmful algal bloom of marine algae (*Karenia brevis*) that produces a brevetoxin that is absorbed directly across the gill membranes of fish or through ingestion of algal cells. Fish mortalities associated with K. brevis events are very common and widespread. Blooms of red tides have been increasing in frequency in the Gulf of Mexico since the 1990s and have likely killed Gulf sturgeon at both the juvenile and adult life stages.
10. Aquaculture: Although the state of Florida has BMPs to reduce the risk of hybridization and escapement, the threat of introduction of captive fishes into the wild continues.

Additionally, other emerging threats to Gulf sturgeon include contaminant spills, such as oil, and vessel propeller strikes. It may be that these are not a new threat, rather some that we have only recently become more aware of due to higher public awareness.

Both acute and episodic events are known to impact individual populations of Gulf sturgeon that in turn, affect overall population numbers. For example, on August 9, 2011, an overflow of “black liquor” (an extremely alkaline waste byproduct of the paper industry) was accidentally released by a paper mill into the Pearl River near Bogalusa, Louisiana, that may have affected the status and abundance of the Pearl River population. While paper mills regularly use acid to balance the black liquor’s pH before releasing the material, as permitted by the Louisiana

Department of Environmental Quality, this material released was not treated.[30] The untreated waste byproduct created a low oxygen ("hypoxic") environment lethal to aquatic life. These hypoxic conditions moved downstream of the release site killing fish and mussels in the Pearl River over several days. Within a week after the spill, the dissolved oxygen concentrations returned to normal in all areas of the Pearl River tested by Louisiana Department of Wildlife and Fisheries. The investigation of fish mortality began on August 13, 2011, several days after the spill occurred. Twenty-eight Gulf sturgeon carcasses (38-168 cm TL) were collected in the Pearl River after the spill (Sanzenbach 2011a; Sanzenbach 2011b) and anecdotal information suggests many other Gulf sturgeon carcasses were not collected. The smaller fish collected represent young-of-year and indicate spawning is likely occurring in the Pearl River. The spill occurred during the time when Gulf sturgeon were still occupying the freshwater habitat. Because the materials moved downriver after the spill, the entire Pearl River population of Gulf sturgeon was likely impacted.

6.2.12 Critical Habitat of Gulf Sturgeon

NMFS and USFWS jointly designated Gulf sturgeon critical habitat on April 18, 2003 (50 CFR §226.214). The agencies designated 7 seven riverine areas (Units 1-7) and 7 seven estuarine/marine areas (Units 8-14) as critical habitat based on the physical and biological features that support the species. Critical habitat units encompass a total of 2,783 river kilometers (rkm) and 6,042 km^2 of estuarine and marine habitats (Figure 38). NMFS's jurisdiction encompasses the seven units in marine and estuarine waters (Units 8-14), though NMFS's consultation responsibilities for projects in estuarine waters are limited to specific action agencies (Table 32).

[30] The extreme alkalinity of the untreated black liquor caused it to quickly bond with oxygen (aerobic) to dissociate in water. This reduced the amount of oxygen available within the water column, creating a hypoxic environment (< 1mg/L of dissolved oxygen) lethal to aquatic life.

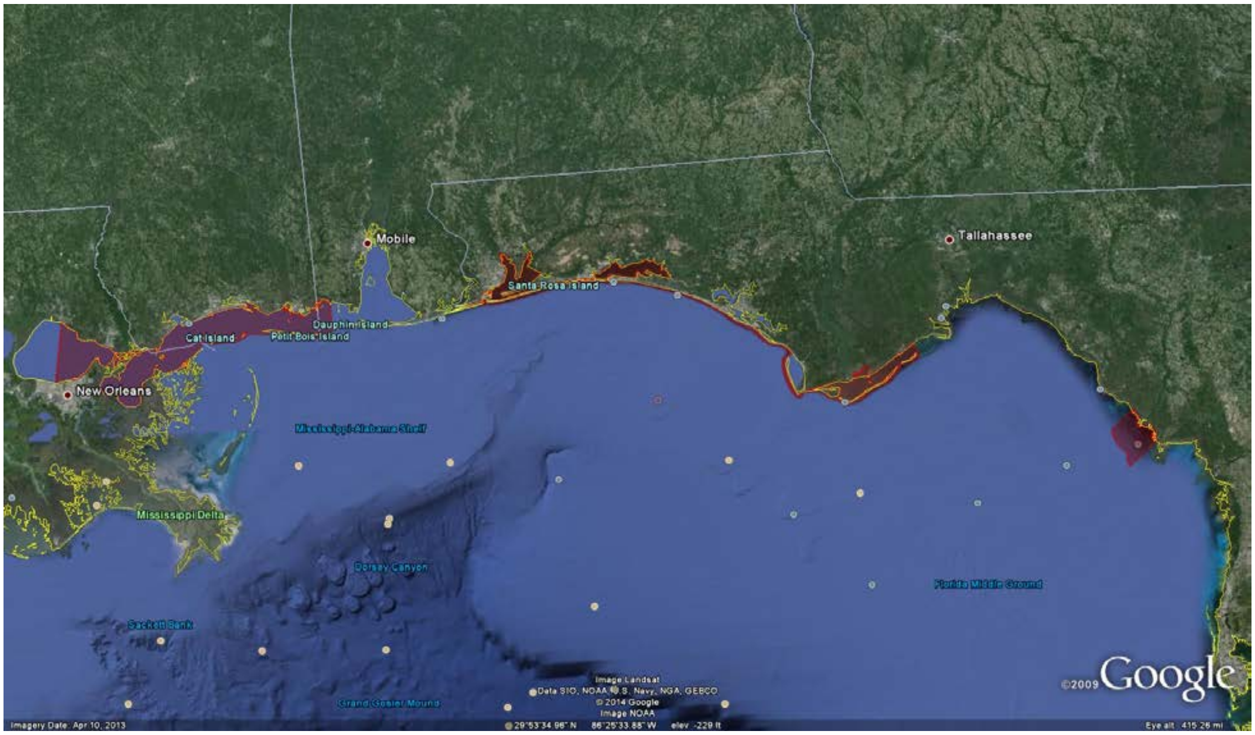


Figure 38. Gulf sturgeon critical habitat in estuarine and marine waters (Units 8-14).

Table 32. Gulf Sturgeon Consultation Responsibility for Projects in Estuarine Waters.

Lead Action Agency	NMFS	USFWS
Department of Transportation		**X**
U.S. Environmental Protection Agency		**X**
U.S. Coast Guard		**X**
Federal Emergency Management Agency		**X**
Department of Defense	**X**	
U.S. Army Corps of Engineers	**X**	
Minerals Management Service (now Bureau of Ocean Energy Management)	**X**	
Other	**X**	

Gulf sturgeon use rivers for spawning, larval and juvenile feeding, adult resting and staging, and to move between the areas that support these components. Gulf sturgeon use the lower riverine, estuarine, and marine environment during winter months primarily for feeding and for inter-river migrations. Within the estuarine environment, Gulf sturgeon are typically found in waters 6.6-13.1 ft (2-4 m) deep and use depths outside this range less than expected based on availability

(Fox et al. 2002). Further, habitats where Gulf sturgeon are typically found have sediments with a high percentage (> (greater than 80 percent) of sand (Fox et al. 2002). Adult sturgeon appear to spend extended periods of time in specific areas of the estuary and then travel relatively quickly to other areas where they again spend extended amounts of time (Edwards and Butterworth 2007; Edwards et al. 2003). (Sulak et al. 2012) believe Gulf sturgeon feed continuously during these periods which may last for 1-3one to three months. Additionally, it appears that there may be certain areas where Gulf sturgeon concentrate. USFWS discovered near-shore areas of concentrated feeding activity for adults from multiple riverine systems in the waters near Tyndall Air Force Base/Panama City Beach, Florida, and waters from Perdido, Florida to Gulf Shores, Alabama (USFWS 2002, 2003, 2004, 2005, and 2006). Estuaries and bays adjacent to riverine areas provide unobstructed passage of sturgeon from feeding areas to spawning grounds.

Essential Features of Critical Habitat

NMFS and USFWS identified 7 seven habitat features essential for the conservation of Gulf sturgeon. Four of these features are found in the marine and estuarine units of critical habitat:

1. Abundant food items, such as detritus, aquatic insects, worms, and/ or mollusk, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, mollusk and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages
2. Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages
3. Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages
4. Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage)

Critical Habitat Units in the Action Area of the Proposed Action

The action area of this project encompasses all 7 seven of the marine and estuarine units of Gulf sturgeon critical habitat (Units 8-14). Descriptions of each unit follow.

Unit 8 encompasses Lake Pontchartrain east of the Lake Pontchartrain Causeway, all of Little Lake, The Rigolets, Lake St. Catherine, Lake Borgne, including Heron Bay, and the Mississippi Sound (Figure 39). Critical habitat follows the shorelines around the perimeters of each included lake. The Mississippi Sound includes adjacent open bays including Pascagoula Bay, Point aux Chenes Bay, Grand Bay, Sandy Bay, and barrier island passes, including Ship Island Pass, Dog Keys Pass, Horn Island Pass, and Petit Bois Pass. The northern boundary of the Mississippi Sound is the shoreline of the mainland between Heron Bay Point, Mississippi and Point aux Pins, Alabama. Critical habitat excludes St. Louis Bay, north of the railroad bridge across its mouth; Biloxi Bay, north of the U.S. Highway 90 bridge; and Back Bay of Biloxi. The southern boundary follows along the broken shoreline of Lake Borgne created by low swamp islands from Malheureux Point to Isleau Pitre. From the northeast point of Isleau Pitre, the boundary continues in a straight north-northeast line to the point 1 nautical mile (nmi) (1.9 km) seaward of the western most extremity of Cat Island (30°13′N, 89°10′W). The southern boundary continues 1 nmi (1.9 km) offshore of the barrier islands and offshore of the 72 COLREGS lines at barrier island passes (defined at 33 CFR §80.815)), (d) and (e)) to the eastern boundary. Between Cat Island and Ship Island there is no 72 COLREGS line. We, therefore, defined that section of the unit southern boundary as 1 nmi (1.9 km) offshore of a straight line drawn from the southern tip of Cat Island to the western tip of Ship Island. The eastern boundary is the line of longitude 88°18.8′W from its intersection with the shore (Point aux Pins) to its intersection with the southern boundary. The lateral extent of Unit 8 is the MHW line on each shoreline of the included water bodies or the entrance to rivers, bayous, and creeks.

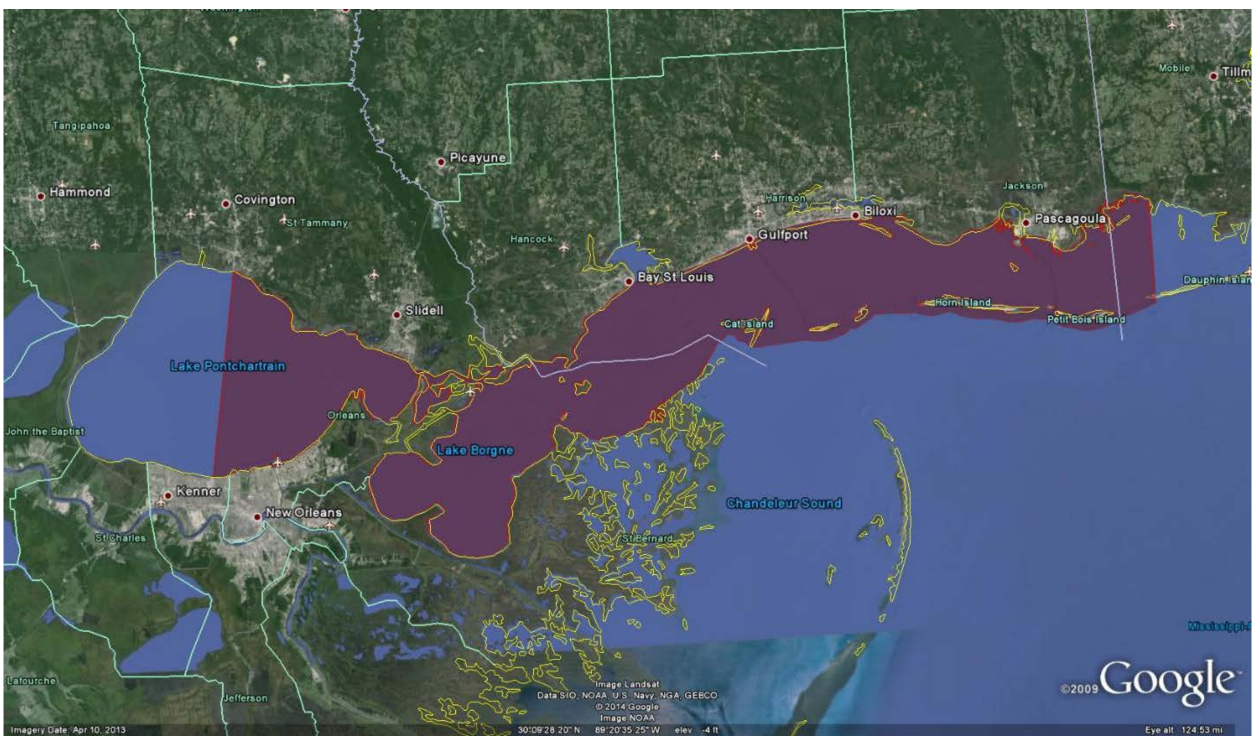


Figure 39. Gulf sturgeon critical habitat Unit 8.

The Pearl River and its distributaries flow into The Rigolets, Little Lake, and Lake Borgne, the western extension of Mississippi Sound. The Rigolets connect Lake Pontchartrain and Lake St. Catherine with Little Lake and Lake Borgne. The Pascagoula River and its distributaries flow into Pascagoula Bay and Mississippi Sound. This unit provides juvenile, subadult, and adult feeding, resting, and passage habitat for Gulf sturgeon from the Pascagoula and the Pearl River subpopulations. One or both of these subpopulations have been documented by tagging data, historic sightings, and incidental captures as using Pascagoula Bay, The Rigolets, the eastern half of Lake Pontchartrain, Little Lake, Lake St. Catherine, Lake Borgne, Mississippi Sound, within 1 nmi (1.9 km) of the nearshore Gulf of Mexico adjacent to the barrier islands and within the passes (Morrow et al. 1998; Reynolds 1993; Rogillio et al. 2002; Rogillio et al. 2007; Ross et al. 2001; Ross et al. 2009b). Substrate in these areas ranges from sand to silt, all of which contains known Gulf sturgeon prey items. The Rigolets is an 11.3 km (7 mi)-long and about 0.6 km (0.4 mi)-wide passage connecting Lake Pontchartrain and Lake Borgne. This brackish water area is used by adult Gulf sturgeon as a staging area for osmoregulation and for passage to and from wintering areas (Rogillio et al. 2002). Lake St. Catherine is a relatively shallow lake with depths averaging approximately 1.2 m (4 ft), connected to The Rigolets by Sawmill Pass. Bottom sediments in Sawmill Pass are primarily silt; Lake St. Catherine’s are composed of silt and sand (Barrett, 1971). Incidental catches of Gulf sturgeon are documented from Lake St. Catherine and Sawmill Pass (Reynolds 1993). Based on the proximity of Little Lake, Lake St. Catherine, and Sawmill Pass to The Rigolets and Pearl River, we believe these areas are also used for staging and feeding and, therefore, were included with The Rigolets as critical habitat.

Rogillio et al. (2002) and Morrow et al. (1998) indicated that Lake Pontchartrain and Lake Borgne were used by Gulf sturgeon as wintering habitat, with most catches during late September through March. Lake Pontchartrain is 57.9 km (36 mi) long, 35.4 km (22 mi) wide at its widest point, and 3-4.9 m (10-16 ft) deep (USDOC, 2002). (Morrow et al. 1998) documented Gulf sturgeon from the Pearl River system using Lake Pontchartrain (verified by tags) and summarized existing Gulf sturgeon records, which indicated greater use of the eastern half of Lake Pontchartrain. Although Rogillio et al. (2002) did not relocate any of their sonic tagged adult Gulf sturgeon in Lake Pontchartrain, NMFS has identified the eastern part of this lake as an important winter habitat for juveniles and subadults. Furthermore, we believe that Gulf sturgeon forage in Lake Pontchartrain during the winter. The Lake Pontchartrain Causeway, twin toll highway bridges, extends 33.6 km (20.9 mi) across Lake Pontchartrain from Indian Beach on the south shore to Lewisburg and Mandeville on the north shore. Sediment data from Lake Pontchartrain indicate sediments have a greater sand content east of the causeway than west (Barrett, 1975). Most records of Gulf sturgeon from Lake Pontchartrain are located east of the causeway, with concentrations near Bayou Lacombe and Goose Point, both on the eastern north shore (Morrow et al. 1998; Reynolds 1993). While Gulf sturgeon have also been documented west of the causeway, generally near the mouths of small river systems (Davis *et al.*, 1970), we excluded the western portion of Lake Pontchartrain because we believe that the sturgeon utilizing this area are coming from western tributaries and not the Pearl River. Lake Pontchartrain connects by The Rigolets with Lake Borgne. Lake Borgne, the western extension of Mississippi Sound, is partly separated from Mississippi Sound by Grassy Island, Half Moon (Grand) Island, and Le Petit Pass Island. Lake Borgne is approximately 14.3 km (23 mi) in length, 3-6 km (5-10 mi) in width and 1.8-3 m (6-10 ft) in depth. Many Gulf sturgeon were anecdotally reported as taken incidentally in shrimp trawls in Lake Borgne 0.6-1.2 km (1-2 mi) south of the Pearl River between August and October from the 1950s through the 1980s (Reynolds 1993). There are twenty-two additional records of Gulf sturgeon in Lake Borgne (D. Walther, FWS, pers. comm. 2002). Known locations are spread out around the perimeter of the lake, including at the mouth of The Rigolets, Violet Canal, Bayou Bienvenue, Polebe, Alligator Point, and at Half Moon Island (Reynolds 1993).

The Mississippi Sound is separated from the Gulf of Mexico by a chain of barrier islands, including Cat, Ship, Horn, and Petit Bois Islands. Natural depths of 3.7-5.5 m (12-18 ft) are found throughout the Sound and a channel 3.7 m (12 ft) deep has been dredged where necessary from Mobile Bay to New Orleans. Incidental captures and studies confirm that both Pearl River and Pascagoula River adult Gulf sturgeon winter in the Mississippi Sound, particularly around barrier islands and barrier islands passes (Reynolds 1993; Rogillio et al. 2007; Ross et al. 2001). Pascagoula Bay is adjacent to the Mississippi Sound. Gulf sturgeon exiting the Pascagoula River move both east and west, with telemetry locations as far east as Dauphin Island and as far west as Cat Island and the entrance to Lake Pontchartrain (Ross et al. 2001). Tagged Gulf sturgeon from the Pearl River subpopulation have been located between Cat Island, Ship Island, Horn Island, and east of Petit Bois Islands to the Alabama State line (Rogillio et al. 2002). Gulf sturgeon have also been documented within 1 nmi (1.9 km) off the barrier islands of Mississippi Sound.

Habitat used by Gulf sturgeon in the vicinity of the barrier islands is 1.9-5.9 m (6.2-19.4 ft) deep (average 4.2 m [13.8 ft]), with clean sand substrata (Heise et al. 1999; Rogillio et al. 2007; Ross et al. 2001). Preliminary data from substrate samples taken in the barrier island areas indicate that all samples contained lancelets (Ross et al. 2001). Inshore locations where Gulf sturgeon were located (Deer Island, Round Island) were 1.9-2.8 m (6.2-9.2 ft) deep and all had mud (mostly silt and clay) substrata (Heise et al. 1999), typical of substrates supporting known Gulf sturgeon prey.

Unit 9 includes Pensacola Bay and its adjacent main bays and coves (Figure 40). These include Big Lagoon, Escambia Bay, East Bay, Blackwater Bay, Bayou Grande, Macky Bay, Saultsmar Cove, Bass Hole Cove, and Catfish Basin. All other bays, bayous, creeks, and rivers are excluded at their mouths. The western boundary is the Florida State Highway 292 Bridge crossing Big Lagoon to Perdido Key. The southern boundary is the 72 COLREGS line between Perdido Key and Santa Rosa Island (defined at 33 CFR §80.810 (g)). The eastern boundary is the Florida State Highway 399 Bridge at Gulf Breeze, Florida. The lateral extent of Unit 9 is the MHW line on each shoreline of the included waterbodies.

The Pensacola Bay system includes five interconnected bays, including Escambia Bay, Pensacola Bay, Blackwater Bay, East Bay, and the Santa Rosa Sound. The Santa Rosa Sound is addressed separately in Unit 10. The Escambia River and its distributaries (Little White River, Dead River, and Simpson River) empty into Escambia Bay, including Bass Hole Cove, Saultsmar Cove, and Macky Bay. The Yellow River empties into Blackwater Bay. The entire system discharges into the Gulf of Mexico, primarily through a narrow pass at the mouth of Pensacola Bay.

The Pensacola Bay system provides winter feeding and migration habitat for Gulf sturgeon from the Escambia River and Yellow River subpopulations. Florida Department of Environmental Protection researchers conducted tracking studies in the Pensacola Bay system from 1999-2002 to observe Gulf sturgeon winter migrations. They identified specific areas in the bays where Escambia River and Yellow River Gulf sturgeon collect, or migrate through, during the fall and winter season. These studies also identified two main habitat types where Gulf sturgeon concentrate during winter months. Movement is generally along the shoreline area of Pensacola Bay. Gulf sturgeon showed a preference for several areas in the bay, including Redfish Point, Fort Dickens, and Escribano Point, near Catfish Basin (Craft et al. 2001a; Fox and Hightower 1998). Sandy shoal areas located along the south and east side of Garcon Point, south shore of East Bay (Redfish Point area) and near Fair Point, appear to be commonly used, especially in the fall and early spring. During midwinter, sturgeon are commonly found in deep holes located north of the barrier island at Ft. Pickens, south of the Pensacola Naval Air Station, and at the entrance of Pensacola Pass. The depth in these areas ranges from 6-12.1 m (20-40 ft). Other areas where tagged fish were frequently located include Escribano Point, near Catfish Basin, and the mouth of the Yellow River. Previous incidental captures of Gulf sturgeon have been recorded in Pensacola Bay, Big Lagoon, and Bayou Grande (Reynolds 1993).

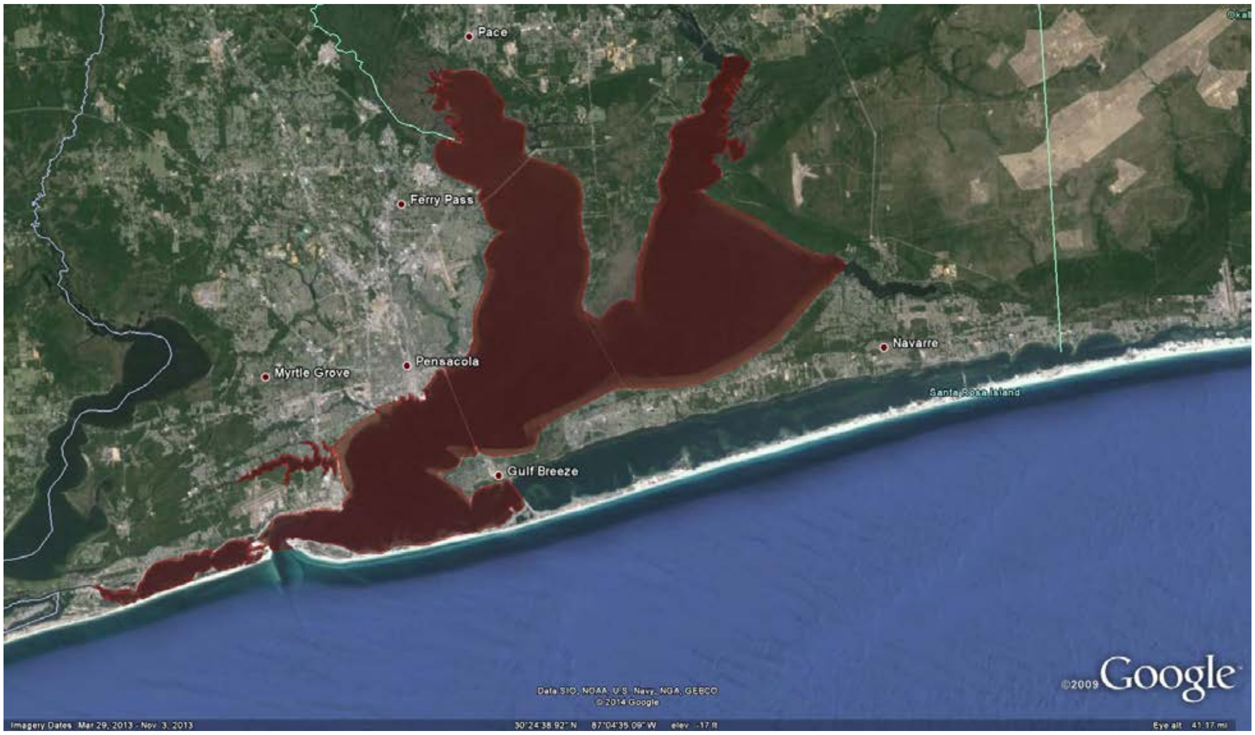


Figure 40. Gulf sturgeon critical habitat Unit 9.

Unit 10 includes the Santa Rosa Sound, bounded on the west by the Florida State Highway 399 bridge in Gulf Breeze, Florida and the east by U.S. Highway 98 bridge in Fort Walton Beach, Florida (Figure 41). The northern and southern boundaries of Unit 10 are formed by the shorelines to the MHW line or by the entrance to rivers, bayous, and creeks.

The Santa Rosa Sound is a lagoon between the mainland and Santa Rosa Island that connects Pensacola Bay in the west with Choctawhatchee Bay in the east. The Sound extends east to west approximately 57.9 km (35.9 mi) and varies in width between 0.32 and 3.5 km (0.2 to 2.2 mi). The Intracoastal Waterway transects the sound. The Santa Rosa Sound is designated as critical habitat because we believe it provides a single continuous migratory pathway between Choctawhatchee Bay, Pensacola Bay, and the Gulf of Mexico for feeding and genetic interchange. Within the last 3,000 years, periodic shoaling closed the opening of Choctawhatchee Bay to the Gulf of Mexico.

For many years, the Santa Rosa Sound provided the only way for Choctawhatchee River Gulf sturgeon to migrate to the Gulf of Mexico (Wakeford 2001) . Recent locations of subadult and adult Gulf sturgeon within the Santa Rosa Sound confirm its present use by the Choctawhatchee River subpopulations (Fox et al. 2002). The Escambia and Yellow Rivers subpopulations may also use this area due to its close proximity. Gulf sturgeon have been located mid-channel and in shoreline areas in 2-5.2 m (6.6-17.1 ft) depths and sand substrate. The approximate length of the critical habitat unit is 52.8 km (33 miles). Bridges were chosen as the eastern and western boundaries for ease in identification. Any portion of the sound not included in this unit is captured by the adjacent critical habitat units.

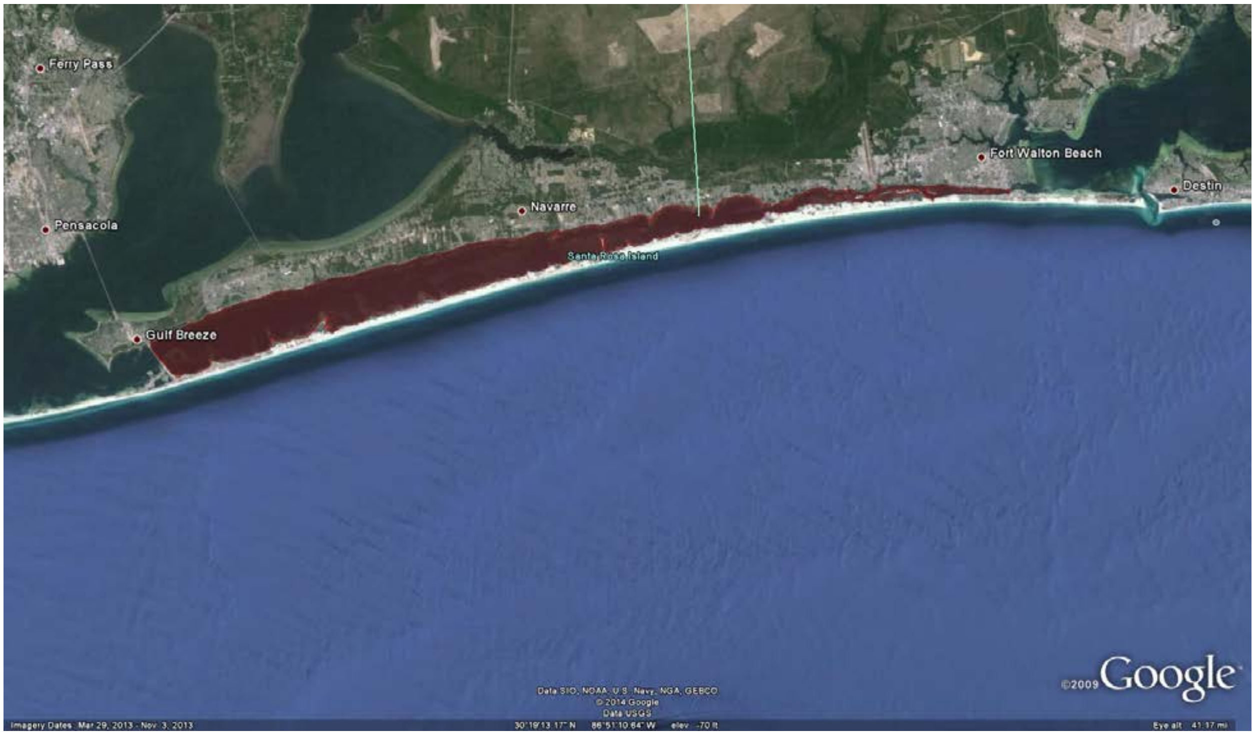


Figure 41. Gulf sturgeon critical habitat Unit 10.

Unit 11 is a portion of the Gulf of Mexico along the shoreline of the Florida panhandle (Figure 42). The western boundary is the line of longitude 87°20.0′W, approximately 1 nmi (1.9 km) west of Pensacola Pass from its intersection with the shore to its intersection with the southern boundary. The northern boundary is the MHW of the mainland shoreline and the 72 COLREGS line at passes as defined at 30 CFR §80.810 (a–g). The southern boundary of the unit is 1 nmi (1.9 km) offshore of the northern boundary; the eastern boundary is the line of longitude 85°17.0′W from its intersection with the shore (near Money Bayou between Cape San Blas and Indian Peninsula) to its intersection with the southern boundary.

Unit 11 includes winter feeding and migration habitat for Gulf sturgeon from the Yellow River, Choctawhatchee River, and Apalachicola River subpopulations. Telemetry relocation data suggest that these subpopulations feed in nearshore Gulf of Mexico waters between their natal river systems (Fox et al. 2002). Gulf sturgeon from the Choctawhatchee River subpopulation have been documented both east and west of Choctawhatchee Bay (Fox et al. 2002).

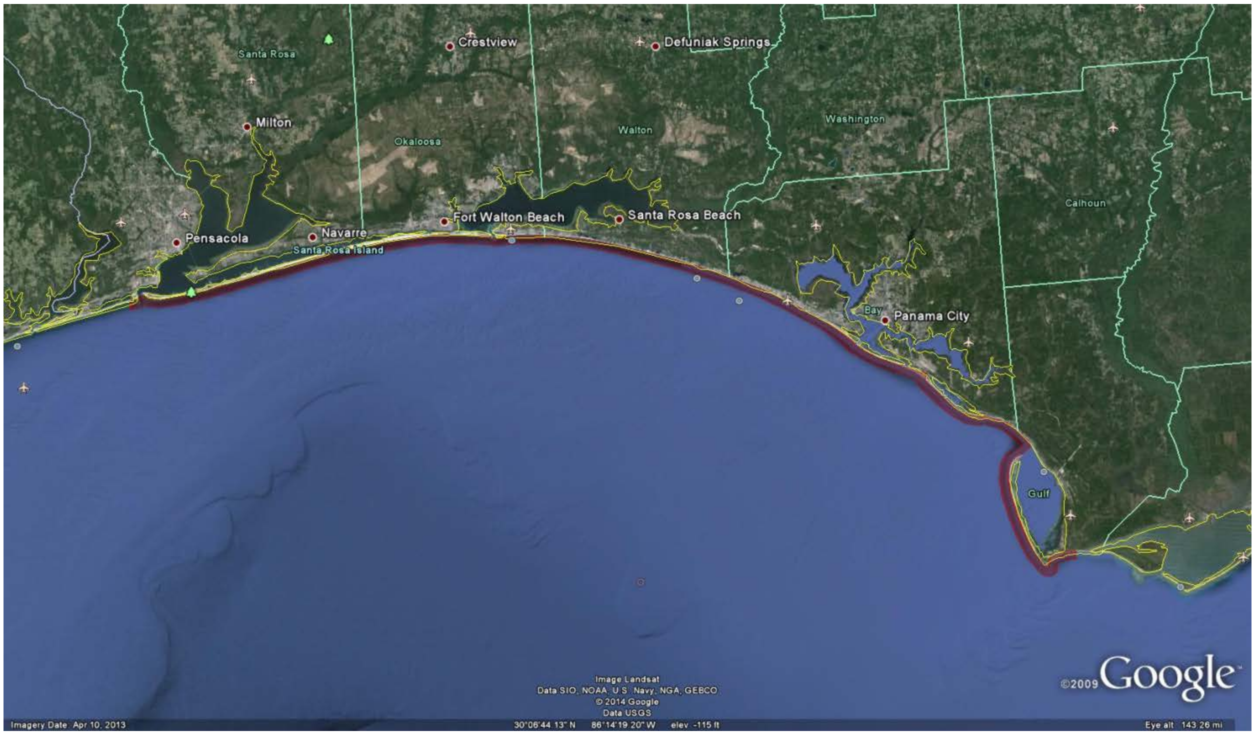


Figure 42. Gulf sturgeon critical habitat Unit 11.

During the winter of 2001–2002, personnel from both USGS and FWS attached pop-up satellite tags to 20 Gulf sturgeon (12 from the Suwannee River, 4 four from the Choctawhatchee River, 2 two from the Apalachicola River, and 2 two from the Yellow River) to identify winter feeding areas in the Gulf of Mexico. These data suggest that Gulf sturgeon from the Yellow River, Choctawhatchee River, and Apalachicola River remain within 1.6 km (1 mi) of the coastline between these river systems. Examination of bathymetry data along the Gulf of Mexico coastline between the Pensacola Bay and Apalachicola Bay reveals that depths of less than 6 m (19.7 ft), where Gulf sturgeon are generally found, are all contained within 1 nmi (1.9 km) from shore. Gulf nearshore substrate contains unconsolidated, fine-medium grain sands which support crustaceans such as mole crabs, sand fleas, various amphipod species, and lancelets. Based on movement patterns, it appears these Gulf sturgeon were feeding in the nearshore Gulf of Mexico on route to their natal rivers. Given this information, we included the nearshore (up to 1 nmi [1.9 km]) Gulf of Mexico waters in this unit between Pensacola and Apalachicola Bays.

Unit 12 includes the main body of Choctawhatchee Bay, Hogtown Bayou, Jolly Bay, Bunker Cove, and Grassy Cove (Figure 43). All other bayous, creeks, and rivers are excluded at their mouths/entrances. The western unit boundary is the U.S. Highway 98 bridge at Fort Walton Beach, Florida; the southern boundary is the 72 COLREGS line across East (Destin) Pass as defined at 33 CFR §80.810 (f). The lateral extent of Unit 12 is the MHW line on each shoreline of the included water bodies.

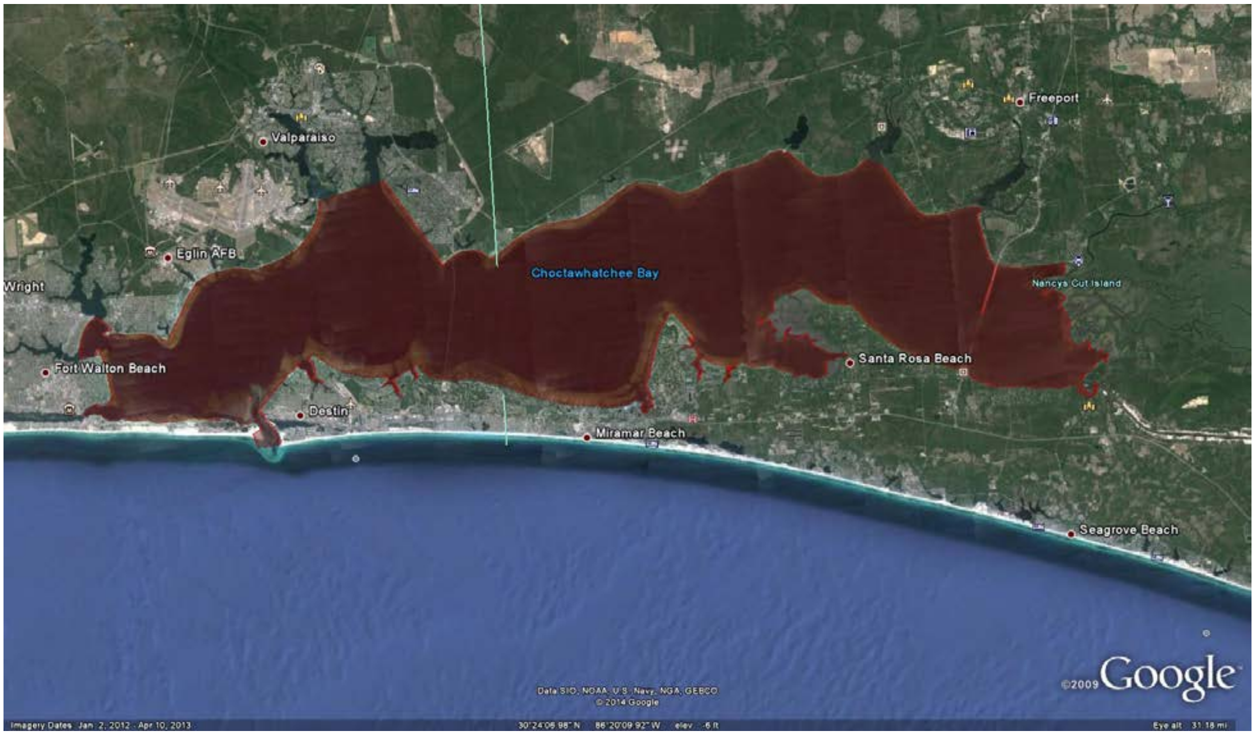


Figure 43. Gulf sturgeon critical habitat Unit 12.

Choctawhatchee Bay provides important habitat for maintaining the health of subadult and adult Gulf sturgeon as evidenced by a large number of Gulf sturgeon overwintering in the system (Parauka et al. 2011). The Choctawhatchee Bay offers a feeding area for both subadults and adults (Fox et al. 2002). Tagged subadults showed a preference for shoreline habitats which are predominated by sandy substrates, low salinity, and water depths less than 3 m (10 ft) (Parauka et al. 2011). Most adult Gulf sturgeon were located in shallow water (2-4 m [6.6-13.1 ft]) with predominantly (greater than 80 percent) sandy sediment (Fox et al. 2002). Ghost shrimp, a component of the sturgeon diet, are typically found in substrates ranging from sandy mud to organic silty sand (Lovett and Felder 1989), and their densities were greatest nearshore along the middle and eastern portions of the Choctawhatchee Bay (Heard et al. 2000), the area frequented by the Gulf sturgeon (Fox et al. 2002). We included the deeper central portion of the Bay in Unit 12 as critical habitat because the Gulf sturgeon are known to use the deeper bay waters for movement between the shoreline areas (Fox et al. 2002).

Unit 13 includes the main body of Apalachicola Bay and its adjacent sounds, bays, and the nearshore waters of the Gulf of Mexico (Figure 44). These consist of St. Vincent Sound, including Indian Lagoon; Apalachicola Bay including Horseshoe Cove and All Tides Cove; East Bay including Little Bay and Big Bay; and St George Sound, including Rattlesnake Cove and East Cove. Barrier Island passes (Indian Pass, West Pass, and East Pass) are also included. Sike's Cut is excluded from the lighted buoys on the Gulf of Mexico side to the day boards on the bay side. The southern unit boundary includes water extending into the Gulf of Mexico 1 nmi (1.9

km) from the MHW line of the barrier islands and from 72 COLREGS lines between the barrier islands (defined at 33 CFR §80.805 (e–h)); the western boundary is the line of longitude 85°17.0’W from its intersection with the shore (near Money Bayou between Cape San Blas and Indian Peninsula) to its intersection with the southern boundary. The eastern boundary of the unit is formed by a straight line drawn from the shoreline of Lanark Village at 29°53.1’N, 84°35.0’W to a point that is 1 nmi (1.9 km) offshore from the northeastern extremity of Dog Island at 29°49.6’N, 84°33.2’W. The lateral extent of Unit 13 is the MHW line on each shoreline of the included water bodies or the entrance of excluded rivers, bayous, and creeks.

Figure 44. Gulf sturgeon critical habitat Unit 13.

The Apalachicola River empties into Apalachicola Bay near Little Bay and Big Bay. The Apalachicola Bay system, a highly productive lagoon-and-barrier island complex, consists of the bay proper, East Bay, St. George Sound, Indian Lagoon, and St. Vincent Sound (Wakeford 2001a). It is relatively shallow, averaging 2-3 m (6.6-9.8 ft) in depth (Dulaiova and Burnett 2008; Huang and Spaulding 2002). The benthic habitat type most often found in Apalachicola Bay system is soft sediment, comprising approximately 70 percent of the estuarine area (Dulaiova and Burnett 2008). Its composition of sand, clay, and silt varies considerably depending on the location in the bay. The Apalachicola Bay connects with the Gulf of Mexico through several passes, including Indian Pass, West Pass, East Pass, and Sike’s Cut, a man-made opening established in the mid-1950s (Odenkirk 1989).

Unit 13 provides winter feeding migration habitat for the Apalachicola River Gulf sturgeon subpopulation. Gulf sturgeon have been documented by sightings, incidental captures, and telemetry studies throughout Apalachicola Bay, East Bay, St. George Sound, St. Vincent Sound, and Indian Lagoon (Odenkirk 1989; Wooley and Crateau 1985). Gulf sturgeon have also been documented in Indian Pass, West Pass, East Pass, and just north of Dog Island (Odenkirk 1989; Wooley and Crateau 1985). Substantial weight gains and the presence of suitable habitat for prey items indicate that Gulf sturgeon are feeding while within these bodies of water (Odenkirk 1989; Wooley and Crateau 1985). These areas are also used for accessing adjacent marine and estuarine feeding areas designated in Unit 11. Gulf sturgeon are believed to migrate from Apalachicola Bay into the Gulf of Mexico following prevailing currents and exiting primarily through the two most western passes (Indian and West) (Odenkirk 1989). No Gulf sturgeon have been documented using Sike's Cut; therefore, Sike's Cut was excluded from our designation. Tag return data from incidental captures and relocation data document Gulf sturgeon south of the Apalachicola barrier islands, generally within 1 one mile of the shoreline (Odenkirk 1989). On June 8, 1992, a commercial shrimp fisher provided anecdotal information that he and other shrimp fishers, had caught hundreds of Gulf sturgeon, with estimated weights generally between 22.7-27.2 kg (50-60 lb), in the same location, each spring (April, May, and June), for the past 30 years (1962-1992). The fisher described the location as south of St. George Island, within a few hundred yards of the beach. He described the capture areas as being adjacent to a shoal extending approximately 3.2 km (2 mi) offshore. Examination of bathymetric data shows that there are several shoals in that general vicinity. Since we were unable to confirm the specific location of the area described by this fisher, we extended this critical habitat unit only 1 nmi (1.9 km) offshore of the barrier islands bordering Apalachicola Bay and Cape San Blas, a distance for which we have supporting telemetry data.

Unit 14 includes Suwannee Sound and a portion of adjacent Gulf of Mexico waters extending 9 nm from shore (16.7 km) out to the State territorial water boundary (Figure 45). Its northern boundary is formed by a straight line from the northern tip of Big Pine Island (at approximately 29°23′N, 83°12′W) to the federal-state boundary at 29°17′N, 83°21′W; the southern boundary is formed by a straight line from the southern tip of Richards Island (at approximately 29°11′N, 83°04′W) to the federal-state boundary at 29°04′N, 83°15′W. The lateral extent of Unit 14 is the MHW line along the shorelines and the mouths of the Suwannee River (East and West Pass), its distributaries and other rivers, creeks, or water bodies.

The Suwannee River system is unique among Gulf sturgeon river systems in that the river flows directly into the Suwannee Sound and Gulf of Mexico without any intervening barrier islands. Suwannee Sound is a shallow (typically less than 2 m (6.6 ft), estuarine basin, a little less than 10 nm (8 km) long and a little over 4 nm (8 km) wide at its widest point. It is enclosed on its seaward side by Suwannee Reef, an approximately 14.6 nm (27 km) long arc of oyster reefs and shoals (Edwards et al. 2003). The bathymetry of waters off the coastline and north and south of

Suwannee Sound is different from the waters adjacent to other systems. Shallow waters are not confined to the nearshore environment, and depths less than 6 m (19.7 ft) extend 9 to- 10 mi (14.5 to 16.1 km) off the coastline.

Telemetry data confirm that subadult and adult Gulf sturgeon leave the river during October and November and enter Suwannee Sound and the nearshore Gulf of Mexico (Carr et al. 1996; Edwards et al. 2003). Tracking data indicate that Gulf sturgeon move slowly and remained offshore of Suwannee Sound in nearby shallow (less than 6 m (19.7 ft)) marine/estuarine habitats for a period of two months, until at least mid or late December. Overall movement patterns are punctuated by periods of slow movement within small areas, suggesting foraging (Edwards et al. 2003). Mason and Clugston (1993) found large, immigrating Suwannee River Gulf sturgeon fed on nearshore coastal shelf organisms, including lancelets (*Branchiostoma caribaeum*), brachiopods (*Glottida pyramida*), unidentified pelagic shrimps, polychaetes, unidentified marine molluscs, starfish, and sea cucumbers. Carr et al. (1996) found that adult Gulf sturgeon feed primarily on brachiopods and ghost shrimp before entering the river. Numerous underwater beds containing brachiopods have been located in the Suwannee River estuary and adjacent areas in Suwannee Sound (D. Murie and D. Parkyn, pers. comm. 2002). Stomach content analyses using a nonlethal method of stomach pumping (lavaging) support that Gulf sturgeon from the Suwannee River subpopulation feed primarily on brachiopods, and to lesser amounts on ghost shrimp, amphipods, and worms prior to entering the river (D. Murie and D. Parkyn, pers. comm., 2002).

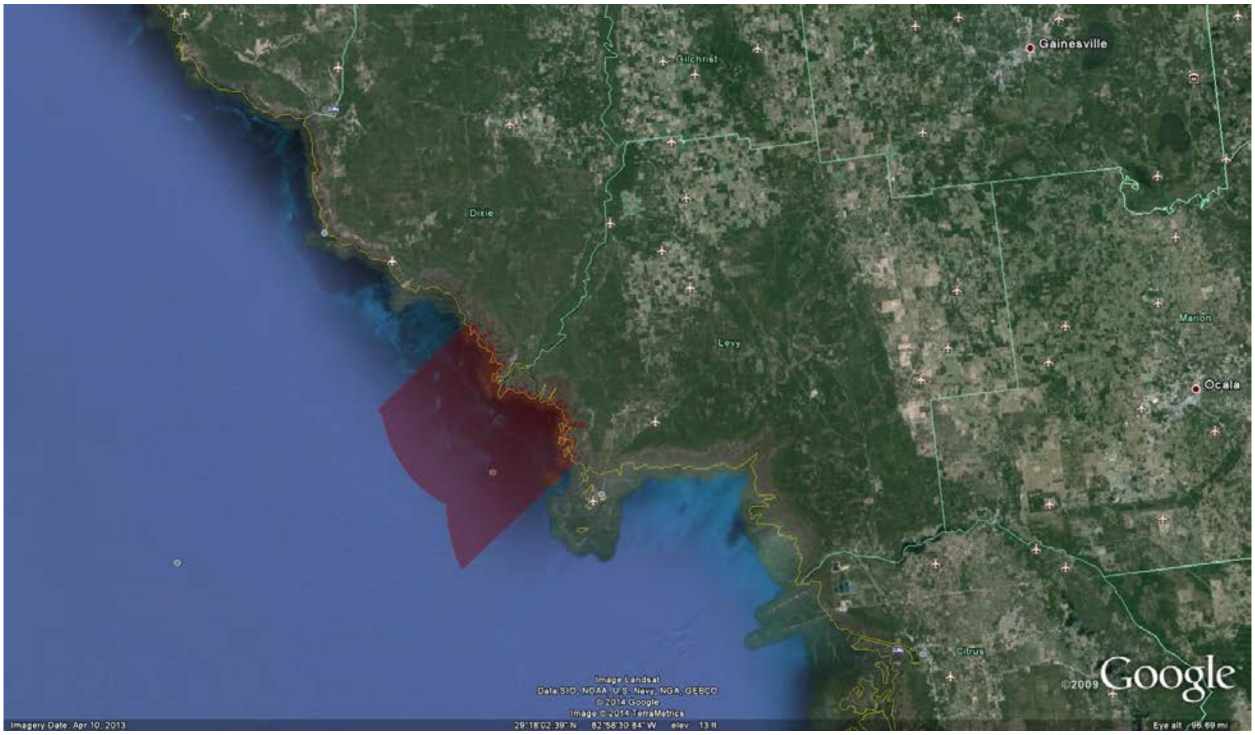


Figure 45. Gulf sturgeon critical habitat Unit 14.

Gulf sturgeon tracking and relocation data were used to delineate the boundaries of this critical habitat unit. In 1998, 18 out of 19 sonic-tagged Gulf sturgeon were consistently relocated and found to be concentrated in a relatively small area (115 km^2 (44.4 mi^2)) offshore of Suwannee Sound (Edwards et al. 2003). Specific locations within the concentration area were around Waldley Channel, West Gap, and Hedemon Reef. The farthest offshore area was Hedemon Reef, approximately 5 to 6 nm (9.3 to 11.1 km) from the Suwannee River opening.

Telemetry data and tag recaptures documented Gulf sturgeon using Gulf of Mexico waters as far out as 9 nm (16.7 km) (Edwards et al. 2003; Sulak and Clugston 1999). Additionally, on March 22, 2002, two Gulf sturgeon were observed jumping in the area of 29°14′N, 83°18′W, further substantiating the Gulf sturgeon's use of shallow State waters further offshore (greater than 6 nm (11.1 km) (Harris, pers. comm., 2002). Benthic samples taken where the fish were jumping were comprised of fine sand substrate and lancelets. Lancelets are recovered less frequently than brachiopods in the stomachs of Suwannee River Gulf sturgeon, but this may be a result of quicker decomposition of lancelets during digestion compared to brachiopods. Our designation, therefore, included waters out to 9 nm (16.7 km) to encompass those areas that we believed were essential for the conservation of Gulf sturgeon. The northern extent of the tracked sturgeon concentration area depicted in Edwards et al. (2003) corresponds approximately to the northern-most extremity of Big Pine Island. We, therefore, chose that easily identifiable location for the northern limit of this critical habitat unit. The southern extent of the concentration area depicted in (Caballero et al. 2007) corresponds approximately to Richards Island. In addition to the telemetry data, Gulf sturgeon sightings are frequently reported around Deer Island and Derrick Key (F. Chapman, UF, pers. comm., 2002). Derrick Key, where Gulf sturgeon sightings are frequently reported, is approximately 1 mile (1.6 km) offshore of Richards Island. Based on these data, we designated the southernmost extremity of Richards Island for the southern limit of Unit 14.

Status of Critical Habitat

Activities associated with coastal development have been and continue to be the primary threat to marine and estuarine units of Gulf sturgeon critical habitat. These activities generally include dredge and fill projects, freshwater withdrawals, and storm water drainage systems. Although many coastal development activities are currently regulated, some permitted direct and/or indirect damage to habitat from increased urbanization still occurs and is expected to continue in the future.

Each unit is impacted by a number of activities including dredging, shoreline armoring, installation of breakwaters, and construction of docks, piers, marinas, and artificial reefs. Since tracking began in 2003, NMFS has documented the amount of critical habitat affected by federal actions (Table 33). Most of these impacts were temporary, with effects lasting a few days to months, but generally less than a year. However, some critical habitat has been permanently lost from each of the units. The majority of permanent loss has occurred in Units 8 and 11 as part of beach nourishment and shoreline stabilization projects.

Table 33. Amount of Critical Habitat Impacted by Federal Actions since 2003.

Unit	Total Acreage Impacted	Permanent Acreage Loss
8	**66,546**	**655**
9	**11,485**	**43**
10	**4.5**	**0.55**
11	**3,925**	**2,851**
12	**15**	**0.12**
13	**671**	**1.8**
14	**10**	**10**

Threats to Critical Habitat

As stated in the final rule designating Gulf sturgeon critical habitat, the following activities, when authorized, funded or carried out by a federal agency, may destroy or adversely modify critical habitat:

- Actions that would appreciably reduce the abundance of riverine prey for larval and juvenile sturgeon, or of estuarine and marine prey for juvenile and adult Gulf sturgeon, within a designated critical habitat unit, such as dredging, dredged material disposal, channelization, in-stream mining, and land uses that cause excessive turbidity or sedimentation.
- Actions that would alter water quality within a designated critical habitat unit, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability, such as dredging; dredged material disposal; channelization; impoundment; in-stream mining; water diversion; dam operations; land uses that cause excessive turbidity; and release of chemicals, biological pollutants, or heated effluents into surface water or connected groundwater via point sources or dispersed non-point sources.
- Actions that would alter sediment quality within a designated critical habitat unit such that it is appreciably impaired for normal Gulf sturgeon behavior, reproduction, growth, or viability, such as dredged material disposal; channelization; impoundment; in-stream mining; land uses that cause excessive sedimentation; and release of chemical or biological pollutants that accumulate in sediments.
- Actions that would obstruct migratory pathways within and between adjacent riverine, estuarine, and marine critical habitat units, such as dams, dredging, point-source-pollutant discharges, and other physical or chemical alterations of channels and passes that restrict Gulf sturgeon movement (68 FR 13399).

Dredge and fill activities associated with the creation and maintenance of navigation channels as well as coastal development can result in the loss of Gulf sturgeon habitat (Wooley and Crateau 1985). Dredging activities can pose significant impacts to aquatic ecosystems by: (1) direct removal/burial of organisms; (2) turbidity/siltation effects; (3) contaminant re-suspension; (4) sound/disturbance; (5) alterations to hydrodynamic regime and physical habitat; and (6) loss of riparian habitat (Chytalo 1996; Winger et al. 2000). In regards to Gulf sturgeon and their critical habitat, dredging may alter benthic feeding areas, disrupt spawning migrations, modify substrate composition, and transform benthic morphology. Dredge and fill activities have and continue to threaten Gulf sturgeon critical habitat.

Evaluations of water and sediment quality in Gulf Sturgeon habitat on the northern Gulf of Mexico coast have consistently shown elevated pollutant loads. Chemicals and metals such as chlordane, DDE, DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later incorporated into the food web as they are consumed by benthic feeders, such as sturgeon or macroinvertebrates. Some of these compounds may affect physiological processes and impede the ability of a fish to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing dissolved oxygen (DO, altering pH, and altering other water quality properties. Although little is known about contaminant effects on Gulf sturgeon, pollution from industrial, agricultural, and municipal activities is believed to be responsible for a suite of physical, behavioral, and physiological impacts to sturgeon species worldwide (Agusa et al. 2004; Bickham et al. 1998b; Chebanov and Billard 2001; Kajiwara et al. 2003; Khodorevskaya et al. 1997; Lescheid et al. 1995).

6.2.13 Oceanic Whitetip Shark

On January 30, 2018, NMFS published a final rule listing the oceanic whitetip shark (*Carcharhinus longimanus*) as threatened under the ESA (83 FR 4153).

6.2.13.1 Species Description and Distribution

The oceanic whitetip shark is distributed worldwide in tropical and subtropical waters between 10 degrees North and 10 degrees South, usually found in open ocean and near the outer continental shelf (Young 2016). They are typically found in waters warmer than 20 degrees Celsius. They can be found as far as 30 degrees North and 35 degree South latitude. Oceanic whitetip sharks can be found at the ocean surface, but most frequently stay between 25.5 and 50 meters from the ocean surface (Carlson and Gulak 2012; Young 2016).

Oceanic whitetip sharks occur from the surface to at least 152 meters deep, and display a preference for water temperatures above 20 degrees Celsius. They can be found in waters between 15 and 28 degrees Celsius, and can briefly tolerate waters as cold as 7.75 degrees Celsius during dives to the mesopelagic zone (Howey-Jordan et al. 2013; Howey et al. 2016). In the Western Atlantic, oceanic whitetips occur from Maine to Argentina, including the Caribbean and Gulf of Mexico. Essential Fish Habitat (EFH) for the oceanic whitetip shark includes localized areas in the central Gulf of Mexico and Florida Keys, and depths greater than 200 m in the Atlantic (from southern New England to Florida, Puerto Rico and the U.S. Virgin Islands.

Little is known about the movement or possible migration paths of the oceanic whitetip shark. Although the species is considered highly migratory and capable of making long distance movements, tagging data provides evidence that this species also exhibits a high degree of philopatry (i.e., site fidelity) in some locations. To date, there have been three tagging studies conducted on oceanic whitetip sharks in the Atlantic. In the Atlantic, young oceanic whitetip sharks have been found well offshore along the southeastern coast of the U.S., suggesting that there may be a nursery in oceanic waters over this continental shelf (Compagno 1984; Bonfil et al. 2008). In the southwestern Atlantic, the prevalence of immature sharks, both female and male, in fisheries catch data suggests that this area may serve as potential nursery habitat for the oceanic whitetip shark (Coelho et al. 2009; Frédou et al. 2015; Tambourgi et al. 2013; Tolotti et al. 2015). Juveniles seem to be concentrated in equatorial latitudes, while specimens in other maturational stages are more widespread (Tambourgi et al. 2013). Pregnant females are often found close to shore, particularly around the Caribbean Islands. For more information on oceanic whitetip distribution, see Young et al. (2016).

Oceanic whitetip sharks have very long and wide paddle-shaped pectoral fins with characteristic mottled white tips (also present on the front dorsal and caudal fins). Its body is grayish bronze to brown, and white underneath. Adults can grow up to 11.25 feet (3.4 meters) and 500 pounds (230 kilograms). The oceanic whitetip shark was proposed for listing as threatened on December 29, 2016 (81 FR 96304).

6.2.13.2 Life History Information

The oceanic whitetip shark gives birth to live young (i.e., “viviparous”). Their reproductive cycle is thought to be biennial, giving birth on alternate years, after a lengthy 10–12 month gestation period. The number of pups in a litter ranges from 1 to 14 (mean = 6), and a positive correlation between female size and number of pups per litter has been observed, with larger sharks producing more offspring (Bonfil et al. 2008; Compagno 1984; IOTC 2014; Seki et al. 1998).

Several of the life history parameters for oceanic whitetip sharks vary by location. Not a great deal is known about oceanic whitetip sharks’ lifespan; estimates range from 12 to 13 years (Seki et al. 1998, Lessa et al. 1998), to 17 years, and even up to 20 years old (Young et al. 2016). Oceanic whitetip sharks are a slow-growing species, with different studies placing growth rates between 0.075 and 0.0852 yr-1. Growth rates are believed to be similar between the sexes (Seki et al. 1998, Lessa et al. 1998; Joung et al. 2016; Young et al. 2016). Age at maturity varies by ocean region, with six to seven years old recorded in the southwest Atlantic, and four to five years old in the North Pacific, for both sexes. Another study of oceanic whitetips in the North Pacific found that females matured at between 8.5 and 8.8 years old, and males reached maturity between 6.8 to 8.9 years old (Seki et al. 1998, Lessa et al. 1998; Joung et al. 2016). Oceanic whitetip sharks are viviparous, meaning they give birth to live young, giving birth every other year to a litter of one to 14 pups, after a gestation period of ten to 12 months (Young et al. 2016).

Oceanic whitetip sharks are regarded as opportunistic feeders, eating teleosts (bony fishes) and cephalopods. Large pelagic fish species commonly found in the stomachs of oceanic whitetips include, blackfin tuna, white marlin, and barracuda.

6.2.13.3 Status and Population Dynamics

There is no range-wide abundance estimate available for oceanic whitetip sharks. However, the species was once one of the most abundant sharks in the ocean; catch data from individual ocean basins indicate that the populations have undergone significant declines (Young 2016).

There is no population growth rate available for oceanic whitetip shark. As indicated above, populations in ocean basins have experienced declines. In the Northwest Atlantic and Gulf of Mexico, declines are estimated to be between 57 and 88 percent (Young 2016). Populations in the Eastern Pacific Ocean are thought to have declined between 80 and 90 percent since the late 1990s (Hall 2013).

There has been a limited amount of research focused on genetic diversity of oceanic whitetip sharks, but what little has been done indicates a low level of genetic diversity. Compared to other pelagic sharks (e.g., silky sharks (*Carcharhinus falciformis*) 0.61 percent ± 0.32 percent), oceanic whitetip sharks display low genetic diversity (0.33 percent ± 0.19 percent) (Ruck 2016) (Camargo et al. 2016; Clarke et al. 2015). Although oceanic whitetip sharks are highly migratory, they appear to display a high degree of philopatry to certain sites, with females giving birth on one side of a basin or the other, and may not mix with individuals of other regions (Howey-Jordan et al. 2013; Tolotti et al. 2015; Young 2016). Thermal barriers (i.e., water temperatures less than 15 degrees Celsius) may prevent inter-ocean basin movements. Population structuring exists between the Western Atlantic and Indo-Pacific Ocean populations (Ruck 2016).

In the Northwest Atlantic, the oceanic whitetip shark was described historically as widespread, abundant, and the most common pelagic shark in the warm parts of the North Atlantic (Backus et al. 1956). Recent information, however, suggests the species is now relatively rare in this region.

6.2.13.4 Threats

Threats to the oceanic whitetip shark include fisheries and the inadequacy of existing regulatory measures that manage these fisheries. In addition to mortality as a result of retention and finning in commercial fisheries, oceanic whitetip sharks experience varying levels of bycatch-related fishing mortality, including at-vessel and post-release mortality.

Although generally not targeted, oceanic whitetip sharks are frequently caught as bycatch in many fisheries, including pelagic longline fisheries targeting tuna and swordfish, purse seine, gillnet, and artisanal fisheries. Oceanic whitetip sharks are also a preferred species for their large, morphologically distinct fins, as they obtain a high price in the Asian fin market. The oceanic whitetip shark's vertical and horizontal distribution significantly increases its exposure to industrial fisheries, including pelagic longline and purse seine fisheries operating within the species' core tropical habitat throughout its global range.

In addition to declines in oceanic whitetip catches throughout its range, there is also evidence of declining average size over time in some areas, and is a concern for the species' status given evidence that litter size is potentially correlated with maternal length. Such extensive declines in the species' global abundance and the ongoing threat of overutilization, the species' slow growth and relatively low productivity, makes them generally vulnerable to depletion and potentially slow to recover from overexploitation. Related to this, the low genetic diversity of oceanic whitetip is also cause for concern and a viable risk over the foreseeable future for this species. Loss of genetic diversity can lead to reduced fitness and a limited ability to adapt to a rapidly changing environment. The biology of the oceanic whitetip shark indicates that it is likely to be a species with low resilience to fishing and minimal capacity for compensation (Rice and Harley 2012).

Available information does not indicate that destruction, modification or curtailment of the species' habitat or range, disease or predation, or other natural or manmade factors are operative threats on this species (81 FR 96304).

6.2.14 Giant Manta Ray

On January 22, 2018, NMFS published a final rule listing the giant manta ray (*Manta birostris*) as threatened under the ESA (83 FR 2916).

6.2.14.1 Species Description and Distribution

The giant manta ray is an elasmobranch with a diamond-shaped body with wing-like pectoral fins measuring up to 25 feet (8 meters) across. Giant manta rays are planktivores, using gill plates (also known as gill rakers) to feed on zooplankton. Giant manta rays reach sexual maturity at about ten years old. They are viviparous, giving birth to one pup every two to three years. Gestation lasts between 12 to 13 months. Giant manta rays can live up to 40 years, so a female may only produce between five to 15 pups in a lifetime (FAO 2012).

Giant manta rays occupy tropical, subtropical, and temperate oceanic waters and productive coastlines. In the Atlantic Ocean, giant manta rays have been observed as far north as New Jersey and are widespread in the Gulf of Mexico. Giant manta rays are commonly found offshore in oceanic waters, but are sometimes found feeding in shallow waters (less than 10 meters) during the day (Miller 2016). Giant manta rays can dive to depths of over 1,000 meters, and also conduct night descents to between 200 and 450 meters deep (Miller 2016).

6.2.14.2 Life History Information

Giant manta rays are migratory, capable of undertaking migrations up to 1,500 kilometers (Graham et al. 2012; Hearn et al. 2014), although some tagged individuals have been observed staying in the same location (Stewart et al. 2016). Giant manta rays have been observed in aggregations of 100 to 1,000 individuals (Miller 2016; Notarbartolo-di-Sciara and Hillyer 1989), at particular sites. These sites are thought to be feeding or cleaning locations, or where courtships take place.

Giant manta rays are elasmobranchs, and although there is no known information on the hearing ability of this species specifically, other species of elasmobranchs have been studied. Hearing ranges of lemon sharks and horn sharks are between 20 hertz and one kilohertz (Casper 2006), and we assume that the hearing range of giant manta rays are within this range as well.

6.2.14.3 Status and Population Dynamics

The Status Review for the species listed found that giant manta rays are at risk throughout a significant portion of their range, due in large part to the observed declines in the Indo-Pacific.

There have been decreases in landings of up to 95 percent in the Indo-Pacific; such declines have not been observed in other subpopulations such as Mozambique and Ecuador (Miller 2016).

There is not a great deal of information on the population structure of giant manta ray. Some evidence suggests that there are isolated subpopulations (Stewart et al. 2016), and possibly a subspecies resident to the Yucatán (Hinojosa-Alvarez et al. 2016).

There are no current or historical estimates of range-wide abundance, although there are some rough estimates of subpopulation size based on anecdotal accounts from fishermen and divers. It is difficult to obtain reliable abundance estimates as the species is only sporadically observed. There are about 11 worldwide (perhaps more), and these subpopulation estimates range from 100 to 1,500 individuals each (FAO 2012; Miller 2016). The only abundance data for giant manta rays in the Atlantic comes from two sources; the Flower Garden Banks Marine Sanctuary in the Gulf of Mexico, with more than 70 individuals, and in the waters off Brazil, with about 60 individuals (Miller 2016). The FGBNMS is an important nursery habitat for juvenile manta rays in the Gulf of Mexico (Stewart et al. 2018).

6.2.14.4 Threats

Natural

There are few known natural threats to giant manta rays. Disease and shark attacks were ranked as low risk threats, and giant manta rays exhibit high survival rates after maturity (Miller 2016).

Anthropogenic

The most significant threat to giant manta ray populations is commercial fishing. Giant manta rays are a targeted species for the mobuild gill raker market. Gills from mobuilds (i.e., rays of the genus Mobula, including *Manta* spp.) are dried and sold in Asian dried seafood and traditional Chinese medicine markets (O'Malley et al. 2017). Sources for gill rakers sold in these markets include China, Indonesia, Vietnam, Sri Lanka, and India; one market in Guangzhou, China, accounts for about 99 percent of the total market volume. In 2011, there was an estimated 60.5 tons of mobuild gill rakers, which almost doubled to 120.5 tons in 2015 (O'Malley et al. 2017).

In addition to the threat from directed fishing, giant manta rays are also captured incidentally in industrial purse seine and artisanal gillnet fisheries. Incidental bycatch is a particular concern in the eastern Pacific Ocean, and the Indo-Pacific (Miller 2016).

6.2.15 Status of Affected Species and Critical Habitats in the Action Area

6.2.15.1 Gulf of Mexico Bryde's Whales

Gulf of Mexico Bryde's whales have been consistently located in a specific area and depth corridor along the northeastern shelf break for the past 25 years. Sightings outside this particular area are few, despite a large amount of dedicated marine mammal survey effort that covered both continental shelf and oceanic waters of the northern Gulf of Mexico, however those surveys were not all dedicated to finding Bryde's whales (Rosel 2016). Since 1954, there have been strandings along the Northern Gulf of Mexico in every state except Texas (Rosel 2016).

This stock is resident year-round in the northeastern Gulf of Mexico, specifically in the DeSoto Canyon area, however the determination of residency has not included records of individual whales over an extended time period (Rosel 2016). There is uncertainty about the former distribution of these whales in waters of north-central and southern Gulf of Mexico. According to the status review, there are some recent sightings data of baleen whales westward into waters off Louisiana (Rosel 2016). Historical whaling data have suggested that Bryde's whales (mistakenly identified as "finbacks") formerly ranged in central and southern Gulf of Mexico (Jefferson and Schiro 1997); Reeves et al. (2011).

According to the most recent stock assessment report, there are 33 individuals in the Northern Gulf of Mexico stock (Waring 2016). Using a parameter correction in their model for inadvertent observer bias, Roberts et al. (2016a) estimated abundance at 44 whales. There are likely less than 100 individuals and population trends are not detectable at this time due to a lack of precise estimates (Rosel 2016).

6.2.15.2 Sperm Whales

Sperm whale groups have been observed throughout the Gulf of Mexico from the upper continental slope near the 100-meter isobath to the seaward extent of the United States EEZ and beyond (Baumgartner et al. 2001; Burks et al. 2001; Roden and Mullin 2000). Aggregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River Delta in waters that are 1,641-6,562 ft (500-2,000 m) in depth (Davis et al. 2000; Davis and Fargion 1996). They are also often concentrated along the continental slope in or near cyclones and zones of confluence between cyclones and anticyclones (Davis et al. 2000). Sperm whales appear to be concentrated in at least two geographic regions of the Northern Gulf of Mexico: an area off the Dry Tortugas and offshore of the Mississippi River delta (Maze-Foley and Mullin 2006). Davis et al. (2000) noted the presence of a resident, breeding population of endangered sperm whales within 50 km of the Mississippi River Delta and suggested that this area may be essential habitat for sperm whales. Consistent sightings and satellite tracking results indicate that sperm whales occupy the northern Gulf of Mexico throughout all seasons (Davis et al. 2000; Davis and Fargion 1996; Jefferson and Schiro 1997; Jochens et al. 2008; Mullin et al. 1994; Sparks et al. 1995). For management purposes, sperm whales in the Gulf of Mexico are considered a separate stock from those in the Atlantic and Caribbean (Engelhaupt et al. 2009; Gero and Whitehead 2007; Jaquet 2006; Jochens et al. 2008). The best abundance estimate available for sperm whales in the northern Gulf of Mexico is 763 individuals (Waring 2016).

Research on the genetic stock structure of Gulf of Mexico sperm whales, gender composition, and kinship patterns indicate a distinct matrilineal population structure of sperm whales in the Gulf of Mexico (Jochens et al. 2008). In this study, 89 individuals (including satellite-tagged, D-tag tagged, opportunistic, and stranded whales) were genotyped using both mtDNA and microsatellite techniques and gender determined using molecular sexing techniques. The majority of whales sampled from groups throughout the north-central Gulf of Mexico fit the classic 'mixed' group scenario, comprised of females and subadults of both sexes. A comparative analysis of matrilineal mtDNA and biparentally inherited nuclear genetic markers has begun to show population structure for these female lineages. Only four mtDNA haplotypes were found in the northern Gulf, with two that are unique on a global scale to this geographic area (Jochens et al. 2008).

BOEM's Sperm Whale Seismic Study provides further conclusions about sperm whales in the northern Gulf of Mexico (Jochens et al. 2008). This study concluded:

1. The data supports the conservation of sperm whales in the northern Gulf of Mexico as a discrete stock.
2. Sperm whales are present year-round in the Gulf, with females generally having significant site fidelity and males and females exhibiting significant differences in habitat use.
3. The sperm whale population off the Mississippi River Delta likely has a core size of about 140 individuals.
4. Gulf of Mexico sperm whales seem to be smaller in individual size than sperm whales in some other oceans.
5. Some groups of sperm whales in the Gulf were mixed-sex groups of females/immatures and others were groups of bachelor males. The typical group size for mixed groups was ten individuals, which is smaller than group sizes in some other oceans.
6. The typical diving and underwater behaviors of the Gulf's sperm whales are similar to those of animals in other oceans.
7. The typical feeding and foraging behaviors of the Gulf's sperm whales are similar to those of animals in other oceans, although differences in defecation rates suggest possible differences in feeding success.
8. In the otherwise oligotrophic (low productivity) Gulf of Mexico, the eddy field contributes to development of regions of locally high surface productivity that in turn may create conditions favorable for trophic cascade of surface production to the depths where Gulf sperm whales dive to forage.

6.2.15.3 Sea Turtles

The five species of sea turtles that occur in the action area are all highly migratory. Therefore, the statuses of the five species (or the DPS) of sea turtles in the action area, as well as the threats to these species, are best reflected in their range-wide statuses and supported by the species accounts in Section 5 (Status of Species). Due to their migratory behavior, loggerheads from other recovery units may be present in the action area. However, the nesting beaches for the Northern Gulf of Mexico Recovery Unit of loggerheads, defined as loggerheads originating from nesting beaches from Franklin County on the northwest coast of Florida through Texas, occur in closest proximity to the action area than other recovery units. Although all recovery units of the

DPS may be present, individuals of the Northern Gulf of Mexico Recovery Unit may be susceptible to affects during certain times of year (e.g., the offshore migration of hatchlings from nesting beaches). The mass majority of Kemp's ridley turtles nest on Gulf of Mexico beaches, which could leave them more vulnerable to threats within the Gulf than the other sea turtles that have nesting beaches in more widespread locations.

6.2.15.4 Gulf Sturgeon

The Gulf sturgeon's marine range includes waters of the Gulf of Mexico primarily from the Suwannee River in Florida west to the mouth of the Mississippi River. The action area includes the entire marine and estuarine geographic range of the species, all five genetically distinct Gulf sturgeon river-specific stocks, and winter habitat for all known (seven) reproducing riverine populations. Gulf sturgeon are known to inhabit and forage in Gulf of Mexico nearshore estuarine and marine habitats during the winter months. There are no data indicating Gulf sturgeon inhabit the deep Gulf of Mexico. Nearshore telemetry receivers indicate winter habitat for Gulf sturgeon is mostly alongshore the northern coast of Mississippi Sound extending out to the Gulf Islands. Edwards et al. (2007) reported on data collected from pop-up archival transmitting tags and found all relocations were consistent with alongshore migration and utilization of relatively shallow habitats. We believe that the status of Gulf sturgeon in the action area, as well as the threats to this species, is supported by the species account in Section 5 of this opinion.

6.2.15.5 Oceanic Whitetip Shark

There were 56 records of oceanic whitetips in the Gulf of Mexico from 1975-1995 on commercial longline vessels as part of the SEFSC Pelagic Longline Observer Program (Kohler et al., 1998). All records are beyond 200 meters, the majority of which were mature sized individuals out near the 2000 meter bathymetry line within federal waters of the Gulf of Mexico out to the EEZ.

According to the status review, one oceanic whitetip shark was tagged in the Gulf of Mexico in the NMFS Co-operative Shark Tagging Program from 1962-1993. We do not have any recent records for this species in the Gulf of Mexico, but there is not much effort in the region they have previously been caught. In 2011 and 2012, no oceanic whitetip sharks were caught in four pelagic longline surveys (B. Hueter, Mote Marine Laboratory, pers. comm. October 5, 2017).

Information in the status review suggests there was an 88 percent decline of oceanic whitetip sharks in the Gulf of Mexico since the 1950's (Young et al. 2016).

Given the large size of the action area and the wide range of the oceanic whitetip shark, oceanic whitetip sharks could occur throughout the action area. Therefore, the status of oceanic whitetips sharks in the action area, as well as the threats to this species, is supported by the species accounts in Section 6.2.13 (Status of Species).

6.2.15.6 Giant Manta Ray

The giant manta ray in the Gulf of Mexico is not common, however there is a known small population at the FGBNMS of more than 70 individuals (Miller and Klimovich 2017). It is thought that FGBNMS in the Gulf of Mexico are important nursery areas for juvenile manta rays (Stewart et al., in press). Some individual mantas may be occassionally observed in coastal areas, though we consider sightings rare, and the status review says that this larger of the two manta species may be more oceanic than the other.

Given the large size of the action area and the wide range of the giant manta ray, individuals could occur throughout the action area. Therefore, the status of giant manta rays in the action area, as well as the threats to this species, is supported by the species accounts in Section 6.2.14 (Status of Species).

6.2.15.7 Gulf Sturgeon Designated Critical Habitat

Gulf sturgeon critical habitat encompasses seven nearshore or inshore water areas and seven riverine areas between the west coast of Florida and the mouth of the Mississippi River. The action area overlaps with the marine and estuarine areas of critical habitat (Units 8-14; Figure 39 through Figure 45). These marine and estuarine areas of critical habitat support prey necessary for Gulf sturgeon foraging. Water and sediment quality is necessary for normal growth, behavior, and viability of all life stages, as is safe and unobstructed migratory pathways for passage between rivers and marine habitats. Because Gulf sturgeon are thought to fast in freshwater habitats, the marine and estuarine critical habitat units are essential in providing foraging opportunities during these residence periods. Because the action area wholly encompasses the marine and estuarine areas of critical habitat, the status of Gulf sturgeon critical habitat in the action area is best described in Section 5 (Status of the Species).

6.2.15.8 Loggerhead (Northwest Atlantic Distinct Population Segment) Designated Critical Habitat

Critical habitat for the NWA DPS of loggerhead sea turtles, in the form of *Sargassum* habitat and nearshore reproductive habitat, is present in the action area. *Sargassum* critical habitat (LOGG-S-02**;** Figure 33) is designated offshore in the action area and nearshore reproductive critical habitat (N-31 to N-36; Figure 34 and Figure 35) for loggerheads is designated in coastal waters of the action area. *Sargassum* habitat serves as developmental and foraging habitat for young loggerheads. Nearshore reproductive habitat provides hatchlings and nesting females unobstructed waters to move to or from high-density nesting beaches. These habitat types within the action area comprise only a portion of the overall designated critical habitat, as *Sargassum* and nearshore reproductive habitats are also located in the Atlantic Ocean along the southeastern coast of the United States. Although *Sargassum* habitat in the Gulf of Mexico is only designated as critical habitat for loggerhead sea turtles, is also important juvenile habitat for Kemp's ridley, green, and hawksbill sea turtles occurring in the Gulf of Mexico.

Essential features of nearshore reproductive habitat are listed as: (1) Nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 CFR 17.95(c) to 1.6 km (1 mile) offshore; (2) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and (3) Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents (79 FR 39855).

Within the proposed action area the essential features of nearshore reproductive habitat (Units LOGG-N-31 through LOGG-N-36) of designated critical habitat for loggerheads have not been adversely impacted to date by federal actions that have undergone consultation. No structures have been constructed within the nearshore reproductive habitat that (1) obstruct the free transit of nesting females and hatchlings through the surf zone and outward to open water, (2) promote notable increases in predatory species, (3) disrupt wave patterns necessary for hatchling orientation out to open waters, or (4) create excessive longshore currents which could sweep hatchling sea turtles off course as they attempt to reach open waters. The profile of the surf zone approach to the beach has not been altered to a degree that would preclude or deter nesting females from accessing the beach. While nighttime activities such as dredging and sand placement (as well as onshore structures) often utilize artificial lighting, safeguards required by the Terms and Conditions (T&Cs) of past consultations minimize the potential for altering the habitat in such a manner that it impacts the ability of turtles to effectively transit through the surf zone.

Similarly, *Sargassum* Unit LOGG-S-02 of critical habitat for the NWA DPS of loggerhead sea turtles is found within the proposed action area but has not been adversely affected by any projects since its designation. NMFS is not aware of any projects that have affected the four primary constituent elements of the critical habitat unit, which are (1) Convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of Sargassum and inhabitance of loggerheads; (2) Sargassum in concentrations that support adequate prey abundance and cover; (3) Available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and (4) Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., >10 m depth. While vessel traffic could temporarily affect the concentration of *Sargassum* by breaking up larger mats when transiting through them, we do not believe this will occur at a scale large enough to adversely affect the ability of the feature to perform its function. According to the designation rule [79 FR 39855], *Sargassum* habitat and the loggerhead sea turtle prey items living within could be affected by "oil and gas exploration, development, and transportation… in the process of normal operations and during blowouts and oil spills, which release toxic hydrocarbons and also require other toxic chemicals for cleanup."

7 ENVIRONMENTAL BASELINE

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. §402.02; 84 FR 44976 published August 27, 2019). In this section, we discuss the environmental baseline within the action area as it applies to species that are likely to be adversely affected by the proposed action.

Focusing on the impacts of the activities in the action area specifically allows us to assess the prior experience and state (or condition) of the endangered and threatened individuals and areas of designated critical habitat that occur in an action area that will be exposed to effects from the action under consultation. This is important because in some states or life history stages, or areas of their ranges, listed individuals or critical habitat features will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other states, stages, or areas within their distributions. These localized stress responses or stressed baseline conditions may increase the severity of the adverse effects expected from the proposed action.

7.1 Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Effects of climate change include sea level rise, increased frequency and magnitude of severe weather events, changes in air and water temperatures, and changes in precipitation patterns, all of which are likely to impact ESA resources. NOAA's climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://www.climate.gov).

In order to evaluate the implications of different climate outcomes and associated impacts throughout the 21st century, many factors have to be considered. The amount of future greenhouse gas emissions is a key variable. Developments in technology, changes in energy generation and land use, global and regional economic circumstances, and population growth must also be considered.

A set of four scenarios was developed by the Intergovernmental Panel on Climate Change (IPCC) to ensure that starting conditions, historical data, and projections are employed consistently across the various branches of climate science. The scenarios are referred to as representative concentration pathways (RCPs), which capture a range of potential greenhouse gas emissions pathways and associated atmospheric concentration levels through 2100 (IPCC 2014). The RCP scenarios drive climate model projections for temperature, precipitation, sea level, and other variables: RCP2.6 is a stringent mitigation scenario; RCP2.5 and RCP6.0 are intermediate scenarios; and RCP8.5 is a scenario with no mitigation or reduction in the use of fossil fuels. The IPCC future global climate predictions (2014 and 2018) and national and regional climate predictions included in the Fourth National Climate Assessment for U.S. states and territories (2018) use the RCP scenarios.

The increase of global mean surface temperature change by 2100 is projected to be 0.3 to 1.7°C under RCP 2.6, 1.1 to 2.6°C under RCP 4.5, 1.4 to 3.1°C under RCP 6.0, and 2.6 to 4.8°C under RCP8.5 with the Arctic region warming more rapidly than the global mean under all scenarios (IPCC 2014). The Paris Agreement aims to limit the future rise in global average temperature to 2°C, but the observed acceleration in carbon emissions over the last 15 to 20 years, even with a lower trend in 2016, has been consistent with higher future scenarios such as RCP8.5 (Hayhoe et al. 2018).

The globally-averaged combined land and ocean surface temperature data, as calculated by a linear trend, show a warming of approximately 1.0°C from 1901 through 2016 (Hayhoe et al. 2018). The IPCC Special Report on the Impacts of Global Warming noted that human-induced warming reached temperatures between 0.8 and 1.2°C above pre-industrial levels in 2017, likely increasing between 0.1 and 0.3°C per decade. Warming greater than the global average has already been experienced in many regions and seasons, with most land regions experiencing greater warming than over the ocean (Allen et al. 2018). Annual average temperatures have increased by 1.8°C across the contiguous U.S. since the beginning of the 20th century with Alaska warming faster than any other state and twice as fast as the global average since the mid-20th century (Jay et al. 2018). Global warming has led to more frequent heatwaves in most land regions and an increase in the frequency and duration of marine heatwaves (Allen et al. 2018). Average global warming up to 1.5°C as compared to pre-industrial levels is expected to lead to regional changes in extreme temperatures, and increases in the frequency and intensity of precipitation and drought (Allen et al. 2018).

Several of the most important threats contributing to the extinction risk of ESA-listed species, particularly those with a calcium carbonate skeleton such as corals and mollusks as well as species for which these animals serve as prey or habitat, are related to global climate change. The main concerns regarding impacts of global climate change on coral reefs and other calcium carbonate habitats generally, and on ESA-listed corals and mollusks in particular, are the magnitude and the rapid pace of change in greenhouse gas concentrations (e.g., carbon dioxide and methane) and atmospheric warming since the Industrial Revolution in the mid-19th century.

These changes are increasing the warming of the global climate system and altering the carbonate chemistry of the ocean [ocean acidification; (IPCC 2014)]. As carbon dioxide concentrations increase in the atmosphere, more carbon dioxide is absorbed by the oceans, causing lower pH and reduced availability of calcium carbonate. Because of the increase in carbon dioxide and other greenhouse gases in the atmosphere since the Industrial Revolution, ocean acidification has already occurred throughout the world's oceans, including in the Caribbean, and is predicted to increase considerably between now and 2100 (IPCC 2014).

The Atlantic Ocean appears to be warming faster than all other ocean basins except perhaps the southern oceans (Cheng et al. 2017). In the western North Atlantic Ocean surface temperatures have been unusually warm in recent years (Cheng et al. 2017). In the western North Atlantic Ocean surface temperatures have been unusually warm in recent years (Blunden and Arndt 2016). A study by (Polyakov et al. 2009) suggests that the North Atlantic Ocean overall has been experiencing a general warming trend over the last 80 years of 0.031±0.0006 degrees Celsius per decade in the upper 2,000 meters (6,561.7 feet) of the ocean. Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney et al. 2012). Since the early 1980s, the annual minimum sea ice extent (observed in September each year) in the Arctic Ocean has decreased at a rate of 11 to 16 percent per decade (Jay et al. 2018). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era . A study by (Polyakov et al. 2009) suggests that the North Atlantic Ocean overall has been experiencing a general warming trend over the last 80 years of 0.031±0.0006 degrees Celsius per decade in the upper 2,000 meters (6,561.7 feet) of the ocean. Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney et al. 2012). Since the early 1980s, the annual minimum sea ice extent (observed in September each year) in the Arctic Ocean has decreased at a rate of 11 to 16 percent per decade (Jay et al. 2018). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2014) and this rise has been linked to climate change. Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, tropical storms, heat waves, and droughts (IPCC 2014).

Climate change has the potential to impact species abundance, geographic distribution, migration patterns, and susceptibility to disease and contaminants, as well as the timing of seasonal activities and community composition and structure (MacLeod et al. 2005; Robinson et al. 2005). Climate change has the potential to impact species abundance, geographic distribution, migration patterns, and susceptibility to disease and contaminants, as well as the timing of seasonal activities and community composition and structure (Evans and Bjørge 2013; IPCC 2014; Kintisch 2006; Learmonth et al. 2006; MacLeod et al. 2005; McMahon and Hays 2006; Robinson et al. 2005). Though predicting the precise consequences of climate change on highly mobile marine species is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring. For example, in sea turtles, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25 to 35°C (Ackerman 1997). Increases in global temperature could skew future sex ratios toward higher numbers of females (NMFS and USFWS 2007aa; NMFS and USFWS 2007fb; NMFS and USFWS 2013ba; NMFS and USFWS 2013cb; NMFS and USFWS 2015). These impacts will be exacerbated by sea level rise. The loss of habitat because of climate change could be accelerated due to a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and/or changes in prevailing currents, both of which could lead to increased beach loss via erosion (Antonelis et al. 2006; Baker et al. 2006).

Changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, dissolved oxygen levels, nutrient distribution) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish), ultimately affecting primary foraging areas of ESA-listed species including marine mammals, sea turtles, and fish. Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012). Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. They predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some predicted to experience losses. Notably, leatherback turtles were predicted to gain core habitat area, whereas loggerhead turtles and blue whales were predicted to experience losses in available core habitat. McMahon and Hays (2006) predicted increased ocean temperatures will expand the distribution of leatherback turtles into more northern latitudes. The authors noted this is already occurring in the Atlantic Ocean. (MacLeod 2009) estimated, based upon expected shifts in water temperature, 88 percent of cetaceans will be affected by climate change, with 47 percent predicted to experience unfavorable conditions (e.g., range contraction). Willis-Norton et al. (2015) acknowledged there will be both habitat loss and gain, but overall climate change could result in a 15 percent loss of core pelagic habitat for leatherback turtles in the eastern South Pacific Ocean.

Similarly, climate-related changes in important prey species populations are likely to affect predator populations. For example, blue whales, as predators that specialize in eating krill, are likely to change their distribution in response to changes in the distribution of krill (Clapham et al. 1999; Payne et al. 1986; Payne et al. 1990). Pecl and Jackson (2008) predicted climate change will likely result in squid that hatch out smaller and earlier, undergo faster growth over shorter life-spans, and mature younger at a smaller size. This could have negative consequences for species such as sperm whales, whose diets can be dominated by cephalopods. For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperatures regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott 2009).

This review provides some examples of impacts to ESA-listed species and their habitats that may occur as the result of climate change. While it is difficult to accurately predict the consequences of climate change to a particular species or habitat, a range of consequences are expected that are likely to change the status of the species and the condition of their habitats.

7.2 Sound

NMFS has established criteria to predict varying levels of responses of marine species to anthropogenic sound, based upon hearing injury and behavioral responses (http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm). Responses to sound exposure may include lethal or nonlethal injury, temporary hearing impairment, behavioral harassment and stress, or no apparent response. Contributions to ambient sound levels include vessels, geophysical exploration, and the construction, operational, and decommissioning of offshore structures. It is expected that the policy on managing anthropogenic sound in the oceans will provide guidance for programs such as incidental harassment permits under the Marine Mammal Protection Act and permits for research involving sound-producing activities. NOAA is working cooperatively with the ship-building industry to find technologically-based solutions to reduce the amount of sound produced by commercial vessels. Through ESA consultation with NMFS, BOEM and BSEE have implemented and periodically revised Gulf of Mexico-wide measures, such as BOEM NTL 2016-G02, to reduce the risk of harassment to sperm whales from sound produced by geological and geophysical surveying activities and the explosive removal of offshore structures.

NOAA has implemented the CetSound Ocean Sound Strategy (http://cetsound.noaa.gov/) that provides for a better understanding of man-made sound impacts on cetacean species. CetSound produced modeled ambient sound maps for several sound source types in the Gulf of Mexico. Annual average ambient sound sums of the modeled source types including seismic airgun surveys at different frequencies and depths is displayed in Figure 46. Other modeled events that can be viewed on the CetSound website for the Gulf of Mexico include annual average ambient sound for only seismic airguns surveys, summed sound sources without airguns, and explosive severance of an oil platform during decommissioning.

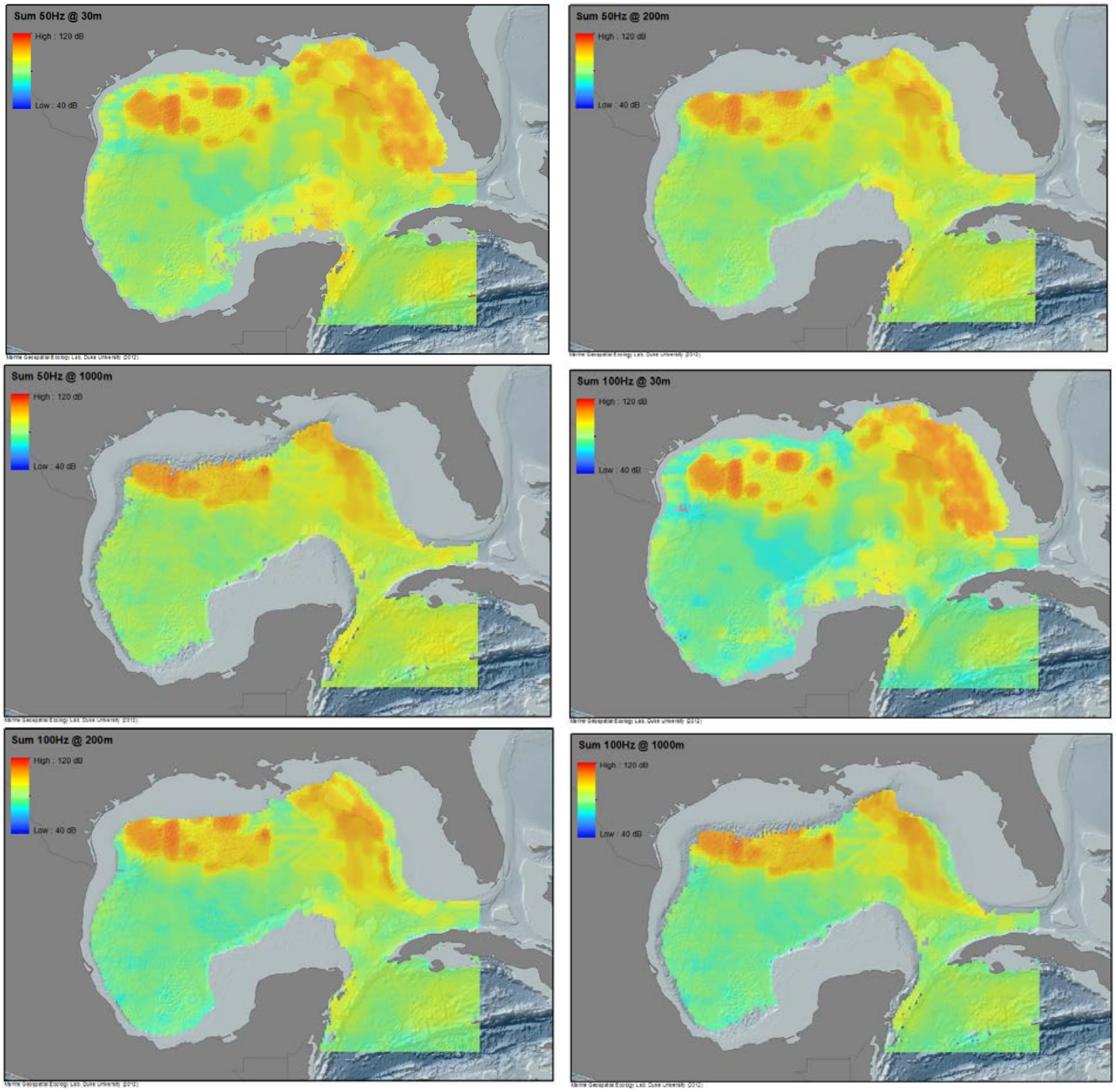


Figure 46. Predicted average contribution to ambient sound from modeled sound sources including seismic airgun surveys at different depths for 50 Hz and 100 Hz. Source: Marine Geospatial Ecology Lab, Duke University (2012) as published on CetSound website.

The Gulf of Mexico soundscape is being studied over the long-term by NOAA's Sound Reference Station Network (https://www.pmel.noaa.gov/acoustics/ocean-sound-reference.html). This network uses static PAM hydrophone (sound recorder) units to monitor trends and changes in the ambient sound field in U.S. federal waters. In addition to this network, there have been several other hydrophone units in the northern Gulf of Mexico (Figure 47). A study by Wiggins et al. (2016) placed two high-frequency acoustic recording packages (HARPs) in 100 m to 250 m water depths and three HARPs in approximately 1,000 m water depth to compare low-frequency sound pressure spectrum levels over three years.

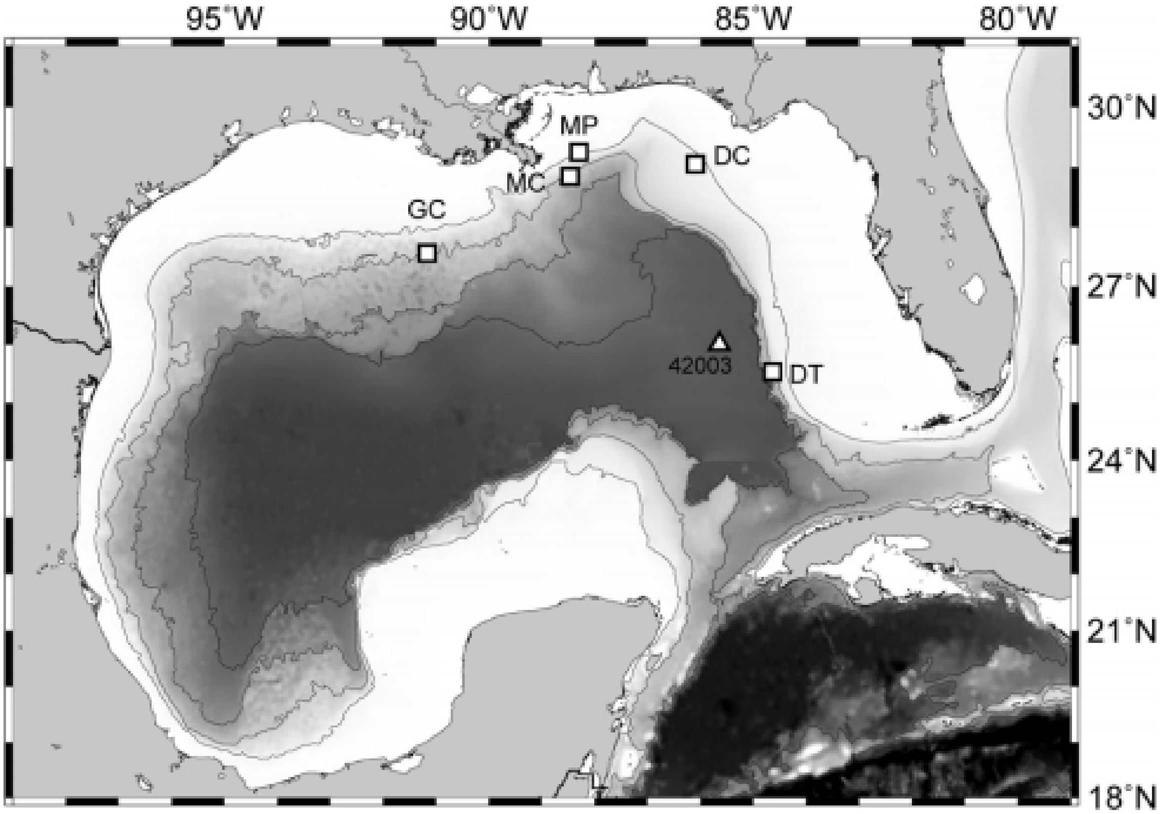


Figure 47. Five HARP locations, which collected data over several months during 2010-2013, are displayed as squares notated with site codes [GC, Green Canyon; MC, Mississippi Canyon; MP, Main Pass; DC, De Soto Canyon; and DT, Dry Tortugas]. The triangle is a NOAA weather bouy station used to measure wind speeds. Figure from (Wiggins et al. 2016).

The (Wiggins et al. 2016) study concluded:

1. Deepwater sites (GC, MC, DT) had the highest sound pressure levels below 100 Hz and they reported some of the highest measured averages over long periods.
2. Gulf of Mexico ship traffic, especially bulk carriers, is of the highest ranked in U.S. ports; however, seismic airgun pulses are the dominant source of low frequency, high sound levels in the deep water.
3. When a Hurricane swept through in August 2012, the sound pressure levels being recorded dropped by over 10 to 81 dB re 1μPa^2 at 40 Hz, likely due to cessation of shipping and seismic operations.
4. Shallow sites (MP, DC) differed from each other and from the deepwater sites and generally were quieter than the deeper sites. This was attributed to proximity far from anthropogenic activity.

Sound is a stressor that is produced by many activities discussed in the remaining baseline sections below.

7.3 Fisheries Bycatch and Interactions

Commercial and recreational fisheries can result in substantial detrimental impacts on populations of ESA-listed species. Past fisheries contributed to the steady decline in the population abundance of many ESA-listed fish species. Although directed fishing for the species covered in this opinion is prohibited under the ESA, many are still captured as “bycatch” in fishing operations targeting other species. Bycatch occurs when fishing operations interact with marine mammals, sea turtles, and fish species that are not the target species for commercial sale. Large marine species are particularly susceptible to entanglement in fishing gear that is being actively fished as well as derelict or “ghost fishing” gear.

7.3.1 Federal Fisheries

Commercial and recreational fisheries managed by NMFS under the Magnuson-Stevens Act in the Gulf of Mexico have interacted with sea turtles, sperm whales, and Gulf sturgeon throughout the past. While interactions between federal fisheries and sperm whales or Gulf sturgeon are rare, threatened and endangered sea turtles are more susceptible to interactions with several types of fishing gear in the action area including gillnet, hook-and-line (i.e., vertical line), and trawl gear. For all fisheries for which there is a fishery management plan (FMP) or for which any federal action is taken to manage that fishery, the impacts have been evaluated via section 7 consultation. Past consultations have addressed the effects of federally permitted fisheries on ESA-listed species, sought to minimize the adverse impacts of the action on ESA-listed species, and, when appropriate, have authorized the incidental taking of these species. Formal section 7 consultations have been conducted on the following federal fisheries that operate in the action area: Coastal Migratory Pelagics, Highly Migratory Species (HMS) Atlantic Shark and Smoothhound, Gulf of Mexico Reef Fish, and Southeastern Shrimp Trawl Fisheries. NMFS has issued an ITS for the take of sea turtles in each of these fisheries that can be found in **Appendix D** of this opinion. A summary of each consultation is provided below, but more detailed information can be found in the respective biological opinions (NMFS 2011b; NMFS 2011c; NMFS 2012b; NMFS 2015a).

Sperm whales can become entangled in fishing gear such as longlines or gillnets. While this species is less susceptible to threats posed by fishing gear than other more coastal cetaceans, there is a report of a sperm whale entanglement within the Gulf of Mexico. Further, Thode et al. (2015) and Straley et al. (2015) used PAM and decoy sound production to demonstrate that sperm whales may be attracted to the acoustic cues of fishing vessels for catch depredation, which could lead to gear entanglement.

The BIA for Gulf of Mexico Bryde’s whales spatially overlaps with several state and federal fisheries that may pose a threat to marine mammals. The gillnet and Florida West Coast sardine purse seine fisheries are less likely to overlap; and the large pelagics longline, snapper-grouper and other reef fish bottom longline/hook-and-line, shark bottom longline/hook-and-line, pelagic hook-and-line/harpoon, shrimp trawl and butterfish trawl fisheries may overlap. Direct interactions with gillnets, purse-seines, shrimp trawls, and trap pots may be unlikely, but indirect interactions, such as entanglement in derelict “ghost fishing” gear may be of concern for Bryde’s whales. Indirect effects such as ecosystem wide trophic impacts may also be of concern (Rosel 2016).

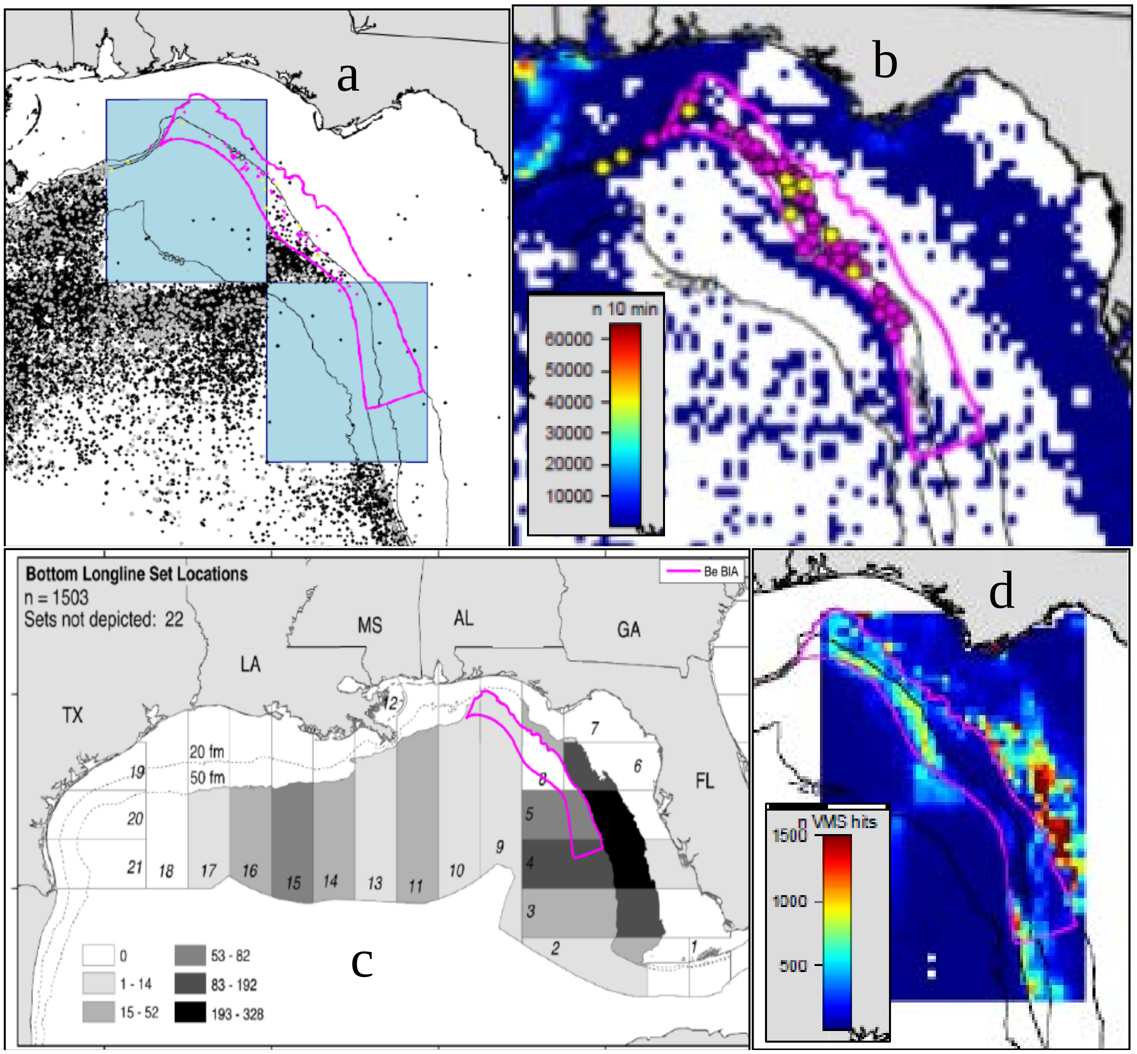


Figure 48. a.) Pelagic longline set locations - blue boxes represent the De Soto Canyon MPA, which is closed to pelagic longline fishing year-round and covers approximately 2/3 of the Bryde’s whale BIA. b.) Shrimp trawl active fishing effort near the BIA from 2002-2014. c.) Bottom longline sets from 2006-2009. d.) Vessel Monitoring System ping locations from vessels carrying reef fish permit and shark directed permit, and may represent both transiting and active fishing. Figures from Rosel (2016).

Gulf sturgeon are believed to be susceptible to capture only in trawls and gillnet gear via entanglement. However, because Gulf sturgeon occur in the Gulf of Mexico only during winter months and during that time most migrate alongshore and to barrier island habitats within shallower state waters, we believe federal fisheries have only a minor impact on the species. On December 15, 2009, an observer documented a Gulf sturgeon capture in a shrimp trawl operating in federal waters; the animal was released alive. This observation was the first and only record of a Gulf sturgeon incidentally caught by a federal shrimp trawl. This capture, among other things, led to reinitiation of consultation on the federal shrimp fisheries in the southeastern United States. Previous section 7 consultations on federal fisheries discounted effects on Gulf sturgeon because of their rarity in federal waters. The 2014 biological opinion on the federal shrimp fisheries (NMFS 2014c) determined that while capture of Gulf sturgeon in shrimp trawls remains an unlikely event, trawling could adversely affect the species though it would not jeopardize its continued existence.

7.3.1.1 Coastal Migratory Pelagics Fishery

In 2015, NMFS completed a section 7 consultation on the continued authorization of the coastal migratory pelagics fishery in the Gulf of Mexico and South Atlantic (NMFS 2015a). In the Gulf of Mexico, hook-and-line, gillnet, and cast net gears are used commercially, while the recreational sector uses hook-and-line gear. The hook-and-line effort is primarily trolling. The biological opinion concluded that green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles as well as smalltooth sawfish and Atlantic sturgeon may be adversely affected by operation of the fishery. However, the proposed action was not expected to jeopardize the continued existence of any of these species and an ITS was provided

7.3.1.2 Highly Migratory Species Atlantic Shark and Smoothhound Fisheries

These fisheries include commercial shark bottom longline and gillnet fisheries and recreational shark fisheries under the Fishery Management Plan (FMP) for Atlantic Tunas, Swordfish, and Sharks (HMS FMP). NMFS has formally consulted several times on the effects of HMS shark fisheries on sea turtles (NMFS 2003; NMFS 2008; NMFS 2012a). NMFS has also authorized a federal smoothhound fishery that will be managed as part of the HMS shark fisheries. NMFS (2012b) analyzed the potential adverse effects from the smoothhound fishery on sea turtles for the first time. Both bottom longline and gillnet are known to adversely affect sea turtles. From 2007-2011, the sandbar shark research fishery had 100 percent observer coverage, with 4-6 percent observer coverage in the remaining shark fisheries. During that period, ten sea turtle takes (all loggerheads) were observed on bottom longline gear in the sandbar shark research fishery and five were taken outside the research fishery. The five non-research fishery takes were extrapolated to the entire fishery, providing an estimate of 45.6 sea turtle takes (all loggerheads) for non-sandbar shark research fishery from 2007-2010 (Carlson and Gulak 2012; Carlson et al. 2016). No sea turtle takes were observed in the non-research fishery in 2011 (NMFS 2012a). Since the research fishery has a 100 percent observer coverage requirement, those observed takes were not extrapolated (Carlson and Gulak 2012; Carlson et al. 2016). Because few smoothhound trips were observed, no sea turtle captures were documented in the smoothhound fishery.

The most recent ESA section 7 consultation was completed on December 12, 2012, on the continued operation of Atlantic shark and smoothhound fisheries and Amendments 3 and 4 to the Consolidated HMS FMP (NMFS 2012b). The consultation concluded the proposed action was not likely to jeopardize the continued existence of sea turtles. An ITS was provided authorizing 18 takes (nine of which could be lethal) of each species for hawksbill and leatherback sea turtles every three years. Loggerhead, green and Kemp's ridley turtle takes were 126, 57, and 36, respectively.

7.3.1.3 Gulf of Mexico Reef Fish Fishery

The Gulf of Mexico reef fish fishery uses two basic types of gear: spear or powerhead, and hook-and-line gear. Hook-and-line gear used in the fishery includes both commercial bottom longline and commercial and recreational vertical line (e.g., handline, bandit gear, rod-and-reel).

Prior to 2008, the reef fish fishery was believed to have relatively moderate levels of sea turtle bycatch attributed to the hook-and-line component of the fishery (i.e., approximately 107 captures and 41 mortalities annually, all species combined, for the entire fishery) (NMFS 2005a). In 2008, SEFSC observer programs and subsequent analyses indicated that the overall amount and extent of incidental take for sea turtles specified in the incidental take statement of the 2005 opinion on the reef fish fishery had been severely exceeded by the bottom longline component of the fishery: approximately 974 captures and at least 325 mortalities estimated for the period July 2006-2007.

In response, NMFS published an Emergency Rule prohibiting the use of bottom longline gear in the reef fish fishery shoreward of a line approximating the 50-fathom depth contour in the eastern Gulf of Mexico, essentially closing the bottom longline sector of the reef fish fishery in the eastern Gulf of Mexico for six months pending the implementation of a long-term management strategy. The Gulf of Mexico Fishery Management Council (GMFMC) developed a long-term management strategy via a new amendment (Amendment 31 to the Reef Fish FMP). The amendment included: (1) a prohibition on the use of bottom longline gear in the Gulf of Mexico reef fish fishery, shoreward of a line approximating the 35-fathom contour east of Cape San Blas, Florida, from June through August and ; (2) a reduction in the number of bottom longline vessels operating in the fishery via an endorsement program and a restriction on the total number of hooks that may be possessed onboard each Gulf of Mexico reef fish bottom longline vessel to 1,000, only 750 of which may be rigged for fishing.

On October 13, 2009, SERO completed an opinion that analyzed the expected effects of the continued operation of the Gulf of Mexico reef fish fishery under the changes proposed in Amendment 31 (NMFS-SEFSC 2009b). The opinion concluded that sea turtle takes would be substantially reduced compared to the fishery as it was previously prosecuted, and that operation of the fishery would not jeopardize the continued existence of any sea turtle species. Amendment 31 was implemented on May 26, 2010. In August 2011, consultation was reinitiated to address the DWH oil release event and potential changes to the environmental baseline. Reinitiation of consultation was not related to any material change in the fishery itself, violations of any terms and conditions of the 2009 opinion, or an exceedance of the incidental take statement. The resulting September 30, 2011, opinion concluded the continued operation of the Gulf of Mexico reef fish fishery is not likely to jeopardize the continued existence of any listed sea turtles (NMFS 2011b).

7.3.1.4 Southeastern Shrimp Trawl Fisheries

NMFS has prepared opinions on Gulf of Mexico shrimp trawl fisheries numerous times over the years, most recently in 2014 (NMFS 2014a). The consultation history is closely tied to the lengthy regulatory history governing the use of TEDs and a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial shrimp trawl fisheries. The level of annual mortality described in (NRC 1990c) is believed to have continued until 1992-1994, when U.S. law required all shrimp trawlers in the Atlantic and Gulf of Mexico to use TEDs, allowing at least some sea turtles to escape nets before drowning (NMFS 2002).[31] TEDs approved for use have had to demonstrate 97 percent effectiveness in excluding sea turtles from trawls in controlled testing. These regulations have been refined over the years to ensure that TED effectiveness is maximized through proper placement and installation, configuration (e.g., width of bar spacing), flotation, and more widespread use.

Despite the apparent success of TEDs for some species of sea turtles (e.g., Kemp’s ridleys), it was later discovered that TEDs were not adequately protecting all species and size classes of sea turtles. Analyses by Epperly and Teas (2002) indicated that the minimum requirements for the escape opening dimension in TEDs in use at that time were too small for some sea turtles and that as many as 47 percent of the loggerheads stranding annually along the Atlantic and Gulf of Mexico were too large to fit the existing openings. On December 2, 2002, NMFS completed an opinion on shrimp trawling in the southeastern United States (NMFS 2002) under proposed revisions to the TED regulations requiring larger escape openings (68 FR 8456 2003), February 21, 2003). This opinion determined that the shrimp trawl fishery under the revised TED regulations would not jeopardize the continued existence of any sea turtle species. The determination was based in part on the opinion’s analysis that shows the revised TED regulations are expected to reduce shrimp trawl related mortality by 94 percent for loggerheads and 97 percent for leatherbacks. In February 2003, NMFS implemented the revisions to the TED regulations.

Although mitigation measures have greatly reduced the impact on sea turtle populations, the shrimp trawl fishery is still responsible for large numbers of turtle mortalities each year. The Gulf of Mexico fleet accounts for a large percentage of the sea turtle bycatch in this fishery. In 2010, the Gulf of Mexico shrimp trawl fishery had an estimated bycatch mortality of 5,166 turtles (18 leatherback, 778 loggerhead, 486 green and 3,884 Kemp’s ridley). By comparison, the southeast Atlantic fishery had an estimated bycatch mortality of 1,033 turtles (8 leatherback, 673 loggerhead, 28 green and 324 Kemp’s ridley) in 2010 (NMFS 2014b).

[31] TEDs were mandatory on all shrimping vessels. However, certain shrimpers (e.g., fishers using skimmer trawls or targeting bait shrimp) could operate without TEDs if they agreed to follow specific tow-time restrictions.

On May 9, 2012, NMFS completed a biological opinion that analyzed the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the Magnuson-Stevens Act (NMFS 2012c). The opinion also considered a proposed amendment to the sea turtle conservation regulations to withdraw the alternative tow-time restriction at 50 CFR §223.206(d)(2)(ii)(A)(3) for skimmer trawls, pusher-head trawls, and wing nets (butterfly trawls) and instead require all of those vessels to use TEDs. The opinion concluded that the proposed action was not likely to jeopardize the continued existence of any sea turtle species. An ITS was provided that used anticipated trawl effort and fleet TED compliance (i.e., compliance resulting in overall average sea turtle catch rates in the shrimp otter trawl fleet at or below 12 percent) as surrogates for sea turtle takes. On November 21, 2012, NMFS determined that a Final Rule requiring TEDs in skimmer trawls, pusher-head trawls, and wing nets was not warranted and withdrew the proposal. The decision to not implement the Final Rule created a change to the proposed action analyzed in the 2012 opinion and triggered the need to reinitiate consultation. Consequently, NMFS reinitiated consultation on November 26, 2012. Consultation was completed in April 2014; it determined the continued implementation of the sea turtle conservation regulations and the continued authorization of the Southeast U.S. shrimp fisheries in federal waters under the Magnuson-Stevens Act was not likely to jeopardize the continued existence of any sea turtle species. The ITS maintained the use of anticipated trawl effort and fleet TED compliance as surrogates for numerical sea turtle takes.

7.3.2 State Fisheries

Several coastal state fisheries are known to incidentally take listed species, and available information on these fisheries is documented through different agencies (NMFS 2014c). Various fishing methods used in these commercial and recreational fisheries, including trawling, pot fisheries, gillnets, and vertical line are known to incidentally take sea turtles and/or Gulf sturgeon (NMFS 2014c). The past and current effects of state fisheries on listed species are currently not determinable. Most state data are based on extremely low observer coverage or sea turtles were not part of data collection; however, available data provide insight into gear interactions that could occur but are not indicative of the magnitude of the overall problem. The 2001 HMS biological opinion (discussed in fisheries section above) has an excellent summary of turtles taken in state fisheries throughout the action area.

In addition to commercial state fisheries, protected sea turtles can also be incidentally captured by hook and line recreational fishers. Observations of state recreational fisheries have shown that loggerhead, leatherback, Kemp's ridley, and green sea turtles are known to bite baited hooks. Further, observations show that loggerheads and Kemp's ridleys frequently ingest the hooks. Hooked turtles have been reported by the public fishing from boats, piers, beaches, banks, and jetties. A detailed summary of the known impacts of hook-and-line incidental captures to loggerhead sea turtles can be found in the TEWG reports (TEWG 1998; TEWG 2000).

Though not as commonly as sea turtles, Gulf sturgeon are also likely to interact with state fisheries. The Gulf sturgeon recovery plan (USFWS and GSMFC 1995) documents that Gulf sturgeon are occasionally incidentally captured in state shrimp fisheries in bays and sounds along the northern Gulf of Mexico. There are two recorded interactions (NMFS 2014 SHRIMP BO) of a Gulf sturgeon with the shrimp trawl fishery: one in federal waters (January 1, 2011) and one in state waters of the Gulf of Mexico (December 15, 2009).

In the Pearl River, Mississippi/Louisiana, a trammel/gillnet fishery is conducted for gar. Because of the gear (minimum of 3-in mesh square, up to 3,000 ft in length) and the year-around nature of the fishery, it is probable that Gulf sturgeon are intercepted in this fishery. While state regulations prohibit taking or possession of whole or any body parts, including roe, there is no reporting to determine capture or release rates.

7.4 Oil and Gas

Oil and gas operations on the OCS that have been ongoing for more than 50 years involve a variety of activities that may adversely affect ESA-listed species in the action area. These activities and resulting impacts include vessels making supply deliveries, drilling operations, seismic surveys, fluid spills, oil spills and response, and oil platform removals. To the extent the past, present or anticipated impacts arise from federal actions that are not part of the federal actions under consultation here, they form part of the environmental baseline (e.g., prior, completed exploration, development and decommissioning activities).

Natural seeps provide the largest petroleum input to the offshore Gulf of Mexico, about 95 percent of the total. (Mitchell et al. 1999) estimated a range of 280,000-700,000 bbl per year (40,000-100,000 tonnes per year), with an average of 490,000 bbl (70,000 tonnes) for the northern Gulf of Mexico, excluding the Bay of Campeche. Using this estimate and assuming seep scales are proportional to surface area, the (NRC 2003) estimated annual seepage for the entire Gulf of Mexico at about 980,000 bbl (140,000 tonnes) per year, or about three times the estimated amount of oil spilled by the 1989 Exxon Valdez event (about 270,000 bbl) (SteynSteyn 2010) or a quarter of the amount released by the DWH event (4.9 million bbl of oil) (Lubchenco and Sutley 2010). As seepage is a natural occurrence, the rate of approximately 980,000 bbl (140,000 tonnes) per year is expected to remain unchanged into the foreseeable future.

7.4.1 Lease Sales and Drilling

The sale of OCS leases in the Gulf of Mexico and the resulting exploration and development of these leases for oil and natural gas resources has affected the status of ESA-listed species in the action area. BOEM administers the OCSLA and authorizes the exploration and development of wells in Gulf leases. As technology has advanced over the past several decades, oil exploration and development has moved and will continue to move further offshore into deeper waters of the Gulf (Murawski et al. 2020). The development of wells often involves additional activities such as the installation of platforms, pipelines, and other infrastructure. Once operational, a platform will generate a variety of wastes including a variety of effluents and emissions. Each of these wastes can contribute to the baseline. Additionally, although the release of oil is prohibited, accidental oil spills can occur from loss of well control and thus adversely affect sea turtles, sperm whales, and Gulf sturgeon in the Gulf of Mexico. Previous biological opinions considered the effects resulting from the variety of actions associated with lease sales and development. These opinions determined that oil and gas leasing may adversely affect protected sea turtles, sperm whales, and Gulf sturgeon, but was found not likely to jeopardize their continued existences. However, that opinion did not contemplate the effects of a disastrous blowout and resulting extremely large oil spill event. The DWH incident resulted in exceedance of take limits in the ITS of the 2007 opinion, and alteration of the environmental baseline. This biological opinion is the result of reinitiation of consultation on the 2007 opinion.

7.4.2 Seismic Surveys

Seismic exploration is an integral part of oil and gas discovery, development, and production in the Gulf of Mexico. Seismic surveys are routinely conducted in virtually all water depths, including the deep habitat of the sperm whales. NMFS considered the effects of seismic operations in a biological opinion issued to BOEM on its 2007–2012 OCS Gulf of Mexico program. That opinion concluded that seismic surveys, with BOEM-required mitigation, were likely to adversely affect sperm whales by harassment. Required protective measures can be found in the BOEM NTL 2016-G02 “Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program.” Oil and gas activities are not permitted in the FGBNMS, except for occasional G&G surveys that require approval to occur.

7.4.3 Oil Rig Removals

Both the USACE and BSEE permit the removal of oil rigs in the Gulf of Mexico. These removals often use explosives to sever associated pile structures that can impact a variety of species, including any ESA-listed species, in the action areas. The USACE oversees rig removals in state waters while BSEE permits these activities in federal waters of the OCS. The USACE consults with NMFS on a project-by-project basis for decommissioning activities that use explosives.

In regard to rig removals in federal waters, a formal ESA section 7 consultation was completed with BSEE in 2006 and in 2008 the ITS was amended following completion of an MMPA rule. That opinion found that the permitting of structure removals in the Gulf of Mexico was not likely to result in jeopardy for sperm whales and loggerhead, Kemp’s ridley, green, hawksbill, or leatherback sea turtles. Incidental take, by injury or mortality, of three sea turtles per year or 18 sea turtles during the six-year period of the action covered in the opinion was anticipated during detonations. Most of the takes were predicted to be loggerhead sea turtles. In addition to the Reasonable and Prudent Measures within the ITS, BOEM has also issued “Idle Iron Decommissioning Guidance for Wells and Platforms” (NTL 2018-G03) to inform lessees about mitigation and reporting requirements. The removal of non-operating oil platforms is expected to continue to affect protected sea turtles.

7.4.4 Oil spills

Oil spills are accidental and unpredictable events, but are a direct consequence of oil and gas development and production from oil and gas activities in the Gulf of Mexico. Oil releases can occur at any number of points during the exploration, development, production, and transport of oil. Any discharge of hydrocarbons into the environment is prohibited under U.S. law. Instances oil spills are generally small (less than 1,000 barrels) but there are spills that occur that are of larger size. One example is the Taylor Energy site that has been flowing in Mississippi Canyon since 2004 at an estimated oil flux rate of nine to 108 barrels per day (NCCOS 2019). BSEE tracks spills greater than one barrel and posts those data to their website: https://www.bsee.gov/stats-facts/offshore-incident-statistics/spills.

When compared with the rest of the world, more than 50 percent of the loss of well control events come from the federally regulated waters of the US Gulf of Mexico (BSEE 2017). According to (BSEE 2017) from 2000-2015, four of the 117 loss of well control events were categorized as total loss, and the event with the highest risk is the blowout or surface flow type incident.

7.4.4.1 Deepwater Horizon

On April 20, 2010, while working on an exploratory well approximately 50 miles offshore Louisiana, the semi-submersible drilling rig DWH experienced an explosion and fire. The rig subsequently sank and oil and natural gas began leaking into the Gulf of Mexico. Oil flowed for 86 days, until the well was capped on July 15, 2010. Millions of barrels of oil were released. Additionally, approximately 1.84 million gallons of chemical dispersant was applied both subsurface and on the surface to attempt to break down the oil. There is no question that the unprecedented DWH event and associated response activities (e.g., skimming, burning, and application of dispersants) have resulted in adverse effects on listed species and changed the baseline for the Gulf of Mexico ecosystem. Effects of the spill went beyond the footprint that was visually detected through satellite shown in Figure 16, above. Berenshtein et al. (2020b) used in situ observations and oil spill transport modeling to examine the full extent of the DWH spill, beyond the satellite footprint, that was at toxic concentrations to marine organisms. Figure 49 below displays visible and toxic (brown); invisible and toxic (yellow) and non-toxic (blue) oil concentrations.

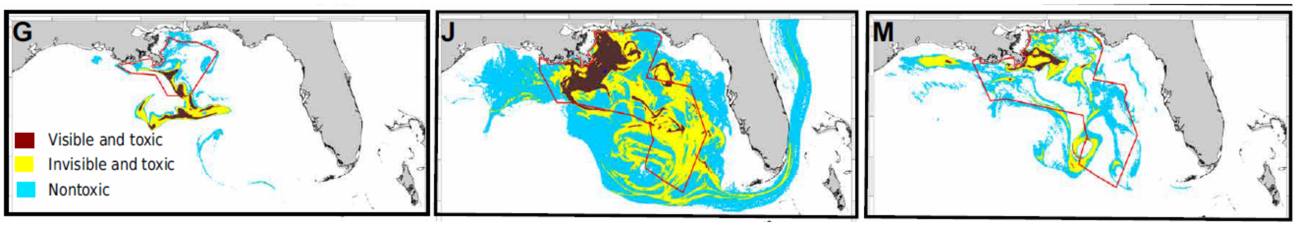
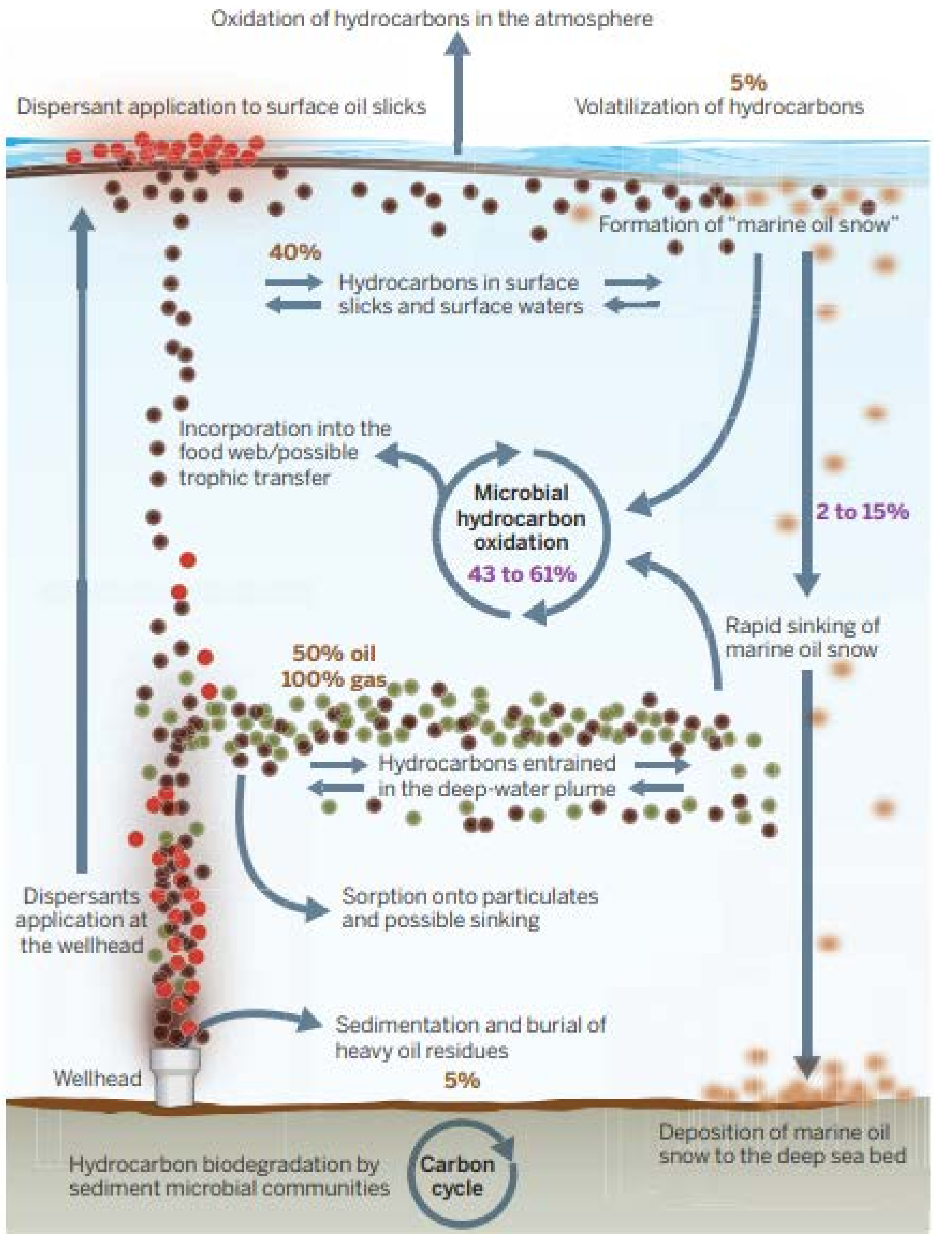


Figure 49. Figure from Berenshtein et al. (2020a) showing spatiotemporal dynamics of the spill for dates showing cumulative oil concentrations in figures G- 15 May 2010; J- 18 June 2010; and M- 2 July 2010.

The investigation conducted under the National Resource Damage Assessment regulations under the Oil Pollution Act (33 USC §2701 *et seq.*) assessed natural resource damages stemming from the DWH oil spill. Specific impacts to Kemp's ridley, green, loggerhead, and hawksbill sea turtles; sperm whales, Bryde's whales; Gulf sturgeon, and habitats of these species was determined (Trustees 2016). The findings of this assessment provide details regarding impacts to the environmental baseline of listed species and critical habitats in the Gulf of Mexico and is summarized below and can be found at http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan. The unprecedented DWH spill and associated response activities (e.g., skimming, burning, and application of dispersants) resulted in adverse effects on listed sea turtles, sperm whales, Bryde's whales, and Gulf sturgeon. Despite natural weathering processes over the years since the DWH, oil persists in some habitats where it continues to expose and impact resources in the northern Gulf of Mexico resulting in new baseline conditions (BOEM 2016; Trustees 2016). The true impacts to offshore megafauna populations and their habitats may never be fully quantified, though it was necessary to characterize these impacts for response, damage assessment and restoration activities (Frasier 2020).

According to Joye (2015), below shows the approximate distribution of offshore oil and gas during DWH. Note that this figure also has percentages of the fate of discharged hydrocarbons.



Where did the oil and gas go? The percentages given in brown in the figure reflect the approximate distribution of oil (brown circles) and gas (green circles) during the Deepwater Horizon well blowout (*2–4*); dispersant addition is noted by red circles. Available data (purple percentages) suggest that the long-term fate is known for only 45 to 76% of the discharged hydrocarbons (*7–9*). Some of the unaccounted-for oil may have been deposited in coastal marshes or beaches (not shown on the figure). Vertical and horizontal aspects are not to scale.

Figure 50. Diagram showing offshore distribution of oil and gas during DWH (Joye 2015).

While post-spill restoration has happened and continues, the effects of the restoration efforts and potential benefits raise uncertainty regarding overall effectiveness of restoration efforts (Wallace et al. 2019). It is unclear how these restoration efforts have changed the baseline relative to what it would be if those efforts had not happened.

Gulf of Mexico Bryde's whales

Similar to sperm whales described in the next section, the Gulf of Mexico Bryde's whale population was adversely affected by the DWH spill and response. Nearly half of the population was impacted by DWH oil Figure 51, resulting in an estimated 22 percent maximum decline in population size that will require 69 years to recover to the pre-spill population size (Trustees 2016). Small populations like the Gulf of Mexico Bryde's whales are highly susceptible to stochastic, or unpredictable, processes and genetic effects that can reduce productivity and resiliency to perturbations. The population models used by the Trustees (2016) did not account for these effects, and, therefore, the capability of the Bryde's whale population to recover from this injury is unknown.

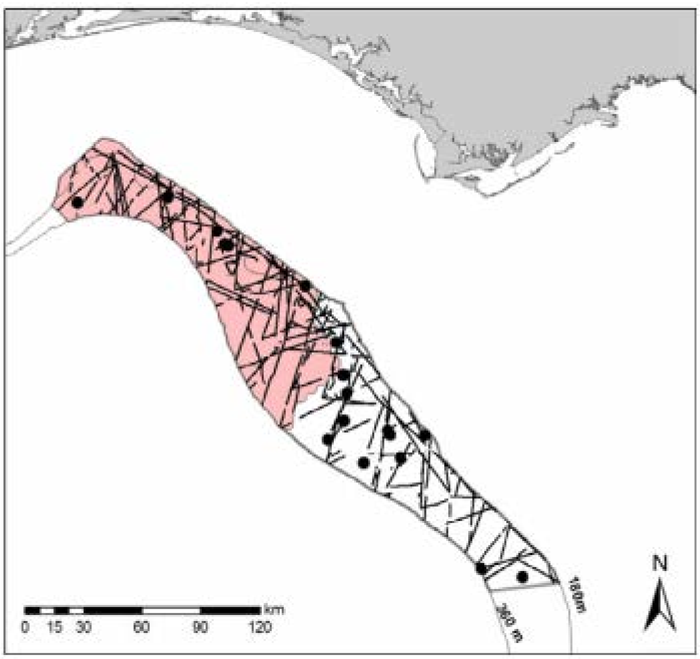


Figure 51. Line transects and sightings of Bryde's whales with the red area respresenting the overlap of DWH oil exposure and the area where Bryde's whales are typically found. Figure from MMIQT (2015).

Sperm Whales

Sperm whales could have been exposed to toxic oil components through inhalation, aspiration, ingestion, and dermal exposure. There were 19 observations of 33 sperm whales swimming in DWH surface oil or that had oil on their bodies (Diaz 2015 as cited in Trustees 2016). The effects of oil exposure include physical and toxicological damage to organ systems and tissues, reproductive failure, and death. Sperm whales suffered from multiple routes of exposure at the same time, over intermittent timeframes and at varying rates, doses, and chemical compositions of oil. The estimation of effects to sperm whales is largely based on observed impacts to bottlenose dolphins resulting from exposure to DWH oil. The DWH oil spill occurred in deep water sperm whale habitat. The same routes of internal oil exposure (ingestion, inhalation, and aspiration) would have occurred in sperm whales that have been shown to adversely affect coastal bottlenose dolphins. The surface oil and vapors at the surface were more concentrated offshore near the leaking well head that could have exposed sperm whales to high levels of contaminants between dives that were known to have occurred with dolphins.

Sperm whales were likely exposed to harmful toxins during DWH. Corexit 9500 and 9527 were both chemical dispersants used during the DWH response. These dispersant compounds were found to be cytotoxic (kills cells) and Corexit 9527 was found to be genotoxic (damages DNA) to sperm whale skin cells (Wise et al. 2014). A three-year study focusing on DWH-relevant metals found whale skin samples with genotoxic metals (aluminum, arsenic, chromium, nickel and lead) at concentrations higher than global averages, and patterns for DWH-relevant metals decreased with time from the oil spill (Wise et al. 2018).

A study of the causes of an Unusual Mortality Event of bottlenose dolphins occurring from 2010-2014 in Louisiana, Mississippi, and Alabama concluded that the contaminants from the DWH oil spill contributed to the high numbers of dolphin deaths over the four-year period (Venn-Watson et al. 2015). Live animals had a high prevalence of lung disease and were five times more likely to have moderate to severe lung disease compared to a population unaffected by the DWH oil spill (Schwacke et al. 2014). Dead animals had a significantly higher prevalence of adrenal gland disease (thin adrenal gland cortices) and lung disease (primary bacterial pneumonia) compared to an unaffected population (Venn-Watson et al. 2015). The rare, life-threatening, and chronic adrenal gland and lung diseases identified in the stranded animals were consistent with exposure to petroleum compounds as seen in other mammals such as mink (Mazet et al. 2001; Schwartz et al. 2004). Moribillivirus infections were not the leading cause of death in the northern Gulf of Mexico Unusual Mortaility Event of bottlenose dolphins (Fauquier et al. 2017). De Guise et al. (2017) created a conceptual model to explain the documented changes in immune function and the health effects observed in live and dead dolphins associated with the DWH spill. The model included potential relationships starting from PAH exposure to various health effects such as loss of fetus, and susceptibility to secondary bacterial infections like pneumonia or intra-cellular pathogens like *Brucella* (De Guise et al. 2017). Historical northern Gulf of Mexico Unusual Mortality Events (1990-2009) did not result in as many mortalities when compared with the current Unusual Mortality Event, and the most common causes of those prior are unlikely to be associated with the current event (Litz et al. 2014).

A large number of strandings of dead perinatal dolphins (recently born) resulted from exposure to DWH oil (Schwacke et al. 2014). Compared to unaffected populations, perinatal dolphins affected by DWH were significantly more likely to have died in utero or soon after birth, have fetal distress, and have pneumonia (Colegrove et al. 2016). A multi-year study of animals in Barataria Bay, Louisiana showed calving success in only two of ten pregnant females. (Colegrove et al. 2016) concluded late term pregnancy failures and development of in utero infections were the likely causes of the large number of pre-term dolphins being aborted during 2011-2013. The Barataria Bay and Mississippi Sound stocks that inhabit areas that were exposed to oil during DWH had low reproductive success compared with other stocks that were in areas not oiled during the spill, with a two-fold difference in success (Kellar et al. 2017). According to Kellar et al. (2017) these findings are consistent with numerous studies linking PAHs to reproductive abnormalities and early developmental impairments. The Barataria Bay stock saw an increase in mortality for the first three years following DWH and then survival rebounded in late 2013 (McDonald et al. 2017b). Schwacke et al. (2017) estimated a 39 year recovery for the Barataria Bay stock of common bottlenose dolphins. Similarly, Smith et al. (2017) documented slow recovery of Barataria Bay dolphin health with evidence of persistent lung disease and impaired stress response (low amount of hormones detected even during capture).

The largest number of dolphin deaths occurred in Barataria Bay, Louisiana, the area with the greatest amount of oiling from DWH. The presence of increased coastal PAH levels in Barataria Bay lasted for two years following DWH (Schwacke et al. 2013), which coincided with the longest lasting cluster of dolphin strandings in Barataria Bay through the end of 2011. In a less oiled area, increased rates of fetus and calf strandings also occurred in Mississippi and Alabama following DWH. In these areas, there was an average increase of 34.5 percent in calf deaths compared to a (a 72.5 percent loss compared to a baseline calf loss of 38 percent over the years 2000-2005 and 2009-2010) in Mississippi and Alabama (data from NMFS Southeast U.S. Marine Mammal Stranding Program Database, July 9, 2015).

Applying the expected effects from bottle dolphins to sperm whales, NOAA (2015) determined that 16 percent of the Gulf of Mexico population or about 262 whales were exposed to DWH oil. Thirty-five percent of those whales (or approximately 92 whales) were likely killed. In total, an estimated 6 percent of the Gulf of Mexico sperm whale population was killed. The initial exposure likely resulted in whale deaths later in time due to adrenal and lung disease as was observed in bottlenose dolphins. In addition to the sperm whale deaths, an estimated 46 percent of exposed females that survived suffered reproductive failure through aborted fetuses or early calf death. Thirty-seven percent of all exposed whales, including pregnant females, likely suffered adverse health consequences as a result of DWH oil exposure.

At the population level, the Sperm Whale Seismic Study (SWSS) study (Jochens et al. 2008) reported the overall proportion of calves within the mixed groups of sperm whales prior to DWH to be 11 percent. The proportion of calves observed in the Gulf of Mexico was similar to those reported for other stable populations of sperm whales reported off the Seychelles Islands and Sri Lanka in which calves make up 9.8 percent and 12.6 percent of those populations, respectively (Whitehead et al. 1997). Chiquet et al. (2013) conducted a sensitivity analysis for sperm whales and concluded that even under the best case parameters for vital rates for the stable population of sperm whales in the Gulf of Mexico, the growth rate of the population is extremely slow (about 0.96 percent per year) as has been reported for other sperm whale populations with a stable age distribution (Whitehead and Mesnick 2003).

In as assessment of the long-term reproductive effects that DWH is having on the Gulf of Mexico sperm whale population, Trustees (2016) completed population modeling based on the mortalities associated with adverse health consequences of oil exposure and the reduced reproductive success in pregnant females. It is likely the number of females and calves in the population has been reduced. Sixteen percent of the sperm whale population was exposed to oil. Considering these effects at the population level in the Gulf of Mexico, DWH oil exposure resulted in a maximum population reduction of seven percent requiring 21 years to recover to the pre-spill population size. The effects of the 21-year recovery period are slowing the recovery of the sperm whale population in the Gulf of Mexico. At a more subtle, but still crucial, level, the summed negative effects of the DWH oil spill on the Gulf of Mexico ecosystem across resources, up and down the food web, and among habitats, will continue to impact sperm whales due to the long life of marine mammals and their strong dependence on a healthy ecosystem (Bossart 2011; Moore 2008; Reddy et al. 2001; Ross 2000; Wells et al. 2004).

Sea Turtles

The DWH oil spill extensively oiled vital foraging, migratory, and breeding habitats of sea turtles throughout the northern Gulf of Mexico. *Sargassum* habitats, benthic foraging habitats, surface and water column waters, and sea turtle nesting beaches were all affected by DWH. Sea turtles were exposed to DWH oil in contaminated habitats; breathing oil droplets, oil vapors, and smoke; ingesting oil-contaminated water and prey; and by maternal transfer of oil compounds to developing embryos. Translocation of eggs from the Gulf of Mexico to the Atlantic coast of Florida resulted in the loss of sea turtle hatchlings. Other response activities, including vessel strikes and dredging also resulted in turtle deaths.

Three hundred nineteen live oiled turtles were rescued and showed disrupted metabolic and osmoregulatory functions, likely attributable to oil exposure, physical fouling and exhaustion, dehydration, capture and transport (Stacy et al. 2017). Accounting for turtles that were unobservable during the response efforts, high numbers of small oceanic and large sea turtles are estimated to have been exposed to oil resulting from the DWH spill due to the duration and large footprint of the spill. It was estimated that as many 7,590 large juvenile and adult sea turtles (Kemp's ridleys, loggerheads, and unidentified hardshelled sea turtles), and up to 158,900 small juvenile sea turtles (Kemp's ridleys, green turtles, loggerheads, hawksbills, and hardshelled sea turtles not identified to species) were killed by the DWH oil spill (Table 34 and Table 35). Small juveniles were affected in the greatest numbers and suffered a higher mortality rate than large sea turtles. Leatherback foraging and migratory habitat was also affected and though impacts to leatherbacks were unquantified, it is likely some died as a result of the DWH spill and spill response (NMFS USFWS 2013; Trustees 2016).

Table 34. Oceanic Juvenile Sea Turtles Exposed and Killed (estimate) by the DWH Oil Spill

Species	Total Exposed	Heavily Oiled, Dead	Non-heavily Oiled, Dead	Total Dead
Kemp's ridley	206,000	35,500	51,000	86,500

Species	Total Exposed	Heavily Oiled, Dead	Non-heavily Oiled, Dead	Total Dead
Loggerhead	29,800	2,070	8,310	10,400
Green	148,000	15,300	39,800	55,100
Hawksbill	8,560	595	2,390	2,990
Unidentified	9,960	1,310	2,600	3,910
Total	402,320	54,775	104,100	158,900

Source: (Trustees 2016; Wallace et al. 2015)

Table 35. Large Juveniles and Adult Sea Turtles Exposed and Killed (estimate) by the DWH Oil Spill

Species	Total Exposed	Heavily Oiled, Dead	Non-heavily Oiled, Dead	Total Dead
Kemp's ridley age 4+	21,000	1,700	950	2,700
Kemp's ridley age 3	990	380	30	410
Kemp's, all	22,000	2,100	980	3,100
Loggerhead	30,000	2,200	1,400	3,600
Unidentified	5,900	630	260	890
Total	57,900	4,930	2,640	7,590

Source: (Trustees 2016; Wallace et al. 2015)

Subsequent to the PDARP release and as part of the DWH natural resource damage assessment, McDonald et al. (2017c) estimated approximately 402,000 surface-pelagic sea turtles were exposed with 54,800 likely heavily oiled. Additionally, approximately 30 percent of all oceanic turtles affected by DWH and not heavily oiled were estimated to have died from ingestion of oil (Mitchelmore et al. 2017).

The DWH incident and associated response activities (e.g., nest relocation) saved animals that may have been lost to oiling, but resulted in some future fitness consequences for those individuals. Nests from loggerheads, Kemp's ridleys, and green turtles were excavated prior to emergence and eggs were translocated from Florida and Alabama beaches in the northern Gulf of Mexico between June 6 and August 19, 2010 to a protected hatchery on the Atlantic Coast of Florida. More than 28,000 eggs from 274 nests were translocated and nearly 15,000 hatchling turtles emerged and were released into the Atlantic Ocean (Table 36).

Table 36. Summary of Egg Translocation and Hatchling Release during the DWH Response

Species	Clutches	Number of Eggs	Hatchling Released
Kemp's ridley	5	483	125
Loggerhead	265	27,618	14,216
Green	4	580	455
Total	274	28,681	14,796

Source: (Provancha and Mukherjee 2011)

Hatchlings from nesting beaches in the Gulf of Mexico were released in the Atlantic Ocean and not the Gulf of Mexico. Therefore, the hatchlings imprinted on the area of their release beach. It is thought that sea turtles use this imprinting information to return to the location of nesting beaches as adults. It is unknown whether these turtles will return to the Gulf of Mexico to nest; therefore, the damage assessment determined that the 14,796 hatchlings will be lost to the Gulf of Mexico breeding populations as a result of the DWH oil spill. It is estimated that nearly 35,000 hatchling sea turtles (loggerheads, Kemp's ridleys, and green turtles) were injured by response activities, and thousands more Kemp's ridley and loggerhead hatchlings were lost due to unrealized reproduction of adult sea turtles that were killed by the DWH oil spill.

Kemp's ridley sea turtles were the most affected sea turtle species, as they accounted for 49 percent (239,000) of all exposed turtles (478,900) during DWH. Kemp's ridley sea turtles were the turtle species most impacted by the DWH event at a population level. The DWH damage assessment calculated the number of unrealized nests and hatchlings to Kemp's ridleys because all Kemp's ridleys nest in the Gulf of Mexico and belong to the same population (NMFS et al. 2011b). The total population abundance of Kemp's ridleys could be calculated based on numbers of hatchlings because all individuals are reasonably expected to inhabit the northern Gulf of Mexico throughout their lives. The loss of these reproductive-stage females would have contributed to some extent to the decline in total nesting abundance observed between 2011 and 2014. The estimated number of unrealized Kemp's ridley nests is between 1,300 and 2,000, which translates to approximately 65,000 and 95,000 unrealized hatchlings. However, this is a minimum estimate because of the overall potential DWH effect because the sub-lethal effects of DWH oil on turtles, their prey, and their habitats might have delayed or reduced reproduction in subsequent years may have contributed substantially to additional nesting deficits observed following DWH. These sub-lethal effects could have slowed growth and maturation rates, increased remigration intervals, and decreased clutch frequency (number of nests per female per nesting season. The nature of the DWH effect on reduced Kemp's ridley nesting abundance and associated hatchling production after 2010 requires further evaluation.

Loggerheads made up 12.7 percent (60,800 animals) of the total sea turtle exposures (478,900). A total of 14,300 loggerhead sea turtles died as a result of exposure to DWH oil. Unlike Kemp's ridleys, the majority of nesting for the Northwest Atlantic Ocean loggerhead DPS occurs on the Atlantic coast, and thus nesting was impacted to a lesser degree in this species. It is likely that impacts to the Northern Gulf of Mexico Recovery Unit of the NWA loggerhead DPS would be proportionally much greater than the impacts occurring to other recovery units, and likely included impacts to mating and nesting adults. Although the long-term effects remain unknown, the DWH impacts to the Northern Gulf of Mexico Recovery Unit may include some nesting declines in the future due to a large reduction of oceanic age classes during DWH. However, the overall impact on the population recovery of the entire NWA DPS is likely small.

Green sea turtles made up 32.2 percent (154,000) of all turtles exposed to DWH oil with 57,300 juvenile mortalities out of the total exposed animals, which removed a large number of small juvenile turtles from the population. A total of four nests (580 eggs) were relocated during response efforts. While green turtles regularly use the northern Gulf of Mexico, they have a widespread distribution throughout the entire Gulf of Mexico, Caribbean, and Atlantic. As described in the *Status of the Species* section, nesting is relatively rare on northern Gulf of Mexico beaches. Although it is known that adverse impacts occurred and numbers of animals in the Gulf of Mexico were reduced as a result of DWH, the relative proportion of the population that is expected to have been exposed to and directly impacted by the DWH event, and thus a population-level impact to green sea turtles, is not likely.

Available information indicates hawksbill and leatherback sea turtles were least affected by the oil spill. Hawksbills made up 1.8 percent (8,850) of all sea turtle exposures. Although leatherbacks were documented in the spill area, the number of affected leatherbacks was not estimated due to a lack of information for leatherbacks compared to other species. Potential DWH-related impacts to leatherback sea turtles include direct oiling or contact with dispersants, inhalation of volatile compounds, disruption of foraging or migratory movements due to surface or subsurface oil, ingestion of prey species contaminated with oil and/or dispersants, and loss of foraging resources which could lead to compromised growth and/or reproductive potential. There is no information currently available to determine the extent of those impacts, if they occurred. Although adverse impacts likely occurred to leatherbacks and hawksbills, the relative proportion of the populations of these species that are expected to have been exposed to and directly impacted by the DWH event is relatively low, and thus a population-level impact is not believed to have occurred due to the widespread distribution and nesting locations outside of the Gulf of Mexico for both of these species.

Gulf Sturgeon

Gulf sturgeon are found in the coastal waters of Florida, Alabama, Mississippi, and Louisiana that were affected by DWH oil. Gulf sturgeon migrate from coastal waters into freshwater rivers between February and May of each year, and thus sturgeon were not present during the period in which oil was still being discharged from the well or by the time oil reached coastal areas. Oil has been reported in coastal areas in increasingly smaller amounts for years following the release. Sturgeon could have been exposed to hydrocarbons once they returned to marine waters after the fall migration from freshwater rivers back to the Gulf of Mexico. Adult and sub-adult Gulf sturgeon only feed during the fall and winter when present in estuarine and marine waters. After the spill, the riverine populations were sampled as they traveled back to the estuaries and open water. NRDA Trustees (2016) estimated that between 1,100 and 3,600 Gulf sturgeon were potentially exposed through oil that submerged into nearshore environments. Individuals from six of the eight river systems were found within the spill footprint within two years of the spill. NRDA sampling will compare the pre-exposure, baseline information from sturgeon migrating out of rivers with post-exposure data collected from fish after they have spent a season feeding in the areas affected by DWH oil. Gulf sturgeon would likely be very slow to recover from additional challenges such as an oil spill.

Several studies have shown crude oil can be harmful to larval stages of fish. Macondo crude oil was shown to cause significant defects in embryonic and larval development of zebrafish (de Soysa et al. 2012). DWH oil-exposed samples of embryonic mahi-mahi resulted in cardiotoxicity, evident from pericardial edema and reduced atrial contractibility (Esbaugh et al. 2016). Similar results were also found for developing hearts of large predatory fish (Incardona et al. 2014a) and long-term effects of embryonic exposure may cause future declines in populations (Incardona et al. 2015).

7.4.5 State Oil and Gas Activities

State oil and gas exploration, production, and development are expected to result in similar effects to protected species as reported in the analysis of federal activities for oil and gas lease sale biological opinions, including impacts associated with the explosive removal of offshore structures, seismic exploration, marine debris, oil spills, and vessel operation.

Louisiana is rich in crude oil and natural gas. Oil and gas deposits are found in abundance both onshore and offshore in state-owned waters. Louisiana's industrial energy consumption is second only to that of Texas. Louisiana's production in the federal OCS continues to expand as new offshore technologies allowed companies to access reserves in deeper areas of the Gulf of Mexico. Louisiana's offshore petroleum industry was dealt a serious blow in 2005 when hurricanes Katrina and Rita damaged offshore oil platforms and curbed production for several months. In 2008, hurricanes Gustav and Ike also caused damage offshore and forced refining and production shutdowns.

Louisiana is also a major importer of crude oil from around the world, typically bringing in about one-fifth of all foreign crude oil processed in the United States. Because Louisiana's infrastructure provides multiple connections to the nation's commercial oil transport network, the U.S. Department of Energy chose the state as a site for two of the Strategic Petroleum Reserve's four storage facilities. State crude oil production and imports that are not sent to other states are processed at Louisiana's 16 operating refineries, clustered mostly along the Lower Mississippi River and in the Lake Charles area. With a refining capacity of more than 2.5 million barrels per day, Louisiana produces more petroleum products than any state but Texas.

Louisiana is one of the top natural gas-producing states in the country, excluding OCS production, Louisiana ranks fifth. Over half of the natural gas that is supplied to Louisiana enters the state via pipelines from Texas. The state also receives, stores, and re-ships natural gas supplies from numerous international sources, including Nigeria, Algeria, and Trinidad and Tobago.

Texas leads the nation in fossil fuel reserves. Texas crude oil reserves represent almost one-fourth of the U.S. total, and Texas natural gas reserves account for over three-tenths of the U.S. total. Texas's oil reserves are found in several geologic basins throughout the state. Major discoveries have been made in the Gulf of Mexico. Texas leads the United States in both crude oil production and refining capacity.

Although Texas oil production is in decline, the state's signature type of crude oil, known as West Texas Intermediate, remains the major benchmark of crude oil in the Americas. Because of its light consistency and low-sulfur content, the quality of West Texas Intermediate is considered to be high, and it yields a large fraction of gasoline when refined. Texas's 27 petroleum refineries can process more than 4.7 million barrels of crude oil per day, and they account for more than one-fourth of total U.S. refining capacity. Most of the state's refineries are clustered near major ports along the Gulf Coast, including Houston, Port Arthur, and Corpus Christi. These coastal refineries have access to local Texas production, foreign imports, and oil produced offshore in the Gulf of Mexico, as well as the U.S. Government's Strategic Petroleum Reserve. Refineries in the Houston area, including the Nation's largest refinery in Baytown, make up the largest refining center in the United States.

Texas's total petroleum consumption is the highest in the Nation, and the state leads the country in consumption of asphalt and road oil, aviation gasoline, distillate fuel oil, liquefied petroleum gases (LPG), and lubricants.

Texas is the Nation's leading natural gas producer, accounting for approximately three-tenths of total U.S. natural gas production. In the early days of Texas oil production, natural gas found with oil was largely considered a nuisance and was often flared (burned off) at the wellhead. Because Texas demand is high, and because the state's natural gas infrastructure is well connected to consumption markets throughout the country, several LNG import terminals have been proposed along the Gulf Coast in Texas.

Florida has minor oil and gas reserves and few other energy resources. However, future deposits of oil and gas may be found on the OCS off Florida's west coast. Congressional and Presidential moratoria prohibiting energy development in most of the OCS were lifted in 2008, but a separate Act (GOMESA) banning energy development within 100-125 miles of Florida remains in effect until 2022. Florida has no oil refineries and relies on petroleum products delivered by tanker and barge to marine terminals near the state's major coastal cities. Florida receives most of its natural gas supply from the Gulf Coast Region via three major interstate pipelines: (1) the Florida Gas Transmission line, which runs from Texas through the Florida Panhandle to Miami, (2) the Gulfstream pipeline, an underwater link from Mississippi and Alabama to central Florida, and (3) the Cypress Pipeline from Elba Island, Georgia to Jacksonville.

Alabama is rich in onshore energy resources, but not offshore waters. Alabama produces a small amount of crude oil from reserves located in the Black Warrior Basin in the north and the Gulf Coast in the south. One petroleum refinery is located near the Port of Mobile, a second is located in Tuscaloosa on the Black Warrior River, and a third is located in Atmore in the southern part of the state. Most offshore energy is in the form of natural gas. Alabama receives additional supplies of natural gas transported by pipeline mainly from the Gulf of Mexico, Louisiana, and Texas.

Although Mississippi is not rich in energy, the State has substantial oil and gas fields that are found primarily in the southern half of the State. In recent years, new deposits have been discovered onshore and offshore along the Gulf Coast. Mississippi currently produces a small amount of crude oil, and has three oil refineries, which together account for about 2 percent of total U.S. refining capacity. Mississippi's largest refinery, located along the Gulf Coast in Pascagoula, processes crude oil imported by marine tanker from Central and South America. Mississippi's natural gas processing industry has expanded in recent years to serve growing offshore supplies brought in via pipelines from the OCS. Mississippi will soon begin importing international supplies from LNG import terminals have been approved near Pascagoula.

7.4.6 Oil and Gas Development in Mexican Waters

According to (BOEM 2017e), Mexico issued rules for seismic exploration in January 2015 and geophysical companies are moving forward aggressively to acquire data in Mexican waters of the Gulf of Mexico. Oil and gas development in Mexican waters may not be as regulated as those in U.S. federal waters. Fisheries or other activities in Mexican waters are not well understood, however they can impact U.S. marine fauna and resources. In 1979, the catastrophic Ixtoc oil spill occurred in the Bay of Campeche, releasing approximately three million barrels of oil into the Gulf of Mexico. During this spill, prevailing northerly currents in the western Gulf of Mexico carried spilled oil toward the United States. A 60-mile by 70-mile patch of sheen containing a 300 ft by 500 ft patch of heavy crude moved toward the Texas coast. The heavy crude impacts a relatively small area and contributes to the sheen, tarballs, and other residuals through weathering. On August 6, 1979, tarballs from the spill impacted a 17-mile stretch of Texas beach. Within the last several years, USFWS biologists have documented tar balls washing ashore in Padre Island National Seashore that they suspect are from the Ixtoc incident.

7.5 Vessel Operations

Vessels have the potential to affect Gulf sturgeon, sea turtles, Bryde's whales and sperm whales through collisions with an animal and the production of sound. Vessels operating at high speeds have the potential to strike Gulf sturgeon, sea turtles or marine mammals with their hulls or propellers. Potential sources of adverse effects from federal vessel operations in the action area include operations of the U.S. Department of Defense (DoD), BOEM/BSEE, Federal Energy Regulatory Commission (FERC), USCG, NOAA, and USACE. The Gulf of Mexico is known for a high level of commercial shipping activity and many large ports, especially those with transiting bulk carriers (Wiggins et al. 2016). Vessels are the greatest contributors to increases in low-frequency ambient sound in the sea (Andrew et al. 2011). It is predicted that ambient ocean sound will continue to increase at a rate of ½ dB per year (Ross 2005). Sound levels and tones produced are generally related to vessel size and speed. Larger vessels generally emit more sound than smaller vessels, and vessels underway with a full load, or those pushing or towing a load, are noisier than unladen vessels.

Vessel operations associated with oil and gas activities, as previously described in Section 3.1.4.7 as part of the proposed action, have been considered in previous section 7 consultations. The most recent biological opinion on BOEM lease sales and operations determined that vessels would adversely affect sea turtles. However, that opinion determined that vessels were not likely to adversely affect sperm whales as the potential for direct strikes or harassment was unlikely to occur given the scope of the proposed action being considered. In response to terms and conditions of previous opinions, and in an effort to minimize the potential for vessel strikes to marine mammals and sea turtles, BOEM NTL No. 2016-G01 "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting." Industry-related vessel traffic is a part of the current environmental baseline in the Gulf of Mexico and is expected to continue.

7.6 Dredging

Coastal navigation channels are often dredged to support commercial shipping and recreational boating. Dredging activities can pose significant impacts to aquatic ecosystems by: (1) direct removal/burial of organisms; (2) turbidity/siltation effects; (3) contaminant re-suspension; (4) sound/disturbance; (5) alterations to hydrodynamic regime and physical habitat; and (6) loss of riparian habitat (Chytalo 1996; Winger et al. 2000).

Marine dredging vessels are common within U.S. coastal waters. Although the underwater sounds from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies, they are not believed to have any long-term effect on sea turtles, Bryde's whales, sperm whales, or Gulf sturgeon. However, the construction and maintenance of federal navigation channels and dredging in sand mining sites ("borrow areas") have been identified as sources of sea turtle and Gulf sturgeon mortality. Hopper dredges can lethally harm sea turtles and sturgeons by entraining them in dredge drag arms and impeller pumps. Hopper dredges in the dredging mode are capable of moving relatively quickly and can thus overtake, entrain, and kill sea turtles and Gulf sturgeon as the suction draghead(s) of the advancing dredge overtakes a resting or swimming organism.

To reduce take of listed species, relocation trawling may be utilized to capture and move sea turtles and sturgeon. In relocation trawling, a boat equipped with nets precedes the dredge to capture sturgeon and sea turtles and then releases the animals out of the dredge pathway, thus avoiding lethal take. Relocation trawling has been successful and routinely moves sea turtles and sturgeon in the Gulf of Mexico. Between January 2005 and April 2006 relocation trawling captured and successfully moved two Gulf sturgeon near Mobile Bay, Alabama: five near Gulf Shores, Alabama, one near Destin, Florida, and eight near Panama City Beach, Florida. Seasonal in-water work periods, when Gulf sturgeon are absent from coastal waters, also assists in reducing incidental take.

In 2003, NMFS completed a regional biological opinion on USACE hopper dredging in the Gulf of Mexico that includes impacts to sea turtles, Gulf sturgeon, and Gulf sturgeon critical habitat via maintenance dredging. NMFS determined that (1) Gulf of Mexico hopper dredging would adversely affect Gulf sturgeon and four sea turtle species (i.e., green, hawksbill, Kemp's ridley, and loggerheads) but would not jeopardize their continued existence, and (2) dredging in the Gulf of Mexico would not adversely affect leatherback sea turtles, smalltooth sawfish, or ESA-listed large whales. An ITS for those species adversely affected was issued. The critical habitat analysis concluded that impacts would not have measureable effects on habitat features based on: maintenance only rather than improvements of channels; and remaining sediments would be the same as what was originally in the channel bed.

Numerous other opinions have been produced that analyzed hopper dredging projects that did not fall under the scope of actions contemplated by the regional opinion, including: the dredging of Ship Shoal in the Gulf of Mexico Central Planning Area for coastal restoration projects in 2005, the Gulfport Harbor Navigation Project in 2007, the East Pass dredging in Destin, Florida in 2009, the Mississippi Coastal Improvements Program in 2010, and the dredging of City of Mexico beach canal inlet in 2012. Each of the above free-standing opinions had its own ITS and determined that hopper dredging during the proposed actions would not jeopardize the continued existence of any ESA-listed species or destroy or adversely modify critical habitat of any listed species.

7.7 Construction and Operation of Public Fishing Piers

Since the active hurricane seasons of 2004 and 2005 a number of fishing piers have either been built or rebuilt along the Gulf coast, particularly in Mississippi. The USACE permits the building of these structures and in some cases FEMA provides funding. We determined that the activities associated with the demolition/reconstruction/repair of each pier was not likely to adversely affect any ESA-listed species. However, we did conclude that the fishing likely to occur following the completion of each pier project was likely to adversely affect certain species of sea turtles, but was not likely to jeopardize their continued existence. Incidental capture of sea turtles is generally nonlethal, though some captures result in severe injuries, which may later lead to death. Fishing effort is expected to continue at Gulf piers in the foreseeable future.

7.8 Research Permits

The ESA allows for the issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research (Ssection 10(a)(1)(a)). In addition, section 6 of the ESA allows NMFS to enter into cooperative agreements with states to assist in recovery actions of listed species. Prior to issuance of these permits, the proposal must be reviewed for compliance with section 7 of the ESA.

Sea turtles are the focus of research activities authorized by section 10 permits under the ESA. Authorized activities range from photographing, weighing, and tagging sea turtles incidentally taken in fisheries, to blood sampling, tissue sampling (biopsy), and performing laparoscopy on intentionally captured sea turtles. Research permits issued for sperm whales include photographing (photo-identification), tissue sampling, and tagging. There are no federal permits for Gulf sturgeon research. The number of authorized takes by research permits varies widely depending on the research and species involved but may involve the taking of hundreds of sea turtles annually. Most takes authorized under these permits are expected to be nonlethal. Before any research permit is issued, the proposal must be reviewed under the permit regulations (i.e., must show a benefit to the species). In addition, since issuance of the permit is a federal activity, section 7 analysis is also required to ensure the issuance of the permit is not likely to result in jeopardy to the species.

7.9 Military Operations

Military testing and training in the action area may also affect ESA-listed species. The air space over the Gulf of Mexico is used extensively by the DoD for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf of Mexico. The western Gulf of Mexico has four warning areas that are used for military operations. The areas total approximately 21 million ac or 58 percent of the area. In addition, six blocks in the western Gulf of Mexico are used by the Navy for mine warfare testing and training. The central Gulf of Mexico has five designated military warning areas that are used for military operations. These areas total approximately 11.3 million ac. Portions of the Eglin Water Test Areas (EWTA) comprise an additional 0.5 million ac in the Central Planning Area (CPA). The total 11.8 million ac is about 25 percent of the area of the CPA.

Formal consultations on overall USN activities in the Atlantic have been completed, including U.S. Navy's Activities in East Coast Training Ranges (June 1, 2011); U.S. Navy Atlantic Fleet Sonar Training Activities (AFAST) (January 20, 2011); Navy AFAST LOA 2012-2014: U.S. Navy active sonar training along the Atlantic Coast and Gulf of Mexico (December 19, 2011); Activities in GOMEX Range Complex from November 2010 to November 2015 (March 17, 2011); and Navy's East Coast Training Ranges (Virginia Capes, Cherry Point, and Jacksonville) (June 2010). These opinions concluded that although there is a potential for some USN activities to affect sea turtles and sperm whales, those effects were not expected to impact any species on a population level. Therefore, the activities were determined to be not likely to jeopardize the continued existence of any ESA-listed species.

On October 22, 2018 NMFS issued a conference and biological opinion on the effects of the Navy’s Atlantic Fleet Training and Testing (AFTT) Phase III activities on ESA-listed resources (NMFS 2018). The AFTT action area includes the Gulf of Mexico Range Complex which encompasses approximately 17,000 NM^2 of sea and undersea space and includes 285 NM of coastline. The four operating areas (OPAREAs) within this range complex are: Panama City OPAREA off the coast of the Florida panhandle (approximately 3,000 NM^2); Pensacola OPAREA off the coast of Florida west of the Panama City OPAREA (approximately 4,900 NM^2); New Orleans OPAREA off the coast of Louisiana (approximately 2,600 NM^2); and Corpus Christi OPAREA off the coast of Texas (approximately 6,900 NM^2). The AFTT Phase III opinion includes an ITS with exempted take for the following ESA-listed species found in the Gulf of Mexico: sperm whales, Bryde’s whales, sea turtles, and Gulf sturgeon.

NMFS has completed consultations on Eglin Air Force Base testing and training activities in the Gulf of Mexico. These consultations concluded that the incidental take of sea turtles is likely to occur. These opinions have issued incidental take for these actions: Eglin Gulf Test and Training Range (NMFS 2004b), the Precision Strike Weapons Tests (NMFS 2005b), the Santa Rosa

Island Mission Utilization Plan (NMFS 2005c), Naval Explosive Ordnance Disposal School (NMFS 2004a), Eglin Maritime Strike Operations Tactics Development and Evaluation (NMFS 2013a), and Ongoing Eglin Gulf Testing and Training Activities (NMFS 2017e). These consultations determined the training operations would adversely affect sea turtles but would not jeopardize their continued existence. They further determined that because the activities were to be completed over shallow shelf waters (less than 100 m), that they were not likely to adversely affect sperm whales or Bryde's whales.

7.10 Aquaculture

Florida sturgeon culture is currently limited to native Atlantic sturgeon and a few non-native species. The risk of hybridization between Gulf sturgeon and other sturgeons, as well as escapement of non-native species, are potential threats to Gulf sturgeon in the action area. The geographic location of many farms nearby streams and rivers would allow easy entry of farmed fish into Gulf sturgeon habitat. As many farms use spring-fed wells as their source for irrigation, sturgeon raised in farms have likely acclimated to local water temperatures and would presumably survive in local rivers. While effects of intra-specific competition between native and non-natives sturgeons are unknown, it is likely that habitat overlap would occur as well as a potential for introduction of disease (USFWS and NMFS 2009a). Aquaculture could also have food web effects of non-native/native farmed escapees, either through consumption or predation.

7.11 Marine Debris

The discharge of debris into the marine environment is a continuing threat to the status of species in the action area, regardless of whether the debris is discharged intentionally or accidentally. Marine debris may originate from a variety of sources, though specific origins of debris are difficult to identify. A 1991 report (GESAMP 1990) indicates that up to 80 percent of marine debris is considered land-based and a worldwide review of marine debris identifies plastic as the primary form (Derraik 2002). Debris can originate from a variety of marine industries including fishing, oil and gas, and shipping. Many of the plastics discharged to the sea can withstand years of saltwater exposure without disintegrating or dissolving. Further, floating materials have been shown to concentrate in ocean gyres and convergence zones where *Sargassum* and consequently juvenile sea turtles are known to occur (Carr 1987).

Marine debris has the potential to impact protected species through ingestion or entanglement (Gregory 2009). Both of these effects could result in reduced feeding, reduced reproductive success, and potential injury, infection, or death. Sperm whale ingestion of marine debris is a concern, particularly because their suspected feeding behavior includes cruising along the bottom with their mouths open (Walker and Coe 1990). All sea turtles are susceptible to ingesting marine debris, though leatherbacks show a marked tendency to ingest plastic which they misidentify as jellyfish, a primary food source (Balazs 1985). Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby reducing the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist 1987; Laist 1997). Weakened animals are then more susceptible to predators and disease and are also less fit to migrate, breed, or, in the case of turtles, nest successfully (Katsanevakis 2008; McCauley and Bjorndal 1999).

Pollution from a variety of sources including atmospheric loading of pollutants such as PCBs, stormwater from coastal or river communities, and discharges from ships and industries may affect sea turtles, sperm whales, and Gulf sturgeon in the action area. Sources of marine pollution are often difficult to attribute to specific federal, state, local or private actions.

There are studies on organic contaminants and trace metal accumulation in green, leatherback, and loggerhead sea turtles (Aguirre et al. 1994; Caurant et al. 1999; Corsolini et al. 2000). McKenzie et al. (1999) measured concentrations of chlorobiphenyls and organochlorine pesticides in sea turtles tissues collected from the Mediterranean (Cyprus, Greece) and European Atlantic waters (Scotland) between 1994 and 1996. Omnivorous loggerhead turtles had the highest organochlorine contaminant concentrations in all the tissues sampled, including those from green and leatherback turtles (Storelli et al. 2008). It is thought that dietary preferences were likely to be the main differentiating factor among species. Decreasing lipid contaminant burdens with sea turtle size were observed in green turtles, most likely attributable to a change in diet with age. (Sakai et al. 1995) documented the presence of metal residues occurring in loggerhead sea turtle organs and eggs. Storelli et al. (1998) analyzed tissues from 12 loggerhead sea turtles stranded along the Adriatic Sea (Italy) and found that characteristically, mercury accumulates in sea turtle livers while cadmium accumulates in their kidneys, as has been reported for other marine organisms like dolphins, seals, and porpoises (Law et al. 1991b). No information on detrimental threshold concentrations is available and little is known about the consequences of exposure of organochlorine compounds to sea turtles. Research is needed on the short- and long-term health and fecundity effects of chlorobiphenyl, organochlorine, and heavy metal accumulation in sea turtles.

Like sea turtles, sperm whales may be adversely affected by marine pollution originating from federal, state, or private activities, though little is known regarding the specific pollutants or the effects pollutants may have on individuals. Further, we are unaware of the possible long-term and trans-generational effects of exposure to pollutants. It is not known if high levels of heavy metals, PCBs, and organochlorines found in prey species accumulate with age and are transferred through nursing. Nevertheless, the accumulation of stable pollutants such as heavy metals, PCBs, chlorinated pesticides [DDT, DDE, etc.], and polycyclic aromatic hydrocarbons [PAHs]) is of concern.

Pollution from industrial, agricultural, and municipal activities is believed responsible for a suite of physical, behavioral, and physiological impacts to sturgeon worldwide (Agusa et al. 2004; Barannikova 1995; Barannikova et al. 1995; Bickham et al. 1998a; Billard and Lecointre 2000; Kajiwara 2003; Karpinsky 1992; Khodorevskaya et al. 1997; Khodorevskaya and Krasikov 1999). Pharmaceuticals and other endocrinologically active chemicals may also be affecting Gulf sturgeon. Several characteristics of the Gulf sturgeon (i.e., long lifespan, extended residence in riverine and estuarine habitats, benthic predator) predispose the species to long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants. Some of these compounds may affect physiological processes and impede the ability of a fish to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing DO, altering pH, and altering other water quality properties.

The development of marinas and docks in inshore waters can negatively impact nearshore habitats. Fueling facilities at marinas can sometimes discharge oil, gas, and sewage into sensitive estuarine and coastal habitats. Although these contaminant concentrations do not likely affect the more pelagic waters of the action area, the species of turtles analyzed in this biological opinion travel between nearshore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycles. Further, Gulf sturgeon use coastal areas during a portion of the year and may also be affected by pollution originating from marina facilities. Fuel oil spills could affect animals directly or indirectly through the food chain. Fuel spills involving fishing vessels are common events. However, these spills typically involve small amounts of material. Larger oil spills may result from accidents, although these events would be rare. No direct adverse effects on listed species resulting from fishing vessel fuel spills have been documented.

7.12 Nutrient Loading and Hypoxia

Nutrient loading from land-based sources, such as coastal communities and agricultural operations stimulate plankton blooms in closed or semi-closed estuarine systems. The effects on larger embayments are unknown. Rabalais et al. (2010) provide an example of the large area of the Louisiana continental shelf with seasonally depleted oxygen levels (< 2 mg/liter) that is caused by eutrophication from both point and non-point sources. The oxygen depletion, referred to as hypoxia, begins in late spring, reaches a maximum in mid-summer, and disappears in the fall. Since 1993, the average extent of mid-summer, bottom-water hypoxia in the northern Gulf of Mexico has been approximately 16,000 km^2, approximately twice the average size measured between 1985 and 1992. The hypoxic zone attained a maximum measured extent in 2002, when it was about 22,000 km^2 which is larger than the state of Massachusetts. This zone was predicted to reach its largest area in 2011 (Rabalais et al. 2010), between 22,253 and 26,515 km^2 (average 24,400 km2; 9,421 mi^2) of the bottom of the continental shelf off Louisiana and Texas. The hypoxic zone negatively impacts sea turtle and Gulf sturgeon habitats and prey availability which in turn can affect survival and reproductive fitness.

7.13 Cumulative Anthropogenic Impacts to the Environmental Baseline

A number of activities that may indirectly affect listed species in the action area of this consultation include ocean dumping and disposal and anthropogenic marine debris. The impacts from these activities are difficult to measure. Where possible, conservation actions are being implemented to monitor or study impacts from these sources. Halpern et al. (2015) scored and additively analyzed 19 common stressors to display areas where global cumulative human impacts were greatest (Figure 52**)**. Impact stressors included artisanal fishing, demersal destructive fishing, demersal non-destructive fishing, high by-catch fishing, inorganic pollution, invasive species, nutrient input, ocean acidification, benthic structures (oil rigs), organic pollution, pelagic high-bycatch fishing, pelagic low-bycatch fishing, ocean-based pollution, population pressure, commercial activity (shipping), climate change via sea surface temperature, and climate change via an ultraviolet index. The selected stressors were not comprehensive for the entire world or for specific regions; however, Figure 52 demonstrates the areas where cumulative impacts are high (i.e., Gulf of Mexico included) and that there are few areas left that have not been affected by humans. The authors noted that marine ecosystems may exhibit threshold responses to intense and cumulative stress that creates non-linear relationships of cumulative impact to ecological condition; therefore not only intensity of stressors but also vulnerability or resilience of ecosystems must be accounted for when examining ecosystem condition. (Halpern et al. 2015). Cumulative impact across areas may be much greater (or in rare cases less) than the sum of the individual impacts because of interactive or multiplicative effects (Halpern et al. 2008).

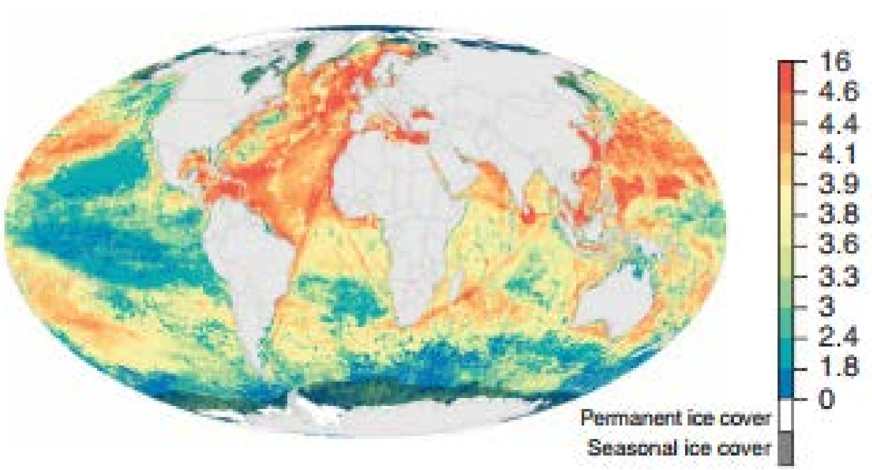


Figure 52. Cumulative human impact to marine ecosystems as of 2013. Figure from Halpern et al. (2015).

7.14 Conservation and Recovery Actions

7.14.1 Gulf of Mexico Bryde's Whales and Sperm Whales

In December 2010, NMFS published a final recovery plan for sperm whale. In 2019, the Gulf of Mexico Bryde's whale was listed as endangered. NMFS has established a long-term monitoring network for the collection of acoustic data in all federal waters including the

Gulf of Mexico. This information will allow managers to better understand and manage potential sound impacts to these two whale species.

The Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) is an ongoing effort between federal partners that is collecting empirical data during aerial and shipboard vessel surveys, satellite tracking of tagged animals, genetic analysis and with the goal to develop updated density models.

7.14.1.1 BOEM's Environmental Studies Program

BOEM funds research projects specifically to inform policy decisions regarding development of Outer Continental Shelf energy and mineral resources. Some of these studies may benefit marine fauna by providing more information towards understanding those resources.

For example, BOEM collects emissions information related to offshore operations and has established a Gulf Wide emission inventory. BOEM is currently conducting a study to perform dispersion and photochemical modelling for the U.S. portion of the Gulf of Mexico to verify effectiveness of existing air quality emissions exemption thresholds and to ensure annual and short-term National Ambient Air Quality Standards are being met (https://opendata.boem.gov/BOEM-ESP-Ongoing-Study-Profiles-2017-FYQ1/BOEM-ESP-GM-14-01.pdf; BOEM 2014a).

There are also summaries for current studies on assessing the effects of anthropogenic stressors on marine mammals and discerning behavioral patterns of sea turtles in the Gulf of Mexico. All of their studies are available through an online system called the Environmental Studies Program Information System found at https://marinecadastre.gov/espis/#/.

7.14.2 Sea Turtles

NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area. These include sea turtle release gear requirements for the Atlantic HMS, South Atlantic snapper-grouper, Gulf of Mexico reef fish fisheries, and TED requirements for the Southeast shrimp trawl fishery. In addition to regulations, outreach programs have been established and data on sea turtle interactions with recreational fisheries has been collected through the Marine Recreational Information Program. The summaries below discuss these measures in more detail.

7.14.2.1 Federal Actions

Critical habitat for loggerhead sea turtles was jointly designated by NMFS and USFWS on July 10, 2014 (79 FR 39856) (see Section 6.2.10 for further description).

Reducing Threats from Pelagic Longline and Other Hook-and-Line Fisheries

On July 6, 2004, NMFS published a Final Rule to implement management measures to reduce bycatch and bycatch mortality of Atlantic sea turtles in the Atlantic pelagic longline fishery (69

FR 40734). The management measures include mandatory circle hook and bait requirements, and mandatory possession and use of sea turtle release equipment to reduce bycatch mortality.

NMFS published the Final Rules to implement sea turtle release gear requirements and sea turtle careful release protocols in the Gulf of Mexico reef fish (August 9, 2006; (71 FR 45428) and South Atlantic snapper-grouper fisheries (November 8, 2011; Lopez-Pujol and Ren 2009). These measures require owners and operators of vessels with federal commercial or charter vessel/headboat permits for Gulf reef fish and South Atlantic snapper-grouper to comply with sea turtle (and smalltooth sawfish) release protocols and have on board specific sea turtle release gear.

Revised Use of Turtle Excluder Devices in Trawl Fisheries

NMFS has also implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles in commercial shrimp trawl fisheries. In particular, NMFS has required the use of TEDs in southeast United States shrimp trawls since 1989 and in summer flounder trawls in the mid-Atlantic area (south of Cape Charles, Virginia) since 1992. It has been estimated that TEDs exclude 97 percent of the sea turtles caught in such trawls. These regulations have been refined over the years to ensure that TED effectiveness is maximized through more widespread use, and proper placement, installation, configuration (e.g., width of bar spacing), and floatation. The NMFS continues to work towards development of new, more effective gear specific to fishery needs.

Placement of Fisheries Observers to Monitor Sea Turtle Captures

On August 3, 2007, NMFS published a Final Rule that required selected fishing vessels to carry observers on board to collect data on sea turtle interactions with fishing operations, to evaluate existing measures to reduce sea turtle captures, and to determine whether additional measures to address prohibited sea turtle captures may be necessary (72 FR 43176). This Rule also extended the number of days NMFS observers could be placed aboard vessels, from 30 to 180 days, in response to a determination by the Assistant Administrator that the unauthorized take of sea turtles may be likely to jeopardize their continued existence under existing regulations.

7.14.2.2 State Actions

Under Section 6 of the ESA, state agencies may voluntarily enter into cooperative research and conservation agreements with NMFS to assist in recovery actions of listed species. NMFS currently has an agreement with all states along the Gulf of Mexico. Prior to issuance of these agreements, the proposals were reviewed for compliance with section 7 of the ESA.

7.14.2.3 Other Conservation Efforts

Sea Turtle Handling and Resuscitation Techniques

NMFS published a Final Rule (66 FR 67495) detailing handling and resuscitation techniques for sea turtles that are incidentally caught during scientific research or fishing activities. Persons participating in fishing activities or scientific research are required to handle and resuscitate (as necessary) sea turtles as prescribed in the Final Rule. These measures help to prevent mortality of hardshell turtles caught in fishing or scientific research gear.

Outreach and Education, Sea Turtle Entanglement, and Rehabilitation

There is a Sea Turtle Stranding Network with extensive participant coverage along the Atlantic and Gulf of Mexico coasts that not only collects data on dead sea turtles, but also rescues and rehabilitates live stranded sea turtles.

A Final Rule (70 FR 42508) published on July 25, 2005, allows any agent or employee of NMFS, the USFWS, the USCG, or any other federal land or water management agency, or any agent or employee of a state agency responsible for fish and wildlife, when acting in the course of his or her official duties, to take endangered sea turtles encountered in the marine environment if such taking is necessary to aid a sick, injured, or entangled endangered sea turtle, or dispose of a dead endangered sea turtle, or salvage a dead endangered sea turtle that may be useful for scientific or educational purposes. NMFS already affords the same protection to sea turtles listed as threatened under the ESA [50 CFR §223.206(b)].

NMFS has also been active in public outreach efforts to educate fishermen regarding sea turtle handling and resuscitation techniques. As well as making this information widely available to all fishermen, NMFS recently conducted a number of workshops with Atlantic HMS pelagic longline fishers to discuss bycatch issues including protected species, and to educate them regarding handling and release guidelines. NMFS intends to continue these outreach efforts and hopes to reach all fishers participating in the Atlantic HMS pelagic longline fishery.

Recovery Plans and Reviews

The second revision to the recovery plan for the loggerhead sea turtle was completed January 11, 2009 (NMFS and USFWS 2009). The recovery plan for the Kemp's ridley sea turtle was published 2011 (NMFS et al. 2011a). Recovery teams comprised of sea turtle experts have been convened and are currently working towards revising these plans based upon the latest and best available information. Five-year status reviews were completed in 2013 for hawksbill and leather back sea turtles, and in 2015 for green, and Kemp's ridley sea turtles. A review of the loggerhead sea turtle's status was conducted in 2009 (Conant et al. 2009). These reviews were conducted to comply with the ESA mandate for periodic status evaluation of listed species to ensure that their threatened or endangered listing status remains accurate. Both loggerhead and green sea turtles were reclassified under the ESA (76 FR 58868; 80 FR 15271).

7.14.3 Gulf Sturgeon

7.14.3.1 Federal Actions

Critical habitat for Gulf sturgeon was jointly designated by NMFS and USFWS on April 18, 2003 (50 CFR §226.214) (see Section 6.2.12 for further description). Additionally, a Gulf sturgeon recovery/management plan was prepared in 1995 (USFWS and GSMFC 1995). An updated recovery plan is currently under development by USFWS and NMFS.

Gulf sturgeon may benefit from the use of devices inserted into trawl nets designed to exclude other species, such as sea turtles. Evidence of exclusion from a shrimp trawl net was documented when an Atlantic sturgeon caught off South Carolina by a shrimp trawler in December 2011 exited through the TED alive. NMFS has required the use of TEDs in some Gulf of Mexico shrimp trawls since 1989 and the regulations have been refined over the years to ensure effectiveness is maximized for sea turtle escapement through more widespread use, and proper placement, installation, configuration (e.g., width of bar spacing), and floatation.

7.14.3.2 State Actions

Cooperative conservation partnerships between NMFS and States can be formalized by entering into agreements pursuant to Section 6 of the ESA. NMFS has established partnerships for cooperative research on Gulf sturgeon via conservation agreements in the Gulf of Mexico with the states of Florida, Alabama, Mississippi, and Louisiana. Prior to issuance of these agreements, the proposal must be reviewed for compliance with section 7 of the ESA.

Implementation of the Florida Net Ban (Amendment 3 of the Florida Constitution) in 1995 has likely benefited sturgeon. The Net Ban made unlawful the use of entangling nets (i.e., gill and trammel nets) in Florida waters and likely benefitted or accelerated Gulf sturgeon recovery given residence of sturgeon in near-shore waters where tangling gear is commonly used during much of their life span. Capture of small Gulf sturgeon in mullet gill nets was documented by state fisheries biologists in the Suwannee River fishery in the early 1970s. Large mesh gill nets and runaround gill nets were the fisheries gear of choice in historic Gulf sturgeon commercial fisheries. Absence of this gear in Florida eliminates it as a potential source of mortality of Gulf sturgeon.

Gulf sturgeon is protected in Alabama and Mississippi. It is illegal to take, capture, kill, or attempt to take, capture or kill; possess, sell, trade for anything of monetary value, or offer to sell or trade for anything of monetary value, for Gulf sturgeon. Collection of Gulf sturgeon is only allowed with a scientific collection permit (AL ADC 220-2-92, MS ADC 40-1-28).

In 1992, the State of Louisiana listed Gulf sturgeon as a state threatened species (76 LA ADC pt I, §317). Currently, the harvest of Gulf sturgeon in state waters is prohibited (76 LA ADC pt XIX, §111), and any modifications to habitat must consider the potential effects on sturgeon. Studies are underway to determine the status, distribution, and movements of this species in Louisiana.

7.14.3.3 Other Conservation Efforts

In 1998, Gulf sturgeon were listed under Appendix II of CITES. Appendix II species are threatened with extinction if their trade is not regulated and monitored. Appendix II species require an export permit, which may be issued for any purpose as long as the specimens were legally acquired and export is not detrimental to the species. The listing of sturgeon in CITES provides managers with a mechanism for regulating the import and export of sturgeon and their products, thereby curtailing the illegal caviar trade and the harm it causes to the wild populations. The USFWS, Division of Law Enforcement, is responsible for the enforcement of CITES and is the permit and enforcement authority responsible for regulating the importation of sturgeon from foreign countries (USFWS International Affairs 1998, in (Wakeford 2001b).

8 EFFECTS OF THE ACTION ON SPECIES

"Effects of the action" has been recently revised to mean: all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 C.F.R. §402.17) 50 C.F.R. §402.02. Under the ESA, 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. For this consultation, we are particularly concerned about activities that may kill an animal or result in behavioral and physiological disturbances that may result in the failure of an animal to feed or breed successfully, or otherwise impede animals' ability to complete their life history functions (i.e., a decrease in fitness).

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The destruction and adverse modification analysis considers whether the action produces "a direct or indirect alteration that appreciably diminished the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features." (50 CFR §402.02).

Below we provide key assumptions regarding our effects analysis, estimates of the number of individuals of each ESA-listed species that would be exposed to the stressors, and the potential effects of each stressor on species exposed.

8.1 Estimation of Effects, Including Best Available Data Sources, Analytical Tools and Approaches, and Assumptions

The complexity of the Oil and Gas Program (i.e., multiple simultaneous activities over a broad area for the next 50 years) required us to make several assumptions to complete our effects analyses. Key assumptions described in subsequent sections were used to estimate effects and include the duration of the program, the definition of harass related to marine mammals and other ESA-listed species, and species densities and abundance.

8.1.1 Program Duration

Our analysis is based on projections of oil and gas related activity levels provided by BOEM and BSEE. BOEM and BSEE provided estimates of the effects of potential lease sales occurring up to ten years after issuance of this opinion, or through some time in 2029. The exposure scenarios in this opinion include oil and gas activities Gulfwide. Therefore, BOEM's revised proposed action that removed G&G activities from a large portion of the Eastern Planning Area and a small portion of the Central Planning Area that is under moratorium (GOMESA) is not reflected in the exposure scenarios herein. The GOMESA moratorium expires on June 30, 2022. If exploratory activity or new leases were to be planned or offered in the GOMESA moratorium area during the ten-year period following issuance of this opinion, reinitiation of consultation or a separate consultation would be required, as effects of oil and gas exploration and development in the GOMESA area were not considered in this consultation. The NMFS Permits and Conservation Division's proposed action is valid for five years and only related to G&G survey activity. The sound exposure estimates from geophysical activities in this section do not account for the revised proposed action omitting the area under GOMESA. Therefore the estimates are higher than would be expected under the revised proposed action. We account for this in the Incidental Take Statement (Section 15).

For the vessel strike analysis (Section 8.4), we considered whether there are any additional vessel types that BOEM did not identify as being part of the proposed action, but would not occur but for the Oil and Gas Program. As described below, BOEM considers service vessels, barges, tankers, G&G survey vessels, and G&G service vessels to be part of their proposed action (BOEM 2017b). We agree with BOEM's categorization of vessels in this way, and in most cases, BOEM's characterization of the vessels in these categories and their estimates of the vessel activity for these categories. However, for tankers, BOEM only considers shuttle tankers associated with FPSO systems to be part of the proposed action. Nonetheless, oil and gas produced in the Gulf of Mexico as a result of BOEM's Oil and Gas Program may also be transported by tankers between ports and even exported to other countries. Because this tankering would not occur but for BOEM's Oil and Gas Program in the Gulf of Mexico, the effects of this tankering on ESA-listed species are considered part of the effects of the proposed action. However, since we are not able to determine what percentage of overall tanker traffic would be attributed to the Oil and Gas Program, we treat the estimated vessel traffic associated with the proposed action based on our analysis below as a minimum estimate, and qualitatively consider the effects of this additional vessel traffic in our *Integration and Synthesis* (Section 11).

8.1.2 Species Densities and Abundance in the Action Area

In order to estimate exposure of ESA-listed species to the stressors associated with the proposed action, we required density and abundance estimates of the species determined likely to be adversely affected. While the status of the species sections above (Section 6.2), provide an overview of the species abundance in distribution at the listed entity level, as well as poplation level when data are available, this information is not specific to the action area and thus not considered the best available information for estimating exposure. Here we summarize the data sources on the density, distribution, and abundance of ESA-listed species in the action area, which are then used to estimate exposure of ESA-listed species to each stressor created by the proposed action.

Additionally, we rely on information from current species abundance, which does not take into account population trends over the 50 years of the proposed action. Population trends can fluctuate over time and estimations of effects are based on a snapshot of the current known population status. Thus, should a population trend shift, the estimations made in this opinion may need to be reassessed.

8.1.2.1 Marine Mammal Density and Abundance

The best available density estimate is Roberts et al. (2016b) because it accounts for unobserved animals and takes into account habitat availability. The models and descriptions summarized in the following paragraphs can be found in the published peer-reviewed journal article available at http://seamap.env.duke.edu/models/Duke-EC-GOM-2015/.

Roberts et al. (2016b) modeled marine mammal densities using NMFS' Southeast Fisheries Science Center sightings data prior to 2016 for the Gulf of Mexico and adjusted those data for observer bias, which means that they accounted for the animals that may not have been observed. Observers may not see animals due to many factors including that the observers are on the wrong side of the ship when the animals surface, or from either side cannot see directly off the point of the bow in front of the boat. Additionally, the Roberts et al. (2016b) modeling took into consideration available suitable habitat for each species (e.g., environmental variables such as depth contours). The authors included covariates related to meso-scale fronts and eddies, as well as several formulations of biological productivity, and sought both to improve the explanatory and predictive power of the models and to test the importance of these predictors relative to more commonly-used predictors such as bathymetry and sea surface temperature, thereby contributing to the understanding of the species' spatial ecology. Roberts et al. (2016b) then used the densities to estimate average abundance for individual species.

The Roberts et al. (2016b) models for both the Atlantic and Gulf of Mexico integrated data from nearly 1.1 million linear kilometers of surveys and more than 26,000 sightings collected by researchers at five institutions over 23 years; and the models replaced the U.S. Navy Oparea Density Estimates models, which are obsolete and no longer should be used. The U.S. Navy also used the Roberts et al. (2016b) densities for modeling effects for their Phase III Fleet training and testing activities.

Roberts et al. (2016b) estimates of sperm whale density in the northern Gulf of Mexico were used to determine the average abundance estimate of 2,128 animals in Roberts et al. (2016a). For sperm whales, we used density estimates based on habitat modeling by Roberts et al. (2016a) that are used to derive sperm whale exposure numbers in the particular area defined in that analysis. The number of sperm whale calves exposed to any stressor was calculated as 0.11 of the total exposures, which is the ratio of calves (one and two-year-olds) to females and immature males in the Gulf of Mexico (Jochens et al. 2008) and the female:male ratio as 72:28 of exposures (Engelhaupt et al. 2009).

Roberts et al. (2016b) Bryde's whale density model used in the subsequent analyses estimates abundance at 44 individuals. The abundance estimate of Gulf of Mexico Bryde's whale derived during the species status review and used in the proposed ESA-listing determination for Bryde's whale is 33 individuals. While the Roberts et al. (2016b) densities are considered best available, there are some limitations to those data in that they are based on limited confirmed sightings data, a function of the low number of Gulf of Mexico Bryde's whales. Due to this uncertainty, we were not able to use the vessel strike exposure data related to unconfirmed sightings outside the area where Bryde's whales are known to exist (the Bryde's whale area as described below) towards our jeopardy analysis. This is discussed in section 11.1, *Integration and Synthesis*.

Bryde's whale area

This opinion defines the Bryde's whale area to include the area from 100- to 400- meter isobaths from 87.5° W to 27.5° N as described in the status review (Rosel 2016) plus an additional 10 km around that area. The area designated in the status review was intended to "provide some buffer around the deeper water sightings and to include all sighting locations in the northeastern GOMx, respectively," and was believed to be an area that the whales inhabit year round. The Bryde's whale area for this opinion includes an outward expansion of 10 km around the area identified in the status review, for added protection of this extremely small population and accounting for ecological considerations.

8.1.2.2 Sea Turtle Density and Abundance

There are five species of sea turtle in the Gulf of Mexico: loggerhead, Kemp's ridley, green, leatherback and hawksbill. Densities of sea turtles within the Gulf of Mexico vary by species and life stage. Adult sea turtles are generally more abundant on the continental shelf (in water depths less than 200 m), while oceanic juveniles can be found on both the shelf and in more pelagic environments. Epperly et al. (2002) conducted aerial surveys along the continental shelf to estimate the density of adult sea turtle species within the Gulf of Mexico. These estimates do not represent absolute abundance but rather minimum population sizes as sea turtles are easily missed during aerial surveys (Epperly et al. 2002). Estimates of Kemp's ridley and loggerhead sea turtle densities were updated by the Southeast Fisheries Science Center prior to completion of this consultation to account for changes in population growth since Epperly's 2002 surveys. Updates were not completed for the other three species as no additional data were available. Foley et al. (2007) noted that 96 percent of green sea turtle individuals in the action area represent the North Atlantic DPS and four percent represent the South Atlantic DPS. To account for the population increase of green sea turtles, we applied a scalar to the survey data in Epperly et al. (2002). The scalar was calculated by considering the 4.9 percent annual population increase estimated for the Tortuguero rookery (the largest rookery in the Atlantic with the slowest rate of increase) described by Chaloupka et al. (2008a) and applying it over the time since the last aerial survey was conducted in Epperly et al. (2002) (i.e., $1.049^{18} = 2.4$).

Large Sea Turtles

For large (greater than 30 cm diameter) sea turtles in greater than 200 m water depth, we used data from Navy Phase III modeling (U.S. Navy 2017). These data represent the best available data within the action area and were used by the U.S. Navy in consultation with NMFS on Phase III of the Navy's Atlantic Fleet Training and Testing Area activities, which includes the Gulf of Mexico (NMFS 2018). We consider these density estimates to only represent sea turtles greater than 30 cm in size since they are based on aerial surveys, corrected for sighting availability, which can only detect these larger sea turtles (Epperly et al. 1995; NMFS 2011d). To further differentiate between sea turtle species groups densities, the Navy developed an approach to assign sea turtles to guilds, based on whether they are hardshell turtles or non-hardshell (i.e., leatherbacks). This allows estimates for densities be made for sea turtle observations where specific species identifications were not possible; but whether or not the animal possessed a hardshell. Therefore, the hardshell turtle guild is comprised of green, hawksbill, loggerhead, and Kemp's ridley sea turtles; green turtles are only considered under the hardshell turtle category because this species does not have a separate density estimate. The Navy quantified impacts on the hardshell turtle guild and these were apportioned to individual hardshell turtle species based on known geographic species densities within the action area. If enough data were available for specific species groups, those calculations were made per individual species as well (NMFS 2018).

Shown below are BOEM's acoustic modeling zones 1-7 used for acoustic modeling in BOEM (2017e), clipped to the BOEM planning areas for which average densities across the zones were calculated in zones 4-7[32] (Table 37 and Table 38). We do not have comparable density estimates for Mexican waters and as such, are applying the estimates from surveys completed in U.S. waters to Mexican waters of the action area. To have full coverage of the entire action area for which we have data, we have partitioned the NMFS SEFSC and U.S. Navy data sets for representing turtle abundance in each zone. Data are unavailable for zones 1-3 for hardshell and for zones 4-7 for Kemp's ridley, green or hawksbill sea turtles. Therefore, numbers for those species may be underrepresented for the entire action area. Still, hardshell turtles are grouped as unidentified hardshell turtles in the U.S. Navy data set and would likely be loggerhead, Kemp's ridley or green sea turtles that are larger than 30 cm diameter. By including these hardshell data,

[32] Only average densities from the Navy data for zones 4-7 were used, because we used Southeast Fisheries Science Center data for zones 1-3 (shallower than 200 m).

we are counterbalancing the underrepresentation to be more applicable for representation of exposure estimation.

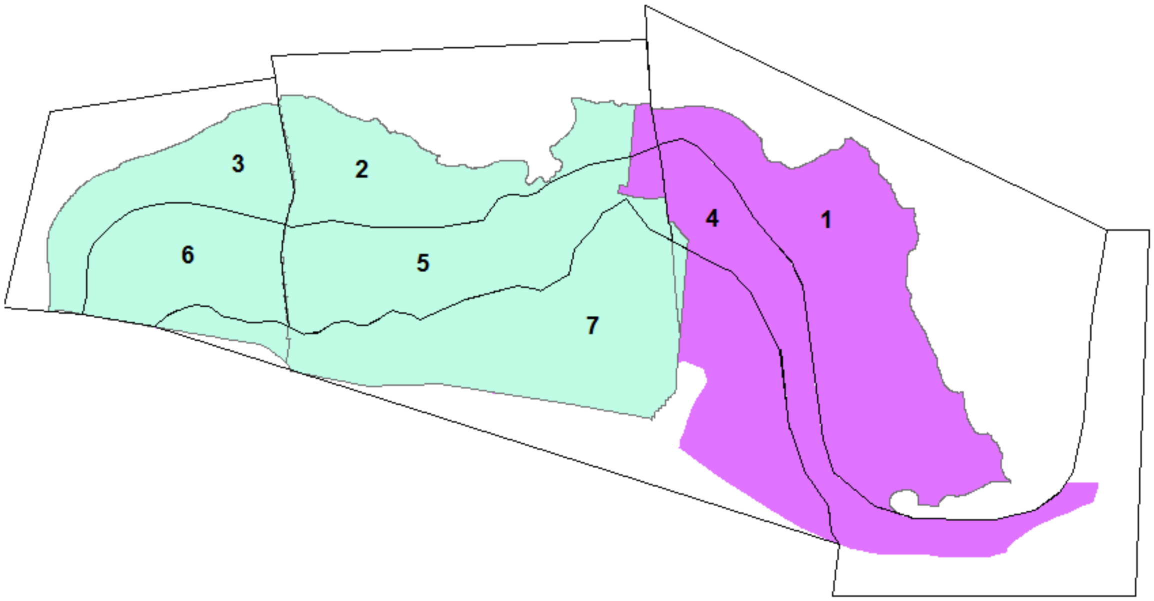


Figure 53. Sea Turtle Density Zones 1-7. The zones with color in them were those used to calculate abundance. Purple portion of the planning area is that under the GOMESA moratorium.

Table 37. Weighted[33] annual average density estimates of adult sea turtles in water depths less than 200 meters.

Species	Density (animals/km^2)	
	Zone 3 (WPA)	Zones 2 and 1 (CPA/EPA)
Kemp's ridley	0.894*	1.623*
Loggerhead	0.384*	1.136*
Green	0.024	0.336
Leatherback	0.010	0.030
Hawksbill	0	0.570

*(*L. Garrison, NMFS Southeast Fisheries Science Center, pers. comm. to K. Baker, NMFS PRD, September 11, 2014; data from 2011-2012 aerial surveys)*

Table 38. Annual average density estimates of adult sea turtles in water depths greater than 200 meters (U.S. Navy 2017).

Species	Zone 4 (EPA)	Zone 5 (CPA)	Zone 6 (WPA)	Zone 7 (CPA)
Leatherback	0.000900636	0.000383992	0.000133798	0.001961663
Loggerhead	0.016960221	0.000233259	0.000352221	0.060653785
Hardshell	0.029727935	0.00007.24317	0.000326894	0.01129076

[33] Inverse variance weighted average.

Small Sea Turtles

Sargassum is the principal feature that defines habitat for oceanic juvenile sea turtles (less than 30 cm). Oceanic juveniles aggregate in *Sargassum* habitats both over the continental shelf and in deeper oceanic waters. *Sargassum* habitat supports abundant prey and provides cover that otherwise would not be available to oceanic stage sea turtles. The diet, high-affinity, and shallow dive behaviors reported for oceanic juveniles associated with *Sargassum* habitat show that *Sargassum* is extremely important for young sea turtles (Witherington et al. 2012b). Oceanic juveniles of four species have been found in floating *Sargassum* in the Gulf of Mexico (Kemp's ridley, loggerhead, green, and hawksbill).

There have not been any oceanic juvenile leatherback sea turtles documented in the Gulf of Mexico. Leatherback nesting is very rare in the Gulf of Mexico. Leatherbacks nest almost exclusively on the east coast of Florida with zero to four nests per year on the west coast (FWRI Statewide Nesting Beach Survey Program), of which multiple nests could be from one individual in any given year. Food resources for juvenile leatherbacks are not well-documented as being associated with the *Sargassum* community. It is likely that larger and older age classes of leatherbacks predominantly occur in the Gulf of Mexico. Considering the high mortality rate of young turtles hatching from the few nests in the entire Gulf of Mexico, the occurrence of oceanic leatherback juveniles would be so rare we have discounted the likelihood of their occurrence. Density estimates for large leatherbacks observed by surveys best represent the total number of leatherbacks that may be present in the action area.

To estimate the total number of oceanic juveniles of the hardshell species that could occur in the Gulf of Mexico, we analyzed the available *Sargassum* habitat that could support food resources for juveniles and information on the density of oceanic juveniles in *Sargassum* habitat. Using satellite imagery, Gower and King (2008) estimated the areas over which *Sargassum* habitat occurs during the months of March, May, and July in the Gulf of Mexico. *Sargassum* begins to grow at a high rate during March in the northwestern Gulf of Mexico. *Sargassum* continues to grow into the summer months, and the amount and areal extent of *Sargassum* peaks in July where it is found throughout the Gulf of Mexico. In summer through the fall, large amounts of *Sargassum* are carried out of the Gulf of Mexico by the Loop Current where it then appears in the Atlantic beginning in July and lasting until about February (Figure 54).

Some oceanic juvenile sea turtles remain and use available *Sargassum* habitat entrained in the Gulf of Mexico basin and concentrate in convergence areas, while many other juveniles may be carried out of the Gulf of Mexico into the eastern Atlantic Ocean with floating *Sargassum* patches. Our oceanic juvenile sea turtle densities estimated below represent the number of pelagic-stage juveniles that could be present in the Gulf of Mexico Planning Areas based on the average annual peak of *Sargassum* habitat available in the action area. We measured the greatest areal extent of *Sargassum* in July based on the map provided by (Gower and King 2008; Gower and King 2011b) to be approximately 252,000 square kilometers (area estimated with the ruler tool in Google Earth, Figure 54). The oil and gas planning areas encompass a total area of

645,800 km^2 in the Gulf of Mexico. To estimate the proportion of the action area containing available *Sargassum* habitat, we divided the July *Sargassum* area by the total oil and gas planning area.

Proportion of Gulfwide planning area covered by *Sargassum*, therefore Available *Sargassum* Habitat Area = July *Sargassum* Area/OCS Gulfwide Planning Area (Figure 1)

= 252,000 km^2 /645,800 km^2

= 0.390214

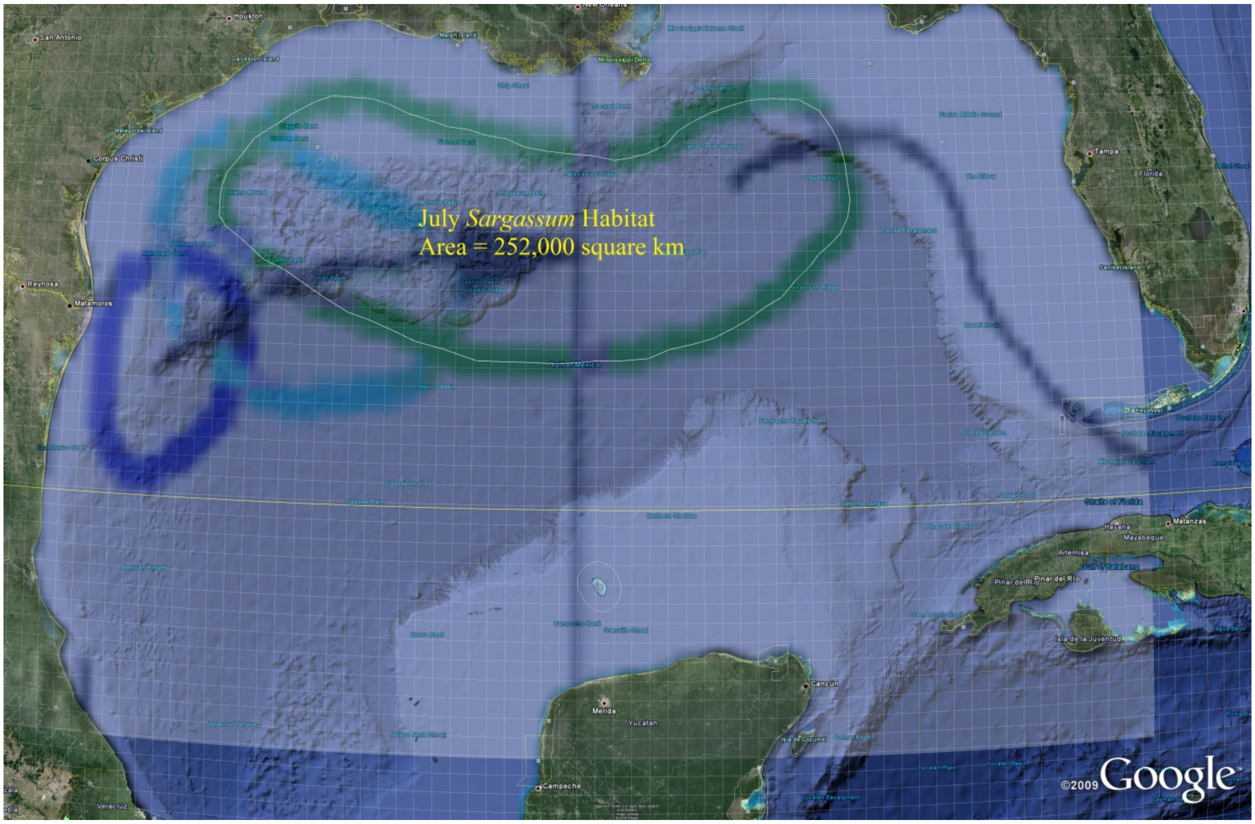


Figure 54. The annual areal extent of available Sargassum habitat during July (©2013 Google). Area in encircled in dark blue is March, light blue is May. Source data from Gower and King (2008).

To obtain an overall abundance estimate for oceanic juvenile sea turtles in the action area, we multiplied the density of juvenile sea turtles by the proportion of available *Sargassum* habitat in July (0.3902). Witherington et al. (2012b) surveyed offshore *Sargassum* patches in the Gulf of Mexico for oceanic juvenile sea turtles during the months of May to October and estimated densities around *Sargassum* habitat. The density for each species occurring in *Sargassum* habitat appears in Table 39 with the densities adjusted for available habitat. Adjusted densities were calculated with the following equation:

Oceanic Juvenile Sea Turtle Density in Oil and Gas Planning Areas = Density in *Sargassum* * Proportion of Available *Sargassum* Habitat

Table 39. Density of oceanic juvenile sea turtles in oil and gas planning areas.

Species	Juvenile Density in *Sargassum* Habitat (number/km^2)[a]	Adjusted Juvenile Density for Action Area (number/km^2)[b]
Kemp's ridley	3.0940	1.2073
Loggerhead	2.5680	1.0021
Green	3.6330	1.4176
Leatherback	0.0	0.0
Hawksbill	0.1085	0.0423

[a] Oceanic juvenile sea turtles densities are from those reported in Witherington et al. (2012)
[b] Adjusted densities were derived by multiplying the juvenile density in *Sargassum* by 0.390214, the proportion of available *Sargassum* habitat in the action area.

8.1.2.3 Giant Manta Rays, Oceanic Whitetip Shark, and Gulf Sturgeon Density and Abundance

We are not aware of any density estimates for giant manta rays within the action area, but they are expected to be infrequently encountered as sightings data are limited and there are no known spawning aggregations in the Gulf of Mexico. There is, however, a small population of about 70 giant manta rays on FGBNMS (Stewart et al. 2018).

We are also not aware of density estimates for oceanic whitetip sharks within the action area, but they are expected to be infrequently encountered. Historically, oceanic whitetip sharks had a global catch of 150-468 metric tons per year, including a high catch rates in deeper waters of the central Gulf of Mexico. They have highest catch rates in deeper waters of the central Gulf of Mexico. Research indicates a 70 percent decline in abundance in the Gulf of Mexico from 1992 to 2000 (Young et al. 2016).

We are not aware of any density estimates of Gulf sturgeon in the action area. However, information is available on their abundance. About 2,800 mature Gulf sturgeon are estimated in the Choctawhatchee River population (Alabama to Florida), and about 400 are estimated in each of the Pearl, Yellow, and Apalachicola River populations (Sulak et al. 2016). The Escambia and Pascagoula River populations each have about 200-300 estimated mature individuals and the Suwanee River population has about 5,000 mature individuals. There are 6,042 square kilometers of estuarine and marine area designated as critical habitat for Gulf sturgeon (68 FR 13370; see Section 8.8); however their full range encompasses an area greater than the established critical habitat. We use this information to analyze the extent of effects to this species.

8.1.3 Effects Analysis Roadmap

Table 40 and Table 41 below provide two “roadmaps” of our effects determinations for each activity (or stressor) and ESA-listed species. Section 9 provides similar “roadmaps” of our effects determinations for each activity (or stressor) and designated critical habitat. The first table (Table 40) displays all activities (or stressors) that we expect would have either no effect (boxes marked as ‘NE’) or are not likely to adversely affect (NLAA) any ESA-listed species. Activity (or stressor) and species combinations that we determined to be “no effect” are not discussed further in this opinion. Activities or stressors that we determined may affect but are not likely to adversely affect (NLAA) all ESA-listed species being considered are discussed further in Section 8.2.

The second table (Table 41) displays those activities or stressors that we determined would likely adversely affect (LAA) at least one ESA-listed species. Table 41 may have boxes marked as either ‘NLAA or ‘LAA’ indicative that the activity (or stressor) “may affect” that particular species. For “may affect” activity, we provide more information on each activity (or stressor), the effects of the associated stressors on ESA-listed species, and our rationale for reaching the effects determinations (Sections 8.4 through 8.8).

For some activities, we do not have enough information to fully evaluate the effects of the activity (or associated stressors) on ESA-listed species in this programmatic opinion. These include certain aspects of pipeline installation and decommissioning, oil spill response and NUTs. Effects determinations for these activities will depend on the specifics of the proposed action and will be evaluated during a second-tier review under this programmatic opinion (see Section 3.4 above for details).

Table 40. Summary of effects determinations for each activity (or stressor) and species evaluated[34]. The activities and stressors in this table either have no effect (NE) or are not likely to adversely affect (NLAA) ESA-listed species in the Gulf of Mexico.

Activity or stressor	Gulf of Mexico Bryde's Whale	Sperm Whale	Sea Turtles: Green (N. Atlantic and S. Atlantic DPS); Hawksbill; Kemps Ridley; Leatherback; Loggerhead N.W. Atlantic DPS)	Gulf Sturgeon	Giant Manta Ray	Oceanic Whitetip Shark
CSEM survey activities	NLAA	NLAA	NLAA	NE	NLAA	NLAA
Entanglement in other seismic survey equipment (hydrophones, geophones, cables, other)[35]	NLAA	NLAA	NLAA	NE	NLAA	NLAA
G&G sediment sampling	NLAA	NLAA	NLAA	NE	NLAA	NLAA
Aircraft sound and operation	NLAA	NLAA	NLAA	NE	NE	NE
Other construction and operation sound sources	NLAA	NLAA	NLAA	NE	NLAA	NLAA
Air emissions	NLAA	NLAA	NLAA	NE	NE	NE
NPDES water discharges	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
Oil spill < 1 bbl	NLAA	NLAA	NLAA	NE	NLAA	NLAA
Pre-severance activities: sediment disturbance and increased turbidity	NE	NLAA	NLAA	NE	NLAA	NLAA
Structure severance: non explosive methods	NE	NLAA	NLAA	NE	NLAA	NLAA

[34] NLAA labels in this table indicate that individual stressors are found to result in insignificant or discountable effects to listed species. In our jeopardy analysis, we further consider whether all effects to listed species in combination, including any insignificant effects, are likely to jeopardize a species' continued existence.
[35] See footnote 33 above.

Table 41. Summary of effects determinations for each activity (or stressor) and species evaluated[36]. The activities and stressors in this table are likely to adversely affect (LAA) at least one ESA-listed species, or the effects are unable to be determined under this programmatic consultation. Effects determinations key: LAA = Likely to adversely affect; NLAA = Not likely to adversely affect; NE = No effect.

Activity or stressor	Gulf of Mexico Bryde's Whale	Sperm Whale	Sea Turtles: Green (N. Atlantic and S. Atlantic DPS); Hawksbill; Kemps Ridley; Leatherback; Loggerhead N.W. Atlantic DPS)	Gulf Sturgeon	Giant Manta Ray	Oceanic Whitetip Shark
Seismic surveys: airguns and boomers	**LAA**[37]	**LAA**[38]	**LAA**	NE	NLAA	NLAA
Other G&G activities producing sound (e.g. HRG, AUV, hazard surveys)	**LAA**[39]	**LAA**[40]	NE	NE	NE	NE
Entanglement in seismic survey equipment – ocean bottom nodes (OBN)[41]	NLAA	NE	**LAA**	NE	NLAA	NLAA
Vessel strike	**LAA**	**LAA**	**LAA**	**LAA**	NLAA	NLAA

[36] NLAA labels in this table indicate that individual stressors are found to result in insignificant or discountable effects to listed species. In our jeopardy analysis, we further consider whether all effects to listed species in combination, including any insignificant effects, are likely to jeopardize a species' continued existence.
[37] This is relevant for rare occurences of animals outside the Bryde's whale area where they are typically observed and that may come into range of a geophysical survey.
[38] Activity also covered by MMPA rule.
[39] This is relevant for rare occurences of animals outside the Bryde's whale area where they are typically observed and that may come into range of a geophysical survey.
[40] Activity also covered by MMPA rule.
[41] Use of equipment that has entanglement or entrapment risk including but not limited to moon pools or other gear without turtle guards require a step-down review under this programmatic consultation (see Sections 3.5.3 & 3.5.4).

Activity or stressor	Gulf of Mexico Bryde's Whale	Sperm Whale	Sea Turtles: Green (N. Atlantic and S. Atlantic DPS); Hawksbill; Kemps Ridley; Leatherback; Loggerhead N.W. Atlantic DPS)	Gulf Sturgeon	Giant Manta Ray	Oceanic Whitetip Shark
Vessel sound and operation	**LAA**	NLAA	NLAA	NLAA	NLAA	NLAA
Offshore Infrastructure/ Pile Driving	NLAA	**LAA**	**LAA**	NE	NE	NE
Oil spill 1 to 1,000 bbl	**LAA**	**LAA**	**LAA**	NLAA	**LAA**	**LAA**
Oil spill > 1,000 bbl	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**	**LAA**
Structure severance: explosives	NE	NLAA	**LAA**	NE	NLAA	NLAA
Post structure removal site clearance - trawling	NLAA	NLAA	**LAA**	NE	NLAA	NLAA
Discharge of marine debris	**LAA**	**LAA**	**LAA**	NLAA	NLAA	NLAA
Entrapment in moon pools[42]	NE	NE	**LAA**	NE	NE	NE

Effects determinations key: LAA = Likely to adversely affect; NLAA = Not likely to adversely affect; NE = No effect

[42] Use of equipment that has entanglement or entrapment risk including but not limited to moon pools or other gear without turtle guards require a step-down review under this programmatic consultation (see Section 3.5).

Stressors are any physical, chemical or biological agent, environmental condition, external stimulus or an event that may induce an adverse response either in an ESA-listed species or their designated critical habitat. In Section 5 (*Stressors Created by the Proposed Action*) we identified the stressors created by the proposed action. Here we analyze how those stressors will interact with ESA-listed species and designated critical habitat in the action area. As previously discussed in Section 6 (*Species And Designated Critical Habitat*) not all stressors are likely to adversely effect each ESA-listed species. Also, many of the activities that will occur across the different stages of the Oil and Gas Program will create similar stressors; i.e., the effects of the stressors on species is expected to be similar regardless of the program phase. Therefore, our analysis considered the stressor rather than the activity. The stressors carried forward for analysis were: vessel operations and collision (vessel strikes), sound, emissions and discharges, entanglement and entrapment, marine debris, and oil spills.

For the effects analyses below, we discuss sea turtles as a group because we expect the effects of each stressor on the five species considered in this opinion to be generally the same. The best available information supports that sea turtle species would respond and be affected similarly. The caveat is that Kemp's ridley sea turtles have a restricted distribution with the majority of the population spending their entire life in the Gulf of Mexico, and they are the most endangered of the five species. Regardless of this, the five species are biologically similar and we expect responses to stressor exposures will be the same for Kemp's ridley turtles as for the other four species. Therefore, it is reasonable for us to separate out each species for the exposure analyses, where appropriate, and to make generalizations with respect to sea turtle responses to stressors, and to do the same in the discussions of risk.

8.2 Stressors Not Likely to Adversely Affect ESA-listed Species

This section describes activities or stressors that may affect ESA-listed species. After analyzing, these individual stressor effects were concluded to be either insignificant or discountable for all ESA-listed species being considered for that stressor, or if a species was entirely NLAA for that stressor (see Table 40 above). As defined in Section 6, discountable effects are those that are extremely unlikely to occur, whereas insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Below, we identify and provide our rationale for these NLAA determinations. There are also some NLAA determinations located in sections 8.4 through 8.8 for those species/stressor analyses that had at least one combination that was LAA (see Table 41 above).

8.2.1 Non-Acoustic G&G Survey Sources and Methods

CSEM sources are a continuous, very low frequency electromagnetic signal (0.05-10 Hz, 1,500 amps) towed about 30 m over the receivers on the sea bed. During CSEM surveys, a vessel deploys receiver nodes at pre-defined coordinates and allows them to freefall to the sea floor at a rate of 1 m per second. According to the requirements of the vessel strike NTL, sea turtles and marine mammals will be avoided during all operations and the potential for the equipment to strike an animal during the short freefall of the receiver is considered discountable. The receivers remain on the sea floor to collect data and store it until they are released to the surface by an acoustic release device. Once on the surface, the receiver is immediately retrieved by the vessel. Bio-degradable anchors that held the node on the sea floor dissolve away after a period of six to nine months of exposure to seawater. There is only minimal disturbance of the sea floor by the impact of the receiver node coming into contact with it during the deployment, data collection, and retrieval of the node. Based on the above analysis, NMFS concludes the potential for any adverse effects to occur to Bryde's whales, sperm whales, sea turtles, giant manta rays, or oceanic whitetip sharks as a result of CSEM survey activities will be discountable.

It is important to note that while these individual stressors are not likely to adversely affect species considered in this opinion, they still are considered for the jeopardy analysis as part of the combined, aggregate effects to ESA-listed species.

8.2.2 Construction Sound Sources other than Pile Driving

We compared the threshold levels for sea turtles, whales, and Gulf sturgeon to the sounds produced from oil and gas construction and operation activities to determine if there is any potential for adverse effects to occur. The potential for any source of sound to adversely affect a listed species depends on its source level and frequency range. Construction and operational sounds produced by the oil and gas industry are provided in Table 42 and Table 90. Most of the construction and operational sound covers a broad range of frequencies and can be heard by both sea turtles and whales. For most of the sounds, SEL measurements are not available and we relied on dB peak and rms levels to determine if the response thresholds are exceeded. If our comparison shows that the sound level of a source exceeds the exposure levels for an effect, we will consider that source further in this analysis.

Table 42. Sources of sound produced during the construction of oil and gas structures and operation of equipment associated with oil and gas activities.

Source of Sound	Source Level (dB)	Frequency (Hz)
Diver Tools	200 (peak) (approx. 185-190 rms)	broadband
Helicopters[43]	156-175 (rms)	45-7,070
Service, crew, and support vessels	160-180 (rms) 187 (peak)	20-10,000
Tug (4 engine)	173-177 (rms) 188-191 (peak)	broadband
Semi-submersible Pipeline Barge	161 (rms) 171 (peak)	10-10,000

[43] Aircraft sound discussed in Section 9.2.3, below.

Source of Sound	Source Level (dB)	Frequency (Hz)
Pipe-laying Vessel	170-182 (rms) 179-191 (peak)	broadband
Drilling from platforms	Up to 137 (rms) at 405 m (approx. 185 (rms) at source) 167-192 (peak)	5-1,200
Producing Platform	162 (peak) (approx. 147-152 rms)	10-10,000

Note: Data from BOEM's 2017-2022 Lease Sale EIS and A Review of Existing Data on Underwater Sound Levels Produced by the Oil and Gas Industry (2008).
Sources and sound levels were provided by BOEM's BA prepared for this opinion and from Genesis Oil and Gas Consultants (2011).

Construction and operational sounds other than pile driving will have insignificant effects on sea turtles, Bryde's whales and Gulf sturgeon. For sea turtles, effects would be limited to short-term avoidance of construction activity itself rather than the sound produced and would have insignificant effects on individuals (see Section 8.5 for more on sea turtle hearing). Gulf sturgeon and Gulf of Mexico Bryde's whales are not expected to be found close to where construction activities would be occurring.

In contrast, our comparison of sound sources with predicted sperm whale responses showed that all sound sources could potentially result in a disturbance. Below, we calculated the number of animals that could be present near individual sources of each sound type (Table 43). Unlike pile driving, these sources are not loud enough to produce levels of sound that would cause temporary hearing loss; therefore, we used the step function of 10 percent of sperm whales beginning to be disturbed at 140 dB (rms).

Table 43. Examples of sources of sound produced during the construction of oil and gas structures and operation of equipment associated with oil and gas, and number of sperm whales that could be present near each source annually.

Source of Sound	Source Level (dB)	ZOI to 150 dB (rms)	Number Exposed
Diver Tools	approx. 185-190 rms	100 m	< 1
Helicopters[44]	156-175 (rms)	18 m	< 1
Semi-submersible Pipeline Barge	161 (rms)	< 4 m	< 1
Pipe-laying Vessel	170-182 (rms)	40 m	< 1
Drilling from platforms	(approx. 185 (rms)	57 m	< 1
Producing Platform	approx. 147-152 (rms)	< 1 m	< 1

Note: ZOI distances calculated by 20 LOGR spreading loss.
ZOI distances were converted to areas and the number of animals exposed = Area of ZOI (km^2) x sperm whale density of 0.002 animals/km^2.

[44] Aircraft sound discussed in Section 9.2.3, below.

It is unlikely a sperm whale would occur close enough to any individual sound source to be affected. However, moving sources such as vessels or more numerous static sound sources have more potential to encounter and affect sperm whales. Sperm whales are also known to occasionally approach and investigate underwater activities. Although the likelihood of these sources affecting sperm whales is low, it is not discountable. We will further consider the sources below for their potential to disturb sperm whales and discuss why their potential effects are insignificant: platform sound (diver tools, drilling, and production), pipeline installation, and aircraft sound.

8.2.2.1 Platform Sound on Sperm Whales

Offshore drilling and production involves a variety of activities that produce underwater sounds. The sound sources are fixed to the immediate platform location. Some sounds such as diver tools are intermittent and infrequent, while other sources such as drilling sound and sound transferred through the platform by machinery occur over longer periods. Sounds emanating from drilling activities from fixed, metal-legged platforms are considered not very intense and generally are at very low frequencies near five Hz. Gales (1982) reported received levels of 119 to 127 dB re 1 μPa-m at near-field measurements, while other measurements have recorded higher levels of sound up to 185 dB (rms) from platforms or 195 dB (rms) from drill ships. Drill ships show somewhat higher sound levels as a result of mechanical sounds generated through the drill ship hull and by the use of thrusters to maintain position while drilling. Sounds from semi-submersible platforms also show rather low sound source levels. In general, the sounds associated with offshore oil and gas exploration and production are generally at low levels and typically at very low frequencies (~4.5 to 38 Hz) (Gales 1982). Although drilling sound may contribute to a localized increase in ambient sound levels, it will not produce sound levels over great enough distances that are sufficient to cause disturbance of sperm whales. Due to the stationary and localized effects of platform-associated sounds, sperm whale encounters near platforms would be very brief as they swim by, and the potential effects of these sounds to disturb sperm whales will be insignificant.

8.2.2.2 Pipeline Installation Sounds on Sperm Whales

The conventional construction season for pipeline installation is spring through fall (MMS 2006). Construction of offshore pipelines will result in sound and turbidity as pipeline is deployed by one barge and a second barge jets the trenches and buries the pipeline. Sediment disturbance may also occur from jetting and trenching of the sea floor to lay the pipeline. Pipelines installed in water depths greater than 500 m use dynamically positioned barges that do not require anchoring to the sea floor or burying of the pipeline. Any potential disturbance would be associated with short-term avoidance of the immediate construction area. Any minor behavioral avoidance of construction activities is expected to be very short-term and limited to very brief encounters. Sperm whales are likely to avoid the high activity of pipe-laying vessels and would not be exposed to the small area of sound produced. The brief avoidance of localized pipe-laying activities will have insignificant effects on sperm whales.

8.2.3 Effects of Aircraft Operation and Sound

Aircraft associated with the proposed action may cause visual or auditory disturbances to ESA-listed cetaceans and sea turtles and more generally disrupt their behavior. Cetacean responses to aircraft depend on the animals' behavioral state at the time of exposure (e.g., resting, socializing, foraging or traveling) as well as the altitude and lateral distance of the aircraft to the animals (Luksenburg and Parsons 2009). The underwater sound intensity from aircraft is less than produced by vessels, and visually, aircraft are more difficult for whales to locate since they are not in the water and move rapidly (Richter et al. 2006). Perhaps not surprisingly then, when aircraft are at higher altitudes, whales often exhibit no response, but lower flying aircraft (e.g., approximately 500 m or less) have been observed to elicit short-term behavioral responses (Luksenburg and Parsons 2009; NMFS 2017b; NMFS 2017f; Patenaude et al. 2002; Smultea et al. 2008a; Wursig et al. 1998). Thus, aircraft flying at low altitude, at close lateral distances and above shallow water elicit stronger responses than aircraft flying higher, at greater lateral distances and over deep water (Patenaude et al. 2002; Smultea et al. 2008a). In a review of aircraft sound effects on marine mammals, resting animals seemed to be disturbed the most, with low flying aircraft with close lateral distances over shallow water elicited stronger disturbance responses than higher flying aircraft with greater lateral distances over deeper water (Luksenburg and Parsons 2009a).

The sensitivity to disturbance by aircraft may also differ among species (Wursig et al. 1998). Several authors have reported that sperm whales react to fixed-wing aircraft or helicopters (Clarke 1956; Fritts et al. 1983; Mullin et al. 1991; Patenaude et al. 2002; Richter et al. 2006; Richter et al. 2003; Smultea et al. 2008b; Wursig et al. 1998). Smultea et al. (2008) studied the response of sperm whales to low-altitude (233-269 m) flights by a small fixed-wing airplane off Kauai and reviewed data available from other studies. They concluded that sperm whales responded behaviorally to aircraft passes in about 12 percent of encounters. All of the reactions consisted of sudden dives and occurred when the aircraft was less than 360 m from the whales (lateral distance). They concluded that the sperm whales had perceived the aircraft as a predatory stimulus and responded with defensive behavior. In at least one case, Smultea and et al. (2008) reported that the sperm whales formed a semi-circular "fan" formation that was similar to defensive formations in sperm whales reported by other investigators. Bowhead whales approached during aerial research surveys only occasionally exhibited short-term behavioral reactions to helicopters (14 percent of groups), and most of these reactions occurred at altitudes below or equal to 150 m (Patenaude et al. 2002). In response to fixed-wing aircraft, only 2.2 percent of bowhead whales exhibited a response, and similarly, most of these responses occurred at altitudes below or equal to 182 m (Patenaude et al. 2002). Based on these studies, and our previous consultations on numerous scientific research permits involving aerial surveys (NMFS 2017a; NMFS 2017b; NMFS 2017c; NMFS 2017f), we expect that the ESA-listed cetaceans considered in this opinion may exhibit no response or short-term behavioral responses to overpassing aircraft. To our knowledge, no physiological responses to aircraft have been documented in the literature, but we conservatively assume that a low-level, short-term stress response is possible.

Little information is available on how ESA-listed sea turtles respond to aircraft, but they do not appear to exhibit a response to unmanned aerial systems (Bevan et al. 2015). For the purposes of this consultation, we assume ESA-listed sea turtles may exhibit similar short-term behavioral responses as described above for cetaceans (e.g., diving, changes in swimming, etc.), which is consistent with those observed during aerial research surveys of sea turtles (NMFS 2017c; NMFS 2017d; NMFS 2017f). As with cetaceans, we are unaware of any data on the physiological responses sea turtles exhibit to aircraft, but we conservatively assume a low-level, short-term stress response is possible.

In summary, while the above review indicates that ESA-listed whales and sea turtles may exhibit short-term behavioral and or stress responses, such responses to aircraft associated with the proposed action are expected to be infrequent and minimal. Routine OCS helicopter traffic would not be expected to disturb animals for extended periods, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from a working area, and at an altitude of about 500 ft between platforms. The duration of the effects resulting from a startle response is expected to be short-term during routine flights, and the potential effects will be insignificant to sperm whales, Bryde’s whales, and sea turtles. Therefore, we find that any disturbance that may result from aircraft associated with the proposed action is not likely to adversely affect ESA-listed whales or sea turtles.

8.2.4 Effects of Oil and Gas Program Sound on Oceanic Whitetip Sharks and Giant Manta Rays

Giant manta rays and oceanic whitetip sharks could potentially overlap with sound producing activities as part of the proposed action. Because these species are considered very rare within the action areas, the number of individuals exposed to sounds from the proposed action is expected to be extremely small. The rare encounter of a manta ray or oceanic whitetip shark with a source vessel would be expected to have minimization measures implemented to reduce or avoid take. The effects of sound on individual fish that may be exposed are expected to be minimal for these fish species (i.e., insignificant), both of which lack swim bladders. We could not find any information suggesting that sounds produced by G&G surveys (i.e., seismic airguns, HRG, CSEM, or other sources) will result in injury or reduced fitness of individual manta rays or oceanic whitetip sharks.

There is little available information on the effects of pile driving on marine fish. Pile driving can potentially result in mortality or injury to fish that are sufficiently close to the source (Popper and Hastings 2009b). Given the low numbers of Giant manta rays and oceanic whitetip sharks within the action area, it is highly unlikely that these species would be found close enough to pile driving activities to result in injury or mortality (i.e., discountable). We expect exposure at a distance may result in a short-term, behavioral response (e.g., startle, avoidance) with no lasting impacts on the individual fish (i.e., insignificant effects). We could not find any information suggesting that sounds produced by oil and gas construction and operations will result in injury or reduced fitness of individual manta rays or oceanic whitetip sharks. In addition, large pelagic species such as these would be expected to avoid areas where construction operations are underway. Similar to sea turtles, with the exception of pile driving, we anticipate that sound-producing construction activities will not expose giant manta rays and oceanic whitetip sharks to levels of sound that will have any adverse effects.

There is considerable variability in the effects of explosive blasts on fish species. Studies suggest that there is far more damage to fish species with swim bladders than to species, such as giant manta rays and oceanic whitetip sharks, which lack such air chambers (Hastings and Popper 2005a). We could not find any information suggesting that sounds from explosive severance and other decommissioning activities will result in injury or reduced fitness of individual manta rays or oceanic whitetip sharks. Given the low numbers of giant manta rays and oceanic whitetip sharks within the action area, it is highly unlikely that these species would be found close enough to explosives to result in injury or mortality (i.e., discountable).

Giant manta rays and oceanic whitetip sharks may be able to hear the sound of passing vessels, but they are not expected to be adversely affected by the sound. Behavioral responses, which may include startle, avoidance, and diving, are expected to be short-term and minor. The sound produced by passing vessels would be brief, and we do not expect the sound levels received by these species would result in injury or reduced fitness of individual fish. We conclude that vessel sound associated with the proposed action will have only insignificant effects, therefore are not likely to adversely affect giant manta rays and oceanic whitetip sharks.

8.2.5 Effects of Air Emissions and Discharges to Water

Under the proposed action, air emissions of NAAQS criteria pollutants and other contaminants (e.g., mercury, greenhouse gases) and discharges to marine waters of pollutants in drilling fluids, drill cuttings, produced water, and other effluents will be routine. The presence of a pollutant in water or air does not necessarily result in adverse effects. An adverse effect occurs when a pollutant occurs at a concentration, duration, and/or frequency sufficient to cause a biological response affecting survival and fitness of exposed individuals or disrupt natural cycles and functions in the ecosystem. The volume and pollutant content of routine emissions and discharges are regulated through permitting that establishes emission and discharge limits that will not result in adverse effects to human health or the environment. However, under this action, accidental releases that exceed permit limits are also possible.

Toxic pollutants present in air emissions from Oil and Gas Program sources can cause direct harm to organisms when inhaled. Once entered into the earth’s atmosphere, pollutants in emissions can harm plant life, influence soil and water chemistry, and become incorporated into the food web. In addition, emissions often include greenhouse gases that contribute to climate change (carbon dioxide, methane, nitrous oxide, fluorinated gases) and ozone depleting gases (chlorofluorocarbons). By altering the intensity of the sun's energy retained within the atmosphere, greenhouse gases influence the earth's temperature regimes, resulting in cascading effects on atmospheric and oceanic currents, the earth's water cycle, and climate stability (Huntington 2006; Sterling 2012).[45] Any air emission effects to onshore air quality requires mitigation under BOEM's regulatory authority and USEPA will be issuing general permits to regulate emissions from the OCS east of 87.5°W longitude (approximately the western border of the Florida panhandle).

Oil and Gas Program discharges complex mixtures of heavy metals and other pollutants, including petroleum hydrocarbons, to marine waters. Toxic pollutants can cause direct effects on individuals and persistent toxic pollutants, like mercury, could become incorporated into the food web causing effects through dietary exposures. Discharges to water are regulated by USEPA through NPDES general permits that limit the discharge volume and concentrations of certain pollutants and require periodic monitoring of pollutant concentrations and discharge toxicity to marine organisms. A summary of the USEPA Region 4 (Central and Eastern Gulf of Mexico) and Region 6 (Central and Western Gulf of Mexico) NPDES general permits for Oil and Gas Program discharges to the OCS can be found in **Appendix E** of this opinion. The NPDES permits and their supporting documentation are available on their website at https://www.epa.gov/npdes-permits. The following sections describe the exposure and effects of air emissions and discharges to water permitted by the USEPA and BOEM for Oil and Gas Program activities in the Gulf of Mexico.

8.2.5.1 Effects of Air Emissions

Of the six principle pollutants identified in the NAAQS, Nitrogen Oxide ($NO_{x)}$ may be the most harmful as it is considered a precursor to ozone, which is formed by complex photochemical reactions in the atmosphere. A 2008 survey of 3,304 platforms from 103 companies in the Gulf of Mexico region determined emission rates and concluded sources of NO_x and Volatile Organic Compounds (VOCs), which may include toxic compounds that are carcinogenic, are the primary pollutants of concern because both are considered to be precursors to ozone (Wilson 2010). Air pollutant emissions generated from projects include the criteria pollutants nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter (PM), PM2.5, PM10, and sulfur dioxide (SO_2), as well as other regulated air pollutants including VOCs, NOx, and greenhouse gases (GHGs). VOC and NOx are the measured precursors for the criteria pollutant ozone, and NOx and SO_2 are measured precursors for PM2.5.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport processes are carried out by the prevailing wind circulations which can vary depending on the time of year. For instance, during the summer, the

[45] Additional information is available at: https://www.epa.gov/ghgemissions/overview-greenhouse-gases.

wind regime in the WPA is predominantly onshore during the day at mean speeds of 6.7-11.2 mph (3-5 m/s). Average winter winds are predominantly offshore at speeds of 8.9-17.9 mph (4-8 m/s). The majority of OCS Program-related emissions occur offshore anywhere from the state/federal waters boundary to 200 mi (322 km) offshore.

There is little information about the toxicity of air emissions associated with oil and gas operations. Based on examples of human risk assessments that estimate risk for human inhalation, and because there are few studies specific to marine species, we extrapolate that the emissions could affect air breathing marine mammals or sea turtles in a similar way that humans are affected if the concentrations were high enough. Adverse effects can include cancer risk, cardiorespiratory, or pulmonary exposures and disease (Amoatey et al. 2019). Similar to on-land facilities, it is expected that the highest concentrations of chemicals [near the water surface] or area of potential effects to ESA-listed species would be located within a few miles downwind of a facility (Olaguer et al. 2016; Smargiassi et al. 2014). Close to the facility the pollutant plume would still be in higher in the atmosphere, or farther away from the facility the pollutant would disperse.

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions within the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a good indicator of turbulence available for dispersion (Lyons and Scott 1990). Heat flux calculations in the WPA (Barber et al. 1988; Han and Park 1988) indicate an upward flux year-round, highest during winter and lowest in summer. According to Huang (2015) BOEM currently uses version 4 of the Offshore Coastal Dispersion model from DiCristofaro and Hanna (1989).

The mixing height is important because it dictates the vertical space available for spreading the pollutants. The mixing height is the height above the surface through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions and is suppressed during stable conditions, resulting in the worst periods of air quality. Although mixing height information throughout the Gulf of Mexico is scarce, measurements near Panama City, Florida (Hsu et al. 1980), show that the mixing height can vary between 1,312 and 4,265 ft (400 and 1,300 m), with a mean of 2,953 ft (900 m). The mixing height tends to be lower in winter, with daily changes smaller than in summer.

Analysis and Conclusion

This analysis separates out the jurisdictional air permitting due to differences for USEPA under CAA (east of 87.5°W latitude) and for BOEM (west of 87.5°W latitude) under OCSLA.

Air permitting under USEPA jurisdiction

Air breathing sea turtles, Bryde's whales and sperm whales could be impacted by pollutants emitted from OCS Oil and Gas Program activities. Yet, based on current CAA regulations, and implementation processes by USEPA, and monitoring, NMFS believes any effects to ESA-listed species from OCS emissions under USEPA jurisdiction will be insignificant. Under the CAA, if a facility is expected to exceed 250 tons of regulated emissions per year (per BACT and other provisions), then control technology is used, air quality modeling is required, and emissions are automatically mitigated. All USEPA-regulated facilities exceed this threshold, thus all facilities regulated by USEPA are subject to these measures and are required to mitigate in accordance with the CAA. USEPA also requires monitoring offshore. Ultimately, all emissions are mitigated down to CAA requirements offshore. Regulations, monitoring, mitigation, and developing emissions-related technologies will ensure these levels stay within the NAAQS as measured offshore. NMFS believes that these regulated emissions' effects on protected species and their designated critical habitats will be insignificant based on the monitoring and applied mitigation to CAA standards offshore. Therefore, emissions under USEPA jurisdiction are not likely to adversely effect ESA-listed species in the Gulf of Mexico.

Air quality under BOEM jurisdiction

As noted above, air breathing sea turtles and whales could be impacted by the types of pollutants emitted from OCS Oil and Gas Program activities. According to BOEM, emissions from the proposed activities are expected to be well within the NAAQS measured onshore, which were designed to protect public health, welfare, animals, and the environment. Under OCSLA, BOEM has authority to issue regulations for "compliance with the national ambient air quality standards pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.), to the extent that activities authorized under this subchapter significantly affect the air quality of any State." 43 U.S.C. § 1334(a)(8). BOEM interprets this to mean they do not have the authority to regulate the air above the OCS if it does not affect the air quality of the states. Because of BOEM's perceived lack of authority to regulate offshore air to meet the onshore NAAQS criteria, BOEM does not monitor offshore emissionsto know whether air quality in BOEM offshore areas are within the NAAQS. Given the physical processes that dictate dispersion and transport of emissions, it is uncertain whether offshore facility emissions can cause NAAQS thresholds to be exceeded onshore. BOEM is currently updating their inventory for Gulf of Mexico emissions and also has a study in progress to model offshore emissions scenarios. Results of this study were not available prior to release of this opinion. In the case of BOEM-regulated activities east of 87.5°W latitude, facilities will be required to comply with the PSD pre-construction permit program (*see* 40 CFR §52.21), and/or the Title V operating permit program requirements (*see* 40 CFR part 71), as well as applicable New Source Performance Standards and National Emissions Standards for Hazardous Air Pollutants. Under NEPA, BOEM analyzes impacts and is working on studies to help address effects, based on their interpretation of the their inventory. According to BOEM's analysis, air quality emissions under their jurisdiction would have minimal impact on the States. From BOEM's most recent available (year 2011) inventory of air emissions (BOEM 2014b):

> Federally-regulated OCS oil and gas production platform and non-platform sources emit the majority of criteria pollutants and greenhouse gases in the Gulf of Mexico with the exception of SO2 (primarily emitted from commercial marine vessels), and N2O (from

> biological sources). These production sources account for a large percentage[46] of the overall emissions in the Gulf of Mexico. A comparison of the 2008 and 2011 emission estimates for non-platform sources indicated a significant increase in criteria pollutant emission estimates, with the exception of SO2. This increase was primarily due to the use of updated USEPA emission factors. The updated emission factors and activity data yielded an overall increase in greenhouse gas emissions.

Based on available information provided by BOEM during consultation, BOEM focuses on the impact of Program activities on the States. BOEM attests that "human activity within the OCS is transitory at best as would be any marine mammal, sea turtle, or air-breathing aquatic species. Personnel on any platform are not considered to be at any imminent risk because the majority of air emissions exit from a stack that measures several meters high above the work environment.". BOEM assures that separation distances of platforms and dispersion and transport of emissions offshore is such that Program activities are not affecting ESA-listed species. BOEM supports that transport processes are carried out by the prevailing wind circulations which can vary depending on the time of year. Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. The mixing height is important because it dictates the vertical space available for spreading the pollutants. The mixing height is the height above the surface through which vigorous vertical mixing occurs. Emissions from the proposed activity are unlikely to have any impacts to marine species because of the atmospheric processes on air pollutant transport, stack height, exit gas velocity from the stack, distance of the marine species from the sources, and temporary vessel activity. BOEM asserts that "because of the combination of 2,953 ft mixing height and upward flux of discharged regulated pollutants year-round from stacks, the contribution of routine events and accidental events (flaring or venting) of the proposed action… to the air-water interface will have no effect on marine mammals or sea turtles and any associated critical habitat in the Gulf of Mexico".

Accidental events associated with oil and gas activities could occur, impacting air quality through smoke from fires and releases of volatile components of oil, natural gas, condensate, refined hydrocarbons, hydrogen sulfide, and NAAQS air pollutants. Response activities affecting air quality could include emissions from *in-situ* burning, the flares used to burn gas and oil, and the dispersants applied from aircraft. Unpermitted releases of substantial size during emergency responses applying these methods would require separate consultation.

We do not agree with BOEM's determination that their activity has no effect, but based on BOEM's reasoning for the diffusion and transport of pollutants, we consider Gulf of Mexico air emissions under BOEM jurisdiction to be at concentrations levels insignificant to air breathing ESA-listed species. Therefore, we conclude that these emissions are not likely to adversely affect ESA-listed species.

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[46] 90% of the total CO emissions, 73% of NOx emissions, 68% of PM10 emissions, 42% of SO2 emissions, 63% of VOC emissions, and 85% of the greenhouse gas emissions.

8.2.5.2 Effects of Discharges to Water

Oil and Gas Program discharges to the Gulf of Mexico OCS may affect protected species by degrading water and sediment quality or through exposures to discharge toxicants at harmful levels. The effects of effluents from oil and gas operations have been analyzed in past Section 7 consultations and will continue to be studied. Waste streams generated by the drilling process include drilling fluids, drill cuttings, produced water, and deck drainage. The platform crew contributes sanitary and domestic wastes. During production, there are additional waste streams including produced sand and well treatment, workover, and completion fluids. Further minor discharges include releases from desalination units, blowout preventer fluids, boiler blowdown, and excess cement slurry.

The USEPA regulates discharges from oil and gas operations to offshore marine waters in the Gulf of Mexico through NPDES general permits. The types and quantities of these discharges are summarized in **Appendix E**. Because of USEPA regulation, most of the routinely discharged chemicals are not expected to result in exposure intensities that would adversely affect any listed species because they are diluted and dispersed when released in marine waters.

Compliance rates among NPDES permits are tracked by USEPA's "Enforcement and Compliance Online Database" (https://echo.epa.gov/ accessed 6/9/2019). These must be considered when relying on permitting as a barrier to environmental harm. According to the database, there are 205 effective and administratively continued[47] NPDES permits identified within the Gulf of Mexico. Effluent violations are reported for 43 of these facilities over the past three years and eight facilities with effluent violations faced formal enforcement actions over the past last five years. Enforcement actions are not the default response to noncompliance. USEPA works with a noncompliant facility to identify causes of noncompliance events and strategies to return to compliance.

Effluent limit violations and accidental discharges have the potential to release chemicals in larger-than-approved volumes or concentrations. In such accidents, deleterious effects from exposures at harmful levels during the discharge and as it dissipates are expected to occur in organisms quickly within the immediate marine environment. If the discharge contained persistent and bioaccumulative toxicants, longer-term effects are possible over a broader area, due to dietary exposures through the marine food webs.

The USEPA's biological evaluation used data from valid[48] toxicity tests of sensitive species, such as mysid shrimp *(Mysidopsis bahia*) and inland silverside minnow (*Menidia beryllina*) exposed to produced water at higher concentrations than what would occur in the ocean. A

[47] A facility with an Administratively Continued permit is discharging under an expired permit that was "Administratively Continued" presumably while permit renewal is underway.
[48] The USEPA data quality requirements for toxicity tests are specified in USEPA 1996; USEPA 2006.

toxicity test exposes fertilized eggs or larvae of the test species to a series of effluent concentrations for determining sublethal toxicity in order to estimate toxicity. The effect of the effluent is measured by the survival and growth of the larvae. Minnows that are 24 hours old or less are exposed, and growth is measured as the difference in the larvae's average mean dry weight compared to that of the controls. Statistics analyzed include: cumulative mortality, healthy fish numbers at the end of the test, time to start and end of hatching, numbers of larvae hatching per day, length/weight of surviving animals, numbers of deformed larvae, and numbers of fish exhibiting abnormal behavior. The test method requires a semistatic or flow-through exposure system. A final survival count is made and the dead fish are removed when the testing time period is over. Tests are reviewed for quality control or "test acceptability criteria", such as maintaining specific protocols for dissolved oxygen, water temperature, test substance concentrations, survivability of control fertilized eggs, ensuring water standards during testing and "good" test organism cultures. Any test not meeting those criteria is considered invalid (USEPA 1996; USEPA 2006). This test acts as a surrogate for determining effects to ESA-listed species because eggs and especially larvae are more susceptible life stages and may better represent effects to sensitive species.

This is a conservative strategy because produced water would dissipate faster in deeper water. When a discharge is found to be not toxic to sensitive species (per toxicity testing described above), USEPA expects that the discharge will not be toxic to other species, including ESA-listed species. Toxicity data for some chemical compounds used for development and production are summarized in (MMS 2001a; MMS 2001b).

Drilling fluids, drill cuttings, and produced water discharges contribute heavy metals and other substances, in particular petroleum hydrocarbons, that may be toxic or detrimental (e.g., increase oxygen demand, sediment) to the surrounding environment. Heavy metals include barium and trace amounts of chromium, copper, cadmium, mercury, lead, and zinc. Several hundred chemical compounds could be part of a total petroleum hydrocarbon mixture, including PAHs benzene, toluene, ethylbenzene, and xylene. The composition of the mixture depends on the source, age, and environmental conditions.

Data from different oceans around the world show that heavy metal and PAH concentrations are present in marine mammal and sea turtle tissues and organs. Elevated concentrations have also been detected in sea turtle eggs and hatchling sea turtles, as well as in the milk of lactating cetaceans. Although these tissue levels provide strong evidence of exposures to these pollutants, we are not able to reliably estimate the contributions of oil industry pollutant loadings to pollutant accumulations in marine species. This is because there are many known and unknown pollutant sources discharging into gulf waters and these species are long lived and travel widely within and outside the Gulf of Mexico over their lifetimes.

Trace metals, including mercury, in drilling discharges have been of particular concern. An analysis conducted by (Neff et al. 1989) looked at the accumulation of mercury and other metals in flounder, clams, and sand worms exposed to barite drilling mud discharges. Flounder did not accumulate any metals during exposure, and the soft-shell clams and sand worms had only slight increases of some metals. The authors noted that most of the accumulated metals were actually in the gut or gills as barite particles, suggesting that metals associated with barite in drilling fluids were not readily incorporated into the tissues of marine organisms.

Produced waters

Produced water is the combination of the formation water (fresh or saline water trapped in the reservoir with the oil or gas), the hydrocarbon target (oil or gas), and any production chemicals added down well. Produced waters can vary widely depending on the geologic age, depth, and geochemistry of the hydrocarbon-bearing strata as well as the chemical composition of the hydrocarbon within the reservoir and the types of production chemicals added (Neff et al. 2011). As described in the proposed action, well completion techniques and chemicals vary depending on the rock properties of the reservoir, and may include fracking and acidizing chemicals. The components of produced water consist of metals, trace elements, monocyclic aromatic hydrocarbons, PAH's, and various other organic chemicals. Petroleum hydrocarbons are the chemicals of the greatest environmental concern (Neff et al. 2011).

Produced water represents the largest volume waste stream from offshore production platforms (Neff et al. 2011; Stephenson 1992). Clark and Veil (2009) estimated that 587 million barrels of produced water were generated in U.S. federal waters in 2007, a rate of approximately 1.6 million barrels per day. Produced waters intended for offshore disposal are treated to remove the majority of oil and gas, solids, and non-aqueous liquids prior to discharge. According to Neff (2002), produced water undergoes a number of changes including dilution, evaporation, adsorption/precipitation, biodegradation, and photo-oxidation following discharge into the marine environment. Collectively these processes reduce the concentration of chemicals in the discharge plume, thus reducing the toxicity to marine organisms (Neff 1987). In areas like the Gulf of Mexico where large quantities of produced water have been discharged continually over long periods of time, Neff believes the local water column microbial communities are well adapted for biodegradation of organic materials in produced waters (Neff 2002).

The OCS oil and gas produced waters contribute metals (i.e., arsenic, barium, cadmium, chromium, copper, lead, and zinc) to the marine environment. Although all of these metals are natural constituents of clean seawater, barium, iron, manganese, mercury, and zinc from produced water are frequently found in higher concentrations than naturally found in seawater (Neff 1987). Yet, metals from produced water are not generally associated with toxicity of the receiving waters as they are usually not in high enough concentrations (Neff 2002). Further, the complex geochemistry of these metals affects their bioavailability in the marine environment (Neff 2002). Metals in the form of pure metal, precipitates, or heavy minerals are not bioavailable to marine organisms (Waldichuk 1985).

Metals in discharged produced water mostly accumulate in the benthic sediments close to the discharge site. The accumulation of metal over background concentrations is typically localized to within 492 ft (150 m) of drilling structures (Kennicutt 1995), though statistically significant increases over background levels have been measured as far as 1,640 ft (500 m) from Gulf of Mexico drilling sites (Presley et al. 1992). Generally, offshore discharges of drilling muds and produced waters are expected to dilute to background levels within 3,281 ft (1,000 m) (CSA 1997). Yet, (Neff 2002) compared concentrations of metals in the tissues of marine organisms in the Gulf of Mexico and in the immediate vicinity of offshore discharges of produced water. This research determined that each were within normal ranges and did not show any evidence of bioaccumulation to potentially toxic levels for the organisms themselves or their consumers (Neff 2002).

Gulf of Mexico produced waters rarely contain more than about 0.1 mg/L total mercury (about ten-fold higher than clean natural seawater). Mercury in produced water is expected to dissipate rapidly following discharge to the ocean. Neff (2002) concluded that the concentration of total mercury in sediments near most of the platforms studied in the GOM is at or near natural background concentrations (about 0.1 ppm) and is rarely over 0.5 ppm. Mercury inputs from offshore oil and gas facilities contributes only 0.3 percent of Gulf of Mexico relative to inputs from the atmosphere and Mississippi River into consideration (Neff 2002).

Monocyclic aromatic hydrocarbons such as benzene, toluene, ethylbenzene, and xylene are found in produced water; however, because of their high volatility, they are lost rapidly following discharge. Most of these volatile compounds immediately dissipate to background levels within 328 ft (100 m) of the discharge (BOEM 2013). The compounds have a low potential to be bioaccumulated by marine organisms and do not adsorb to sediments. Therefore, they pose a very low risk of harm to marine organisms and human consumers of seafood.

PAHs are the petroleum hydrocarbons of the greatest environmental concern in produced water due to their toxicity and persistence in the marine environment (Neff 1987). Some PAHs bioaccumulate and are often found in sediments near produced-water discharges. PAHs are generally found in low concentrations within produced water (0.04-3.0 mg/l) so the potential to bioaccumulate or present additional risks to marine organisms is considered low (Neff 2002). The major sources of the more damaging PAH compounds are found as a component of soot from various combustion sources. These more damaging PAH compounds do not biomagnify in the marine food web and therefore do not pose a hazard to fish that consume biofouling organisms from submerged platform structures (Neff et al. 1987).

A study by Berg (2006) showed that exposure to contaminants containing metals and hydrocarbon components at sublethal levels may result in impaired physiological function and behavior in fish. The range of issues may include endocrine disruption that impacts reproduction and osmoregulation, immune system suppression, inhibition of the olfactory system, inhibition of the nervous system that interferes with behavior, and biochemical changes and developmental interference. All of these on their own may increase mortality and impair the recovery of a population or species (Berg 2006). In a lab study on rainbow trout, Blewett et al. (2017) found that oxidative stress in the gills and liver and morphological changes in the gills when exposed to

2.5%, 7.5% produced water samples relative to the activated charcoal, saltwater-matched and control samples for two days. Results of field and laboratory tests from another study show levels of [toxic] alkyl phenols show up in very low levels in fish muscle and liver tissue because both PAHs and alkyl phenols are rapidly metabolized by vertebrates (Bakke et al. 2013). Studies cited in Bakke et al. (2013) document that compounds present in produced water have potential to exert endocrine effects in fish and the author noted that the exposure levels studied are at concentrations that would be similar to those found in close proximity to discharge points (Bakke et al. 2013).

Drilling Fluids/Muds and Cuttings

Drilling fluids used on the OCS are divided into two categories: water based and non-aqueous-based. In non-aqueous-based drilling fluids, the continuous phase is not soluble in water. Clays, barite, and other chemicals are added to the base fluid, which can be freshwater or saltwater in water-based fluids (WBFs), mineral or diesel oil-based fluids (OBFs), or synthetic-based fluids (SBFs). Additional chemicals are also added to improve the performance of the drilling fluid (Patel et al. 2003). Discharge of OBFs is prohibited under the NPDES permit. There are also limitations on the release of barite containing higher amounts of cadmium or mercury, which are the trace metals of concern.

The discharge of WBFs and cuttings associated with WBFs is allowed almost everywhere on the OCS under the general NPDES permits issued by USEPA Regions 4 and 6, as long as the discharges meet NPDES permit requirements. Discharge of WBFs can result in increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings and the delivery of trace metals. Occasionally, formation oil may be discharged with the cuttings, adding hydrocarbons to the discharge. In shallow environments, WBFs are rapidly dispersed in the water column immediately after discharge and rapidly descend to the sea floor (Neff 1987). In deep waters, fluids dispersed near the water surface would disperse over a wider area than fluids dispersed in shallow waters.

SBFs are manufactured hydrocarbons. Since SBFs are not petroleum-based, they do not contain the aromatic hydrocarbons and PAHs that contribute to OBF toxicity and persistence on the sea floor (International et al. 1995). A SBF mud system may also contain additives such as emulsifiers, clays, wetting agents, thinners, and barite. Since 1992, SBFs have been increasingly used, especially in deep water, because they perform better than WBFs and OBFs. SBFs reduce drilling times and costs incurred from expensive drilling rigs. By 1999, about 75 percent of all wells drilled in Gulf of Mexico waters deeper than 305 m (1,000 ft) were drilled with SBFs (EPA 2000). Although there are many types of SBFs, esters, internal olefins, and linear alpha olefins are most commonly used in the Gulf of Mexico.

A literature review (Neff et al. 2000) discussed knowledge about the fate and effects of SBF discharges on the seabed. Like OBFs, SBFs are hydrophobic, do not disperse in the water column, and therefore are not expected to adversely affect water quality. The SBF-wetted cuttings settle close to the discharge point and affect the local sediments. The primary effects are smothering of the benthic community, alteration of sediment grain size, and addition of organic matter, which can result in localized anoxia during the time it takes for the SBF to degrade (Melton et al. 2004). Different formulations of SBFs use base fluids that degrade at different rates, thus affecting the duration of the impact. Esters and olefins are the most rapidly biodegraded SBFs.

Tests indicate that SBFs and their degradation products should not bioaccumulate (Neff et al. 2000). In a study to measure degradation rates of SBF on the sea floor and to characterize the microbial populations, the sulfate-reducing bacterial counts increased in sediments incubated with SBFs under deep-sea conditions (Nguyen et al. 2006). Biodegradation proceeded after a lag period of up to 28 weeks influenced by both the SBF type and prior exposure of the sediments to SBFs.

The discharge of synthetic-based drilling fluid is prohibited. Both USEPA regions permit the discharge of cuttings wetted with SBF as long as the retained SBF amount is below a prescribed percent, meets biodegradation and toxicity requirements, and is not contaminated with the formation oil or PAH. Ongoing research is aimed at understanding the relationships between chemical structure in SBFs and environmental fates and effects, which will provide the design basis for fluids with better environmental performance.

Drilling fluids are one of the largest sources of mercury from exploration and production activities in the Gulf of Mexico, though they generally contain mercury in low concentrations. Nearly all the mercury in drilling fluid is associated with barite, which is added to the mud as a weighting agent. The USEPA limits mercury in barite to 1 part per million (ppm). The average mercury concentration in modern drilling mud barite is 0.5 ppm and most drilling muds discharged to U.S. waters contain less than 1 ppm mercury.

The mercury in drilling mud barite is sequestered in the solid barium sulfate in sulfide minerals, particularly sphelerite (ZnS). It is extremely insoluble and stable in this form, thus trapping mercury and other trace metals in the barite. Therefore, unless mercuric sulfide in the barite can be microbially methylated, this source of mercury is relatively unavailable for uptake into the marine food web. This is true even under mildly acidic conditions, as might occur in the digestive tract of a marine animal (Crecelius et al. 2007). The solubility of barite and the rate at which it dissolves (and thereby releases associated metals such as mercury), the amount of metals released from the barite, and the rate of dissolution of barite and release of metals after burial under simulated sea floor conditions was studied (Crecelius et al. 2007). The solubility of the associated mercury in seawater at 2 pH concentrations tended to increase with time for at least several months, but remained well below the USEPA water quality criterion. The study concluded that very little (less than 0.1 percent) of the mercury in barite became biologically available (Crecelius et al. 2007).

Another study (Neff 2002) showed that surface sediments collected 20-2,000 m (66-6,562 ft) away from four oil production platforms in the northwestern Gulf of Mexico contained 0.044-0.12 micrograms per gram (µg/g) total mercury. Because concentrations of total mercury in uncontaminated estuarine and marine sediments are generally 0.2 µg /g dry weight or lower, these measured amounts are essentially equivalent to background concentrations for mercury in surficial sediments on the Gulf of Mexico OCS (Neff 2002).

Like produced water, drilling fluids also contain barium and trace amounts of chromium, copper, cadmium, mercury, lead, and zinc. Although levels of these metals can become elevated within a few hundred feet of drilling structures (Kennicutt 1995), dilution to background levels occurs within 3,281 ft (1,000 m) of the discharge point CSA (1997). Sea turtles may bioaccumulate chemicals such as heavy metals that occur in drilling mud as samples from stranded turtles in the Gulf of Mexico carry high levels of organochlorides and heavy metals (Sis et al. 1993).

Other discharges

While produced waters and drilling fluid/cuttings comprise the most harmful effluents discharged from oil and gas activities, a variety of other wastes comprise a large proportion of discharges. These include chemically treated water[49], non-contact cooling water, excess seawater from pressure maintenance and secondary recovery projects, water released during training of personnel in fire protection, ballast or bilge water, treated sewage, treated wastewater, engine waste, biodegradable food waste, desalination brine, boiler blowdown fluids, blowout preventer fluids, excess cement slurry, subsea production fluids and uncontaminated freshwater and saltwater. Wastes and discharges will result from operation of offshore structures and support vessels. These waste streams have the potential to affect the receiving waters by modifying the temperature or salinity, increasing or modifying the phytoplankton community due to increased nutrients, and/or contributing to the potential for toxicity. Due to standard discharge protocols and requirements of NPDES permits, we believe the routine discharges of treated sewage, wastewater, and biodegradable food wastes will not adversely affect listed species of sea turtles, whales, or Gulf sturgeon.

The NPDES general permit limits the maximum concentration of treatment chemicals in discharge not to exceed the most stringent concentration of the following three: 1) the maximum concentrations and any other conditions specified in the USEPA product registration labeling if the chemical is an USEPA registered product, 2) the maximum manufacturer's recommended concentration, or 3) 500 mg/l. A 500 mg/l concentration is equivalent to about 0.05 percent of chemical in the discharged water and the discharge will be further diluted by seawater. The permit also requires that the discharge must pass a 48-hour acute toxicity test prior to discharging. Unlike the discharge of produced water, most of these miscellaneous discharges are

[49] Fresh or seawater with added corrosion inhibitors, scale inhibitors, biocides, and/or other chemicals.

intermittent. The permit action does not authorize discharge of wastewater that does not comply with the permit conditions.

Analysis and Conclusion

During consultation we reviewed the best scientific information available, and the descriptions and restrictions of each proposed discharge type (**Appendix E**), and NMFS agrees with USEPA's determination that the discharge of effluent under conditions of the NPDES general permits is not likely to adversely affect sperm whales, Bryde's whales, sea turtles, Gulf sturgeon, giant manta rays, or oceanic whitetip sharks. Similarly, we believe the discharge of effluent under conditions of the NPDES general permits is not likely to adversely affect designated critical habitat for Northwest Atlantic DPS of loggerhead sea turtles or Gulf sturgeon.

Discharges of produced water, drilling fluids, drill cuttings, and chemically treated miscellaneous discharges under the NPDES general permit will be required to meet the whole effluent toxicity requirements. We rely on the USEPA toxicity tests performed on sensitive species under controlled laboratory conditions. Toxicity tests evaluate survival growth and fertility under ideal laboratory conditions such that effects are not influenced by real world factors like predation, competition, disease, other stressors in the field, and fluctuations in natural water quality parameters. However, in the wild effects on swimming speed, predator detection or evasion, and nest tending influence survival. In addition toxicity test durations may not be long enough detect any lags in responses that may occur (e.g., delayed mortality, metabolism to more toxic form, cascading effects) and full lifecycle and generational tests are not typically conducted, so important effects that not manifested at the exposed life stage or that have generational influences may not be detected. Finally, toxicity test results are usually expressed as endpoints that can be difficult to interpret in terms of biological relevance. The typical endpoints reported include:

- LC50: the concentration of effluent dilution at which half of the exposed organisms die
- NOEC or NOEL: the lowest tested exposure concentration or effluent dilution at which an effect did not differ from controls
- LOEC or LOEL: the lowest tested exposure concentration or effluent dilution at which an effect differed significantly from controls
- EC50 or other EC##: the effect concentration or dilution (EC) at which a certain proportion of an effect was observed (e.g., EC10 = concentration at which 10 percent of test organisms show an adverse response).

A 50 percent mortality rate is clearly not an acceptable level of effect for imperiled species and NOECs and LOECs are not ideal measures of effects because they are influenced by study design. Depending on the number and distribution of exposures tested and underlying variability in responses, a NOEC could actually represent a 35 percent difference in response from controls in a poorly designed study. An EC## reflecting a biological response threshold (i.e., 1 percent, 5 percent) would be a more suitable endpoint. Unfortunately, rigorously derived EC## data are rare and dose-response relationships of existing toxicity tests often have very broad confidence intervals.Toxicity tests are not conducted in field trials to incorporate real-world conditions and extrapolations from effects in other species are necessary because ESA-listed species cannot be used in toxicity tests. These tests, using standard lab species under ideal conditions, are the best available data for representing toxicity to ESA-listed species, despite the shortcomings discussed above.

Well treatment fluids are not permitted for discharge if containing priority pollutants. Well treatment fluids are also subject to oil and grease limits (under the effluent limitations guideline), and oil and grease is an indicator pollutant for toxics; thus by limiting oil and grease, the permit also limits discharge of toxic pollutants. The general permit reissuance does not relax any current permit conditions that may adversely affect the water quality of the ocean. The permit also has monitoring requirements and fish/shellfish impingement/entrainment control measures. According to USEPA, these discharges are authorized under the general permit at low levels of toxicity and will quickly be diluted. Sufficient controls will be required to protect the environment and reduce potential effects on ESA-listed species.

NMFS believes that these regulated discharges' effects on protected species and their designated critical habitats will be insignificant based on the following: (1) discharges must meet permit requirements for acceptable toxicity levels that do not cause harm to tested sensitive species (as described above) and other restrictions set forth in the permit, which, according to USEPA's biological evaluation, are intended to protect all aquatic life, including protected species and prevent unreasonable degradation of the marine environment; (2) discharges are expected to quickly dilute and disperse in the vast receiving waters; (3) restrictions will limit many chemicals and nutrients from entering the receiving waters (i.e. no free oil, no floating solids, no garbage, no foam, phosphate free soap and detergents, sanitary waste treated with chlorine); (4) the standard use of curbs, drip pans, and other pollution prevention equipment on offshore structures; (5) toxicity limits are required for facilities intending to discharge drilling fluids, drill cuttings, and/or produced waters to the sea; and (6) based on the USEPA, BOEM, and bioaccumulation studies cited previously, there have been no reported significant adverse environmental impacts including no bioaccumulation resulting from the proposed types of discharges from oil or gas platforms within the Gulf of Mexico, and no adverse effects to NMFS' protected resources have been reported.

The feeding behaviors and habitat use patterns of our protected species influence their exposures and responses to the pollutant discharges that would occur under this action. Bryde's whales feed in an area that is currently not near oil and gas structures, so exposures to discharge toxicants through prey would be extremely unlikely and therefore discountable. Sperm whales, giant manta rays, oceanic whitetip sharks, and sea turtles are wide-ranging animals that feed on prey over great distances so any prey consumed near oil and gas discharge structures would be an insignificant portion of their diet and are therefore expected to be an insignificant exposure to accumulated toxicants. Gulf sturgeon have more localized feeding habits and are generally not found far enough offshore to forage in waters near oil and gas activities, so their exposures would be extremely unlikely and therefore discountable While some specific chemicals occur in higher concentration within a few hundred feet of discharging structures, exposure of protected sea turtles, sperm whales, Bryde’s whales, and ESA-listed fish (Gulf sturgeon, giant manta ray, oceanic whitetip shark) to toxicants from the these discharges are either insignificant or extremely unlikely and therefore discountable.

Because our analysis of best available information leads us to conclude that exposures to toxicants in discharges from oil and gas activities are either insignificant or extremely unlikely to occur (and are therefore discountable), we conclude that these discharges are not likely to adversely affect ESA-listed species.

8.2.5.3 Effects of Other Potential Sources of Water Quality Degradation

Several of the activities that are part of the proposed Oil and Gas Program will likely cause disturbances to the ocean floor and/or result in increased water turbidity. G&G permits for sediment sampling are used to assess a possible pipeline route and determine sediment characteristics of development areas. The common methods used to obtain sediment samples include box cores and piston cores. Coring methods typically involve a box measuring 1 x 1 meters or a use of a piston core that is a 3-inch-diameter, 9-meter-long pipe. Shorter piston cores are also used depending on the sampling needed. A box core samples surface sediment by lowering a steel box to the sea floor, closing it full of sediment, and raising it back to the vessel. A piston corer is a long, heavy tube allowed to freefall to the bottom and plunge into the bottom to extract samples of mud sediment. Sampling typically takes two to three hours per sampling site. According to the requirements of the vessel strike NTL, sea turtles and marine mammals will be avoided during all operations, and the potential for the equipment to strike an animal during the short freefall of the piston core or lowering of a box core is considered discountable. BOEM would implement requirements to ensure protection of any sensitive benthic resources, including setbacks from sensitive sea-bottom communities. The deployment of any sediment sampling equipment on or near coral reefs is prohibited and no impacts will occur. Minor, localized turbidity is expected, but it would quickly dissipate when sampling ends. The minor sea floor disturbances from sediment sampling would have insignificant effects on sea turtles, Bryde’s whales, sperm whales, giant manta rays, and oceanic whitetip sharks.

Pre-severance activities will cause sediment disturbances and increased turbidity within at least a portion of the water column. The area and depth of disturbed sediment would be dependent upon the number and size of service vessels and the number of anchors set, the size of the excavated area, the depth of the below mudline cut, the method of explosive severance (internal or external) and size of charge. The site-specific characteristics of the sediment would further influence the amount of disturbance that would occur.

Water jetting occurs with installation of structures as well as with decommissioning. Jetted or disturbed sediments may contain trace concentrations of persistent organochlorine pesticides and metals from inland agricultural and industrial practices. These sediments were transported by the Mississippi River and other rivers and deposited in coastal/marine waters. The presence of pollutants carried by river discharges is much more common in the sediments of coastal waters and is less likely in deeper waters where the structure removals will occur. Sediments close to oil and gas wells may contain residuals of drilling muds and cuttings that settle to the sea floor adjacent to the point of discharge. Levels of barium, total mercury, and other metals above background levels may be present from drilling muds released at the site.

Trace amounts of hydrocarbons may also be present in sediments adjacent to wells from past practices or spills. Sediment disturbance would occur in a limited area over a time period of less than a week or month for the most extensive removal projects. Therefore, the suspension of any sediment caused by anchoring, sediment excavation, or removal of severed structure would result in a temporary increase of suspended matter, which would rapidly disperse and resettle on the sea floor.

Explosive severance could cause seafloor disturbance depending on the placement of the charges. Additionally, some non-explosive methods could cause increased turbidity. We expect the amount of increased turbidity caused by both explosive and non-explosive methods to be localized and temporary so as not rise to the level of adverse effects on ESA-listed species (i.e., insignificant).

Submerged pipeline installation, flushing (decommissioning), removal of a severed structure from the seafloor, artificial reef creation and site clearance trawling associated with decommissioning may affect the water quality by increasing turbidity or releasing minimal amounts of oil or waste products in localized areas where the activity occurs and we expect that will remain localized and be temporary. Therefore, we consider the effects of these activities to be insignificant.

Analysis and Conclusion

Due to the dispersion of suspended sediments, any exposures that could occur would be brief and at low exposure levels. The impacts to water quality from turbidity and suspension of drilling muds is expected to be temporary and limited to the immediate removal site. The potential for ingestion, skin absorption, or other exposure pathway of contaminants is very low for any single animal. Due to the temporary and localized effects from disturbed sediments during decommissioning activities, the effects on highly mobile species such as whales, sea turtles, sharks, and rays will be insignificant. In summary, sediment disturbances and increased turbidity resulting from pre-severance activities as part of the proposed action are not likely to adversely affect Gulf of Mexico Bryde’s whales, sperm whales, sea turtles, giant manta rays, or oceanic whitetip sharks.

8.3 Effects of Conservation Measures

As discussed in Section 33 *Description of the Proposed Action*, BOEM, BSEE, USEPA, and NMFS Permits and Conservation Division propose various conservation measures to either minimize adverse effects to ESA-listed species or help monitor those effects. These include existing measures such as active NTLs and lease stipulations, and current environmental laws and regulations, as well newly proposed NTLs and MMPA mitigation measures that are considered part of the proposed action for this opinion. In evaluating the effects of the proposed action for each stressor or activity below, we make full consideration of these conservation measures as they are indeed part of the proposed action for this consultation. As such, we consider the effects of the various stressors on ESA-listed or proposed species and designated critical habitat in the context of these conservation measures, including the degree to which we anticipate the mitigation measures will reduce or in some cases eliminate potential adverse effects. When supported by the available data, we quantitatively consider the proposed conservation measures when estimating the exposure of ESA-listed species and designated critical habitat to the stressors created by the proposed action. However, in many cases we are only able to qualitatively evaluate the effectiveness of the proposed measures due to the paucity of data on their effectiveness or because such quantitative consideration is not warranted.

The conservation measures that we anticipate would either minimize adverse effects of the proposed action on ESA-listed species or could be used to monitor such effects are summarized in Table 44 below. For each measure we (1) identify the stressor(s) or activity from which impacts would be minimized, (2) briefly describe the measure and how we anticipate adverse effects would be reduced, (3) provide the ESA-listed species affected by the conservation measure, (4) indicate whether the measure is designed to monitor or mitigate potential adverse effects, and for mitigation how the measure was incorporated into our effects analyses (i.e., either quantitatively or qualitatively), and (5) provide references (either to sections within this opinion or other source documents) for more detailed information about each conservation measure.

Table 44. Conservation measures expected to either minimize adverse effects of the proposed action on ESA-listed species or that could be used to monitor such effects.

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
BOEM use of NAAQS under OCSLA	OCSLA mandates that DOI prescribe regulations providing for compliance with the NAAQS established pursuant to the CAA, to the extent that the OCS oil and gas activities authorized under OCSLA significantly affect the air quality of any state (43 USC §1334(a)(8); see also 30 CFR §550). All new or supplemental EPs and DOCDs, and revised DOCDs must include air emissions information sufficient to determine whether an air quality review is required (30 CFR §550.218 and §550.249).	Air emissions west of 87.5˚W longitude	sperm whale, sea turtles	Section 3.2.2
USEPA use of NAAQS under CAA	The USEPA has set NAAQS for six principal pollutants called “criteria” pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, particle pollution (listed as PM2.5 and PM10), and sulfur dioxide.	Air emissions east of 87.5˚W longitude	Bryde’s whale, sperm whale, sea turtles	Section 3.2.2

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
USEPA Water Quality Standards	Section 301(a) of the CWA, 33 USC §1311(a), makes it unlawful for any person to discharge any pollutant, except in compliance with other CWA provisions that may apply, including compliance with an NPDES permit. NPDES permits must include effluent limitations for authorized discharges that: (1) reflect pollutant reductions achievable through statutorily-specified levels of technology, (2) comply with applicable USEPA-approved state water quality standards, (3) comply with other state requirements adopted under authority retained by states under CWA section 510, 33 USC Section 1370, and (4) are evaluated to determine the degree of degradation to the territorial seas, waters of the contiguous zone, or the oceans. Water-quality based whole effluent toxicity limits are included to ensure certain discharges do not cause unreasonable degradation of the marine environment.	Water discharges	All	Section 3.2.1
BOEM/BSEE Protected Species Stipulations	Applied after a lease sale occurs and is issued for any lease block sold. Lessee and operator requirements include flotsam removal, posting signs regarding marine debris, vessel speed and distance protocols when marine mammals and sea turtles are observed, seismic survey mitigation measures including use of an exclusion zone, addressing important habitats in oil spill contingency plans, and immediate reporting of stranded animals.	Marine debris, vessel strike, vessel sound, seismic survey sound, oil spills	Bryde's whale, sperm whale, sea turtles, and Gulf sturgeon (oil spills only)	Section 3.1.6.1

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
BOEM NTL No. 2016-G01 Vessel Strike Avoidance and Injured/Dead Protected Species Reporting	Guidelines on how to implement monitoring programs to minimize the risk of vessel strikes to protected species and report observations of injured or dead protected species	Vessel strike	Bryde's whale, sperm whale, sea turtles	BOEM NTL web page[50]
BOEM NTL No. 2016-G02 Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program	Clarifies how to implement seismic survey mitigation measures, including ramp-up procedures, the use of a minimum sound source, airgun testing and protected species observation and reporting. Updates regulatory citations and addresses and provides clarification on how measures identified in this NTL will be implemented to assist BOEM, BSEE, and operators in complying with the ESA and MMPA	Seismic survey sound	Bryde's whale, sperm whale, sea turtles	BOEM NTL web page
Mitigations applied under the NMFS Permits and Conservation Division's MMPA rule	Measures to minimize adverse effects to marine mammals include the following: time-area restrictions on airgun surveys for coastal areas, Bryde's whale areas, and the Dry Tortugas; Passive Acoustic Monitoring (PAM) requirements; visual monitoring requirements involving PSOs; monitoring zone specifications; ramp-up requirements for airgun surveys; specified exclusions zones; and shutdown and power-down requirements	Seismic survey sound	Bryde's whale, sperm whale, sea turtles	Section 3.3

[50] BOEM Active Notices to Lessees and Operators https://www.boem.gov/Notices-to-Lessees-and-Operators/

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
BSEE NTL 2018-G03 Decommissioning Guidance for Wells and Platforms	Describes regulations for explosive removal of structures. All explosives use will require NMFS PSOs from the Platform Removal Observer Program. These requirements necessitate different levels of mitigation, monitoring, and reporting for protected species based on the charge size, water depth (species delineations), and use above or below the sea floor. The use of PAM technicians is required when using explosives in water depths less than 200 meters in order to monitor for vocalizations of deep-diving marine mammals.	Explosives used for structural severance	Sea turtles	BSEE NTL web page[51]
BOEM mitigation measures for the risk of entanglement in seismic survey equipment	BOEM has implemented mitigation measures through their permits (as conditions of approval) to reduce the possibility of entanglement in seismic survey equipment. The measures include the use of stiff non-buoyant lines, immediate retrieval of lines following survey completion, and having protected species observers on node retrieval vessels to watch for signs of entanglement. BOEM and BSEE reserve the right to site visit to ensure compliance with all mitigations.	Entanglement in seismic survey equipment	Bryde's whale, sperm whale, sea turtles, manta rays and oceanic whitetip sharks	Section 3.1.3.2

[51] BSEE Notice To Lessees https://www.bsee.gov/guidance-and-regulations/guidance/notice-to-lessees

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
BOEM Effects Avoidance or Minimization Measures for Site Clearance Trawling Requirements under 30 CFR §§ 250.1740-1743	To minimize the effect on sea turtles that may be incidentally captured, BOEM requires a minimum trawl net bag/cod end mesh size (four inches) and a maximum trawl time of 30 minutes. Captured turtles must be resuscitated and released following the requirements for shrimp trawlers in the Gulf of Mexico	Entanglement during site clearance trawling	Sea turtles	Section 3.1.6.6
BSEE NTL 1998-G26 Minimum Interim Requirements for Site Clearance (and Verification) of Abandoned Oil and Gas Structures in the Gulf of Mexico	NTL based on regulations for specific trawling requirements designed to facilitate the removal of any small objects or obstructions (e.g., tools, containers, batteries) that may have been lost or discarded during the operational life of the structure	Marine debris	Bryde's whale, sperm whale, sea turtles	BSEE NTL web page
BSEE NTL No. 2015-G03 Marine Trash and Debris Awareness and Elimination	Provides information on the Offshore Operators Committee (OOC) marine trash and debris awareness training video and slide show.	Marine debris	Bryde's whale, sperm whale, sea turtles	BSEE NTL web page
USCG and USEPA marine trash and debris regulations	USCG regulations to conform with the adopted International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V (Garbage). Under this rule, the only allowed discharges are certain food wastes, cargo residues, cleaning agents and additives in wash waters, and animal carcasses. Additional USCG and USEPA regulations require that operators become more proactive in avoiding accidental loss of solid-waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste.	Marine debris	Bryde's whale, sperm whale, sea turtles	USCG 2013 Interim Rule 78 FR 13481

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
Marine Plastic Pollution Research and Control Act (MPPRCA) and the Marine Debris Research, Prevention, and Reduction Act (MDRPRA)	The MPPRCA requires USEPA and NOAA to study the effects of improper disposal of plastics on the environment and methods to reduce or eliminate such adverse effects. MPPRCA also requires EPA, NOAA, and the USCG to evaluate the use of volunteer groups in monitoring floatable debris. The MDRPRA established programs within NOAA and the USCG identify, determine sources of, assess, reduce, and prevent marine debris.	Marine debris	Bryde's whale, sperm whale, sea turtles	MPPRCA H.R.4668 — 103rd Congress (1993-1994) MDRPRA S. 362 — 109th Congress (2005-2006)
BSEE NTL 2012-N06 Guidance to Owners and Operators of Offshore Facilities Seaward of the Coast Line Concerning Regional Oil Spill Response Plans	Provides clarification, guidance, and information concerning the preparation and submittal of a regional OSRP for owners and operators of oil handling, storage, or transportation facilities, including pipelines. Some of the clarifications and encouraged practices based on lessons learned from the DWH oil spill response	Oil spills	All	BSEE NTL web page
BSEE NTL 2010-N10 Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources	Requires submittal of a signed statement with each application for a well permit stating that the operator will conduct all authorized activities in compliance with all applicable regulations, including the increased safety measures regulations	Oil spills	All	BSEE NTL web page
BSEE NTL 2016-N01 Incident of Noncompliance Response System	BSEE will conduct onsite inspections to assure compliance with the OCSLA, lease terms, rights-of-way, approved plans, and other applicable laws and regulations, including those associated with safety and protection of the environment	Oil spills	All	BSEE NTL web page

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
BSEE NTL 2015-N06 Clarification of Cementing Requirements Following Indications or Identification of an Inadequate Cement Job	Provides guidance and clarification of the regulations related to cementing requirements and the steps necessary to address indications or identification of an inadequate cement job	Oil spills	All	BSEE NTL web page
BSEE NTL 2015-G02 Hurricane and Tropical Storm Effects Reports	Provides guidance on reporting hurricane and tropical storm effects and includes an oil spill pollution report. BSEE uses the data from the pollution report to identify environmental and man-made assets at risk and provide background data for natural resource damage assessments	Oil spills	All	BSEE NTL web page
BSEE NTL 2012-N07 (and 2014-N03) Oil Discharge Written Follow-up Reports	Provides clarification about the type of information required for compliance with report requirements in 30 CFR 254.46(b)(2). Under this regulation for all oil discharges of one barrel or more a written follow-up report must be submitted to BSEE within 15 calendar days after the spillage has been stopped or has ceased	Oil spills	All	BSEE NTL web page
BOEMRE Safety and Environmental Management System (SEMS) Rule (30 CFR §250, Subpart S)	Establishes a holistic, performance-based management tool that requires offshore operators to establish and implement programs and systems to identify potential safety and environmental hazards when they drill; clear protocols for addressing those hazards; and strong procedures and risk-reduction strategies for all phases of activity, from well design and construction to operation, maintenance, and decommissioning.	Oil spills	All	Sections 3.1.5.1 and 3.1.5.2
BSEE's Final Drilling Safety Rule (77 FR 50855 and 81 FR 61834)	Intended to decrease the likelihood of another extremely large spill by increasing effective measures for spill prevention, and ensuring timely containment should such a spill occur.	Oil spills	All	Sections 3.1.5.1 and 3.1.5.2

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
Oil and Gas and Sulphur Operations on the Outer Continental Shelf—Increased Safety Measures for Energy Development on the Outer Continental Shelf (77 FR 50856, August 22, 2012)	Implements safety measures for energy development on the OCS. Includes amending regulations regarding drilling, well-completion, well-workover, and decommissioning regulations related to well-control, including: subsea and surface blowout preventers, well casing and cementing, secondary intervention, unplanned disconnects, recordkeeping, and well plugging.	Oil spills	All	77 FR 50856, August 22, 2012
BSEE NTL 2013-N02 Significant Change to Oil Spill Response Plan Worst Case Discharge Scenario	Intended for owners or operators of oil handling, storage, or transportation facilities located seaward of the coast line. Clarifies what BSEE considers a significant change in an OSRP worst case discharge (WCD) scenario that requires submittal of a revised OSRP for BSEE approval	Oil spills	All	BSEE NTL web page
USEPA proposed amendments to Subpart J of the National Contingency Plan on the use of oil spill dispersants	Proposed changes would help to ensure that chemical and biological agents have met efficacy and toxicity requirements, and that product manufacturers provide important use and safety information. Further, this would equip the planning and response community with the proper information to authorize and use products judiciously to effectively mitigate health and environmental effects from oil discharges.	Oil spill response	All	80 FR 3379, January 22, 2015

Conservation Measure	Description	Stressor(s) and/or Activities Affected	ESA Listed Species Affected	For more information refer to:
Information Requirements for EPs, DPPs, and DOCDs on the OCS: specified in 30 CFR §550.211 through 550.228 and explained in BOEM NTL 2008-G04 Shallow Hazards Program, and BOEM NTL 2009-G27 Submitting Exploration Plans and Development Operations, and BSEE NTL 2010-N06	Guidance on information requirements for various stages of the OCS oil and gas program	General oil and gas exploration, development, and transportation activities	All	BSEE NTL web page BOEM NTL web page
BSEE NTL 2009-G39 Biologically-Sensitive Underwater Features and Areas	Provides for the avoidance and protection of biologically sensitive features and areas (i.e., topographic features, pinnacles, live bottoms, and other potentially sensitive biological features) when conducting OCS operations in water depths less than 300 meters in the GOM	General oil and gas exploration, development, and transportation activities	General habitat benefits for ESA listed Species	BSEE NTL web page
BOEM/BSEE NTL 2014-G02 Designation of Operator of an OCS Oil and Gas or Sulphur Lease	When an operator is designated, they become responsible for all wells that have a bottom hole located within the lease	General oil and gas exploration and development activities	All	BOEM NTL web page
Authorization requirements for in-situ burning of an oil spill	Burning agent use is authorized on a case-by-case basis by concurrence of the USCG on-scene coordinator, Regional Response Team, and Natural Resource Trustees	Oil spill response	All	

8.4 Effects of Vessel Strikes

The large extent of vessel operations associated with the proposed action and two confirmed strikes of whales over the last twenty years raises concerns regarding the potential for vessel strikes of ESA-listed species over the 50 year time period analyzed in this opinion. There is a large shore-based infrastructure to support oil and gas operations in the Gulf of Mexico (Figure 55). It is estimated that there are over 150 different boat owners operating over 850 oil and gas service vessels in the Gulf of Mexico. Larger and faster vessels service the increasing amount of oil and gas activity occurring in deeper waters.

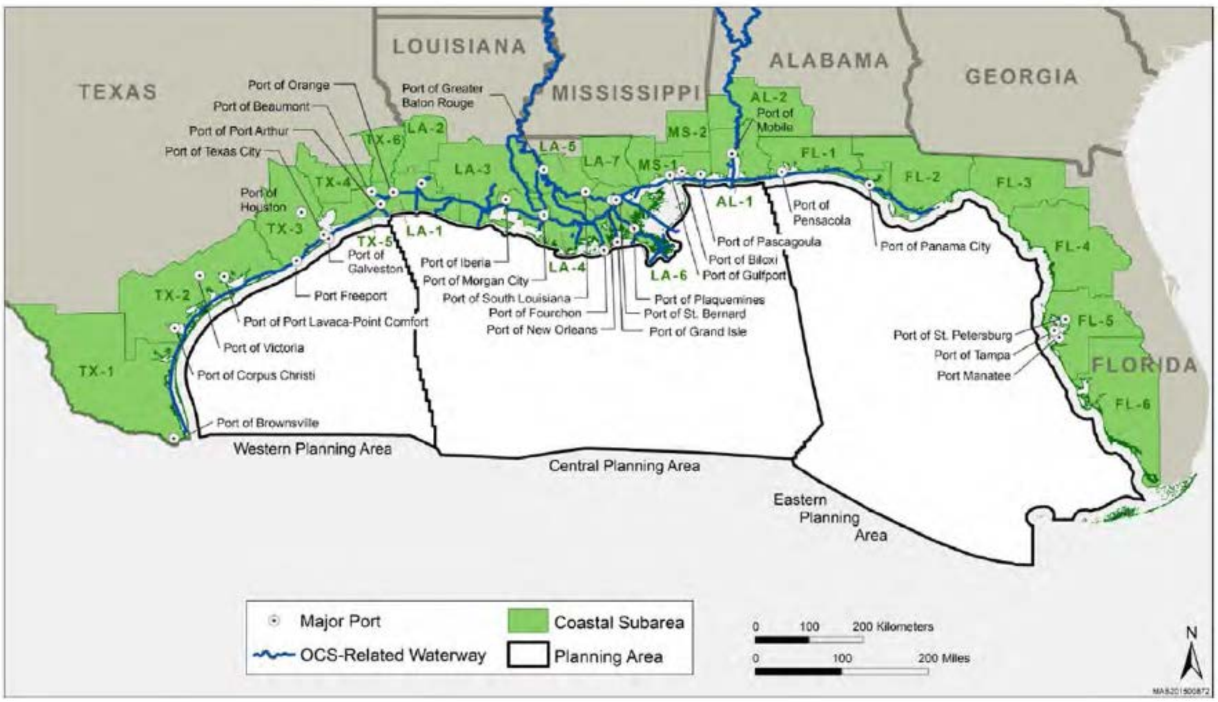


Figure 55. Locations of shore bases (ports) that provide support through vessel services to offshore oil and gas operations.

In addition to potentially disturbing ESA-listed species, vessel traffic associated with the proposed action poses a risk of collision or vessel strike to ESA-listed species that may be found in surface waters. Vessel strikes are known to adversely affect ESA-listed sea turtles, fishes, and marine mammals (Brown and Murphy 2010; Laist et al. 2001; NMFS and USFWS 2008; Work et al. 2010). The probability of a vessel collision depends on the number, size, and speed of vessels, as well as the distribution, abundance, and behavior of the species (Conn and Silber 2013; Hazel et al. 2007; Jensen and Silber 2004; Laist et al. 2001; Vanderlaan and Taggart 2007). If an animal is struck by a vessel, it may experience no injuries, minor non-serious injuries, serious injuries, or death. In most cases, serious injuries are often assumed to result in death given the severity of the wounds and that animals are not adequately monitored to confirm they survived following such events (e.g. Vanderlaan and Taggart 2007a).

In this section, we first evaluate the level of vessel activity and the characteristics of those vessels (e.g., size, speed, etc.) as they relate to the risk of vessel strike to ESA-listed species. Then, by species or species group, we estimate the number of individuals likely to be struck by vessels associated with the proposed action and detail the likely responses. Finally, we provide a brief summary of the overall vessel strike effects analysis. In the *Integration and Synthesis* (Section 11), we then combine information on the likely exposure and responses to evaluate the risk vessel strikes from the proposed action pose to individuals and the populations to which those individuals belong.

Our last analysis of the effects of vessel strikes on sea turtles and sperm whales for the Gulf of Mexico Oil and Gas Program was completed in 2007. That analysis used round trip distances to estimate encounters with listed species. The analysis in this Opinion uses additional information about vessel routes, locations, and speeds to produce more realistic estimates of exposure to vessel traffic. In the last five year species review, vessel strikes were identified as an emerging threat for Gulf sturgeon. Additionally, the Bryde's whale status review and final listing noted that vessel strikes are a threat to Gulf of Mexico Bryde's whales.

In the status reviews used for listing, vessel strike was not identified as a threat for oceanic whitetip shark, but was identified as a low risk threat to giant manta ray. Both of these species occur in the action area and are included in this analysis.

This opinion considers information we have synthesized including strandings data, reported occurrences of vessel injury in live animals, new species' densities, different vessel activity levels and information, different areas of operation, and a longer duration of the proposed action to include more years of Oil and Gas Program activities. The incorporation of this information allows a more thorough analysis of the effects of vessel strikes on listed species in the action area. As such, our effects analysis may not produce the same results as our 2007 analysis.

8.4.1 Vessel Activity Associated with the Proposed Action

In this section we summarize information on the level of vessel traffic associated with the proposed action. In doing so, we evaluate data provided by BOEM as well as additional data that may provide a more accurate representation of vessel activity as it relates to vessel strike risk for certain ESA-listed species. We also consider the characteristics of the estimated vessel activity (e.g. speed, location, etc.) in order to determine the exposure of ESA-listed species to vessel traffic that may result in vessel strikes and the responses (i.e., consequences) associated with those vessel strikes.

BOEM provided vessel traffic data as vessel "trips," which are defined as a vessel leaving port and returning to port. Given this, these data provide a measure of vessel activity near ports. However, estimates of vessel trips are a rather coarse estimate of vessel traffic, especially as it relates to vessel traffic further offshore. For example, a vessel may leave a port, travel 1.5 km and return, while another may leave a port, travel 100 km and return. While both of these would be considered a single trip, clearly the later vessel covered more ground and as such, may pose a greater risk to ESA-listed species in terms of vessel strikes. For any given trip, there could be a wide range of movements, with some being relatively short trips (both in time and distance) and others being much longer and further offshore.

Therefore, for determining exposure (i.e., co-occurrence of vessels and animals) to vessel traffic of whales and sea turtles, we supplemented the data provided to us by BOEM with Automatic Identification System (AIS) vessel traffic data to quantify exposure for sea turtles and whales. These data provide vessel traffic information at a finer temporal and spatial resolution than the BOEM data, which uses vessel trips based on port calls as discussed above. The AIS data provides information not only on trips, but also provides information about the routes taken by tracked ships, the distances traveled, and their speeds. Combined with information on the number of trips, this allowed us to produce more realistic estimates of exposure of ESA-listed species to vessel traffic. The AIS data also allowed us to estimate the percent Oil and Gas Program vessel traffic makes up of all vessel traffic in a spatially explicit manner, which is particularly relevant for examining exposure of ESA-listed species that show clear heterogeneity in their spatial distribution (see Section 9.1.3). Based on AIS data, Oil and Gas Program vessel traffic as identified by BOEM and BSEE (as measured by distance traveled) makes up approximately 43 percent of the vessel traffic in the Gulf of Mexico (see Table 46, below) versus 9.23 percent from the BOEM data. We utilized these AIS vessel traffic data to quantify exposure for sea turtles and whales. However, since trips are measured by port calls nearshore, we relied on the number of vessel trips estimated by BOEM to estimate exposure of Gulf sturgeon, as it is more appropriate based on distribution of the species near ports and shallow navigation channels expected to be the areas of highest risk for vessel interaction with this benthic-dwelling species. Below we summarize the vessel trip and AIS data used in our exposure analysis. For oceanic whitetip sharks and giant manta rays, vessel traffic data were not necessary to perform our effects analysis.

Vessel Trip Information

In estimating vessel trips associated with its Oil and Gas Program, BOEM identified four main categories of vessels. These include service vessels, barges, tankers and G&G survey vessels (BOEM 2017b). These vessel types differ in their function, and in the risk that they pose to ESA-listed species as it pertains to vessel strikes. For example, barges are not self-propelled and as such, require tug boats which typically limits their use to shallow water where ESA-listed whales are unlikely to be found. Furthermore, G&G survey vessels, when actively conducting surveys, travel relatively slowly in many cases (e.g., seismic airgun surveys typically travel less than five knots when surveying), and as such are less likely to strike some ESA-listed species.

Based on BOEM (2017b), there are expected to be an estimated 43,000-541,000 service vessel trips per lease sale for a 50 year period, or 860-10,820 trips annually. When comparing this annual estimate to an estimate of total Gulf of Mexico vessel traffic from 2012, BOEM estimates that Oil and Gas service vessel traffic constitutes between six and nine percent of the total vessel traffic in the Gulf of Mexico (BOEM 2017b).

For barges, BOEM does not provide an estimate of the number of vessel trips nor the relative amount they make up of the greater Gulf of Mexico vessel traffic. However, based on current data and historical trends, BOEM estimates that barging is expected to account for less than one percent of oil transported as part of the proposed action, indicating that it likely does not significantly contribute to overall vessel traffic within the Gulf of Mexico.

Shuttle tankers are used in association with FPSOs and only two are currently in operation, both of which are located in the CPA. Based on BOEM's cumulative scenarios for the next 70 years, 5-14 FPSOs could be installed regionwide, with a maximum of two per decade BOEM (2017b). Zero to five systems are estimated within the WPA and five to nine additional FPSOs are estimated for the CPA/EPA. Calculating the average annual projections for each of the planning areas, and multiplying by 50 years (the duration considered in this opinion), indicates that between 0-4 and between 4-7 FPSOs are projected to be installed in the WPA and CPA/EPA respectively over the next 50 years (conservatively, rounded up).

To estimate the number of shuttle tanker vessel trips associated with these FPSOs, we assumed a maximum installation of two FPSOs per decade across planning areas, with one FPSO installed per planning area (i.e., one every five years, alternating planning areas) until the maximum projected FPSO installations for that planning area was reached. Following this, and considering the two FPSOs currently in operation in the CPA, we multiplied the estimated maximum 110 shuttle tanker trips annually per FPSO provided by BOEM (2017b) by the number of active FPSOs within any given year. In doing so, we assume all FPSOs remain operational for the duration considered in this opinion (i.e., none are decommissioned). For example, for year one, two FPSOs were in operation in the CPA/EPA, producing 110 shuttle trips each per year. This persists until year five when another FPSO is assumed to be installed (in CPA/EPA first, given higher projections for these planning areas) making the total 3 FSPOs in the CPA/EPA producing 110 shuttle trips each per year. Carrying this process forward, annual total shuttle tanker trips range from 220 to 1,320 (average 737) over the course of the next 50 years. By planning area, for the WPA the estimated annual shuttle tanker trips range from 0 to 440 (average 229) and for the CPA/EPA the estimated annual shuttle tanker trips range from 220 to 880 (average 509). Comparing these estimates to the estimate of total Gulf of Mexico vessel traffic for 2012 that BOEM relied on (875,000 vessel trips, as provided in BOEM (2017b)), indicates that over the course of the proposed action the total shuttle tanker traffic represents between 0.03 and 0.15 percent of the total vessel trips in the Gulf of Mexico annually.

G&G activities involve the use of both G&G survey vessels as well as service vessels. BOEM estimates that in total, G&G survey vessels will make 993 trips to shore and G&G services vessels will make 19,689 trips to shore over a 10 year period (Section 3.1.4). While BOEM assumed its estimates for service vessels more generally (as detailed above) encompass G&G service vessels, they do not appear to be explicitly accounted for in evaluating categories of service vessels to derive overall service vessel activity level estimates BOEM (2017b). Based on BOEM's 10 year estimates given above, G&G survey vessels would involve approximately 99 vessel trips annually, and G&G service vessels would involve approximately 1,969 vessel trips annually. This represents approximately 0.01 and 0.23 percent of the total Gulf of Mexico vessel trips respectively (based on the 2012 total vessel traffic estimate used in BOEM (2017b).

Combining the various categories of vessels and the estimates of vessel trips level above, which are all based on projections provided by BOEM, we estimate that on average, the proposed action would involve a maximum of 173,002 vessel trips annually, which represent approximately 20 percent (19.77 percent) of the total number of vessel trips in the Gulf of Mexico when compared to the 2012 overall Gulf of Mexico vessel traffic BOEM relied on of 875,000 trips (Table 45).

Table 45. BOEM-projected number of Oil and Gas Program-related vessel trips in the Gulf of Mexico relative to the total number vessel trips overall.

Vessel Category	Maximum Estimated Annual Trips	Percent of Total Gulf of Mexico Traffic (based on 2012 data)
Service Vessels*	169,614	19.38%
Barges	Not Available	Assumed insignificant
Tankers	1,320	0.15%
G&G Survey Vessels**	99	0.01%
G&G Service Vessels**	1,969	0.23%
Total	173,002	19.77%

**Source data: Page 3-164 from BOEM 2017-2022 Multisale PEIS Cumulative scenario for service vessels.*
***Source data: Table 3.2-6 from BOEM 2017 G&G PEIS.*

This estimate of 19.77 percent is based on BOEM's vessel activity level projections and an estimated total vessel trips of 875,000 in the Gulf of Mexico as cited from BOEM (2017b) using 2012 data from the U.S. Army Corps of Engineers. However, while BOEM uses 875,000 as the total estimate of vessel trips for 2012, summing the number of vessel trips in Table 3-7 of BOEM (2017b) results in 1,099,075 total vessel trips in the Gulf of Mexico in 2012. Using this higher estimate results in a maximum estimate of 15.74 percent of vessel trips in the Gulf of Mexico being associated with the proposed action. Furthermore, a comparison to a larger data set from the U.S. Army Corps of Engineers from 2000-2016[52] (17 years of data) on vessel trips associated with the same waterways as used in Table 3-7 of BOEM (2017b) provides an average of approximately 1,874,128 annual vessel trips in the Gulf of Mexico. Relying on this annual average estimated over 17 years results in a maximum estimate of 9.23 percent of vessel traffic in the Gulf of Mexico being associated with the proposed action. While this is significantly lower than the maximum 19 percent estimated by BOEM (2017b) for service vessels alone, it does lie within the interval BOEM estimated between six and 19 percent and is what we used for our vessel strike analysis for Gulf sturgeon.

[52] U.S. Army Corp of Engineers Ports and Waterways page: http://cwbi-ndc-nav.s3-website-us-east-1.amazonaws.com/files/wcsc/webpub/#/

Automatic Identification System[53] *Vessel Data*

As discussed above, vessel trip data have limitations for examining exposure of ESA-listed species that may be found further offshore, away from ports, as vessel trips data are entirely based on port calls and provide no information on the distance traveled for each trip. To estimate exposure of sea turtles and whales to vessel traffic, we analyzed four years (2015-2018) AIS data collected by the USCG Nationwide Automatic Identification System (NAIS).

For the exposure analyses, it was first necessary to identify those vessels within the AIS database that are associated with the Oil and Gas Program. While vessel type is provided as part of *class 5* AIS messages, the vessel type detail contained in AIS data is not sufficient to adequately characterize vessels as being associated with Oil and Gas Program. As such, we used vessel identifiers in the *class 5* AIS messages to link the AIS data to a database containing the Information Handling Services (IHS) Maritime World Register of Ships[54]. The IHS database houses an extensive amount of vessel-related data, including detailed vessel types, world merchant fleet of vessels with gross tonnage values of 100 or above. With input from BOEM and BSEE, vessel types associated with the Oil and Gas program were identified from the set of vessel types contained in the IHS database (**Appendix F**). Using these selected vessel types, we were able to quantify the historic vessel traffic associated with the Oil and Gas program, as well as other vessel traffic in the Gulf of Mexico more broadly, following the process detailed below.

AIS data that could link to the IHS database were filtered to remove records with suspect speed values (e.g., a vessel at anchor may read zero knots, or some aircraft carry AIS and could cause values greater than 50 knots) and then aggregated into transits based on their timestamps. When the time elapsed between successive AIS records for a given vessel was less than two hours, they were considered part of the same transit. When the spatially-computed distance (geodesic distance between the two point locations) between adjacent records in a vessel transit were found to differ significantly from the distance calculated by multiplying the speed by the time elapsed between the two records (speed-time distance), the transit was flagged and removed from the analyses. We then generated a 10 x 10 kilometer fishnet grid covering the action area. The selected spatial resolution for the fishnet grid was selected to correspond with the spatial resolution of the cetacean density estimates produced by Roberts et al. (2016b). The vessel transits were then overlaid with the action area grid and a variety of vessel traffic metrics, aggregated by month, were calculated for each of the cells in the action area grid. These per grid metrics included vessel counts, transit counts, kilometers of travel, kilometers of travel travelled

[53] AIS is a maritime navigation safety communications system that collects information from shipboard broadcast systems that act like a transponder, operating in the VHF maritime band, that is capable of handling well over 4,500 reports per minute and updates as often as every two seconds (https://www.navcen.uscg.gov/?pageName=aismain). AIS are systems required by the USCG by any self-propelled vessel of 1600 or more gross tons and provide vessel information including vessel identity, type, position, course, speed, navigational status, and other data to shore-based facilities.

[54] https://ihsmarkit.com/products/maritime-world-ship-register.html

at speeds greater than 10 knots, operational hours, and average distance-weighted speeds. The above metrics were calculated using all vessels, as well as calculated using only the subset of vessels identified by BOEM and BSEE as being associated with the Oil and Gas program. For the purposes of estimating exposure of sea turtles and whales, we used the kilometers travelled metric (Figure 56 and Figure 57). To estimate vessel strikes of whales that are most likely to result in serious injury (based on the MMPA definition as any injury that will likely result in mortality, 50 CFR 229.2) or mortality (see further discussion below), we used the kilometers travelled at speeds greater than 10 knots metric.

Table 46. Summary of Vessel Traffic in Gulf of Mexico based on AIS data from 2015-2018.

Year	All Vessel Traffic (km)	Oil and Gas Vessel Traffic (km)	Oil and Gas Vessel Traffic Percent of All Vessel Traffic
2015	21,515,269	9,969,147	46%
2016	20,568,892	8,809,936	43%
2017	20,813,284	8,603,617	41%
2018	24,582,837	10,462,753	43%
Mean	21,870,071	9,461,363	43%

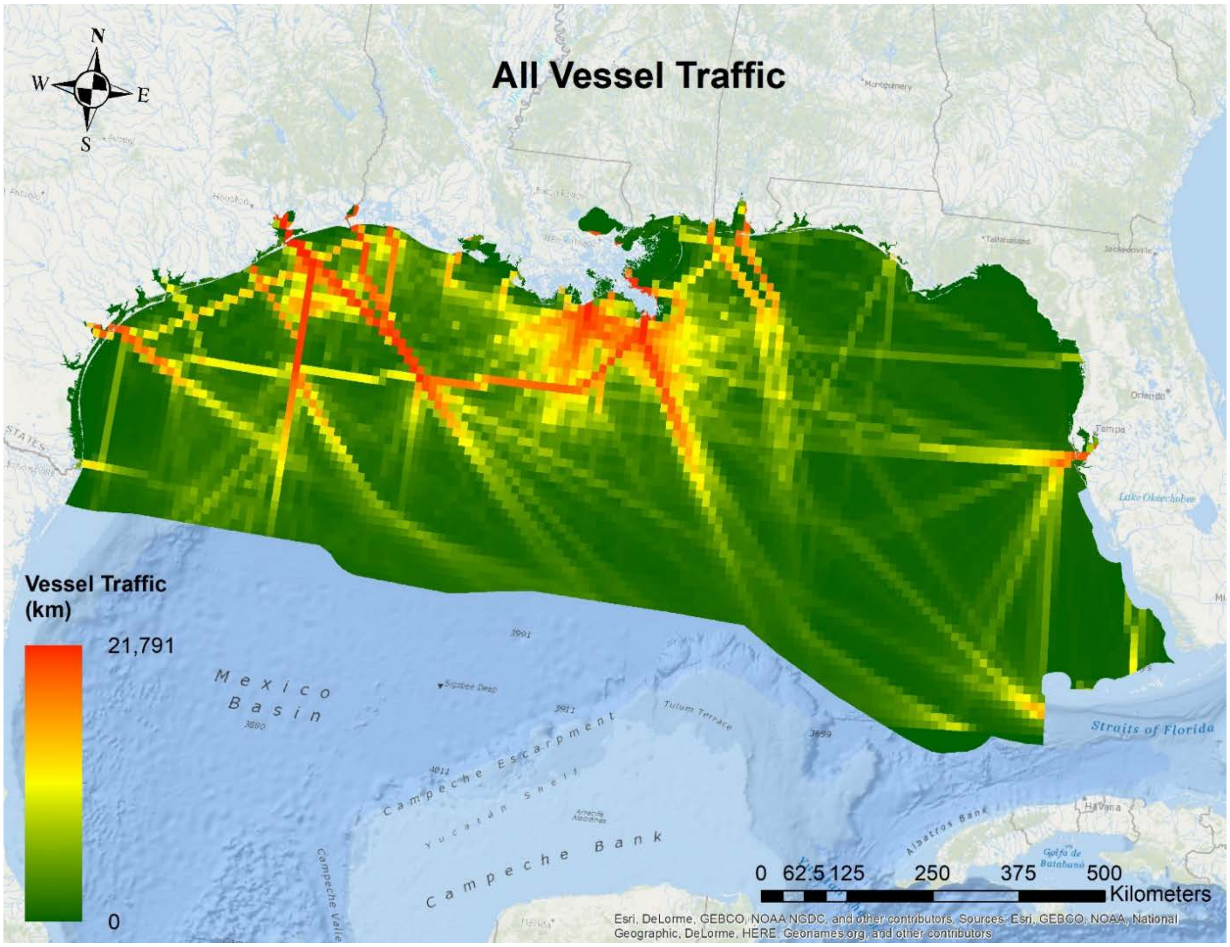


Figure 56. Vessel Traffic in the Gulf of Mexico. Data represent annual average kilometers (km) of vessel traffic from all vessels based on AIS data from 2014-2018.

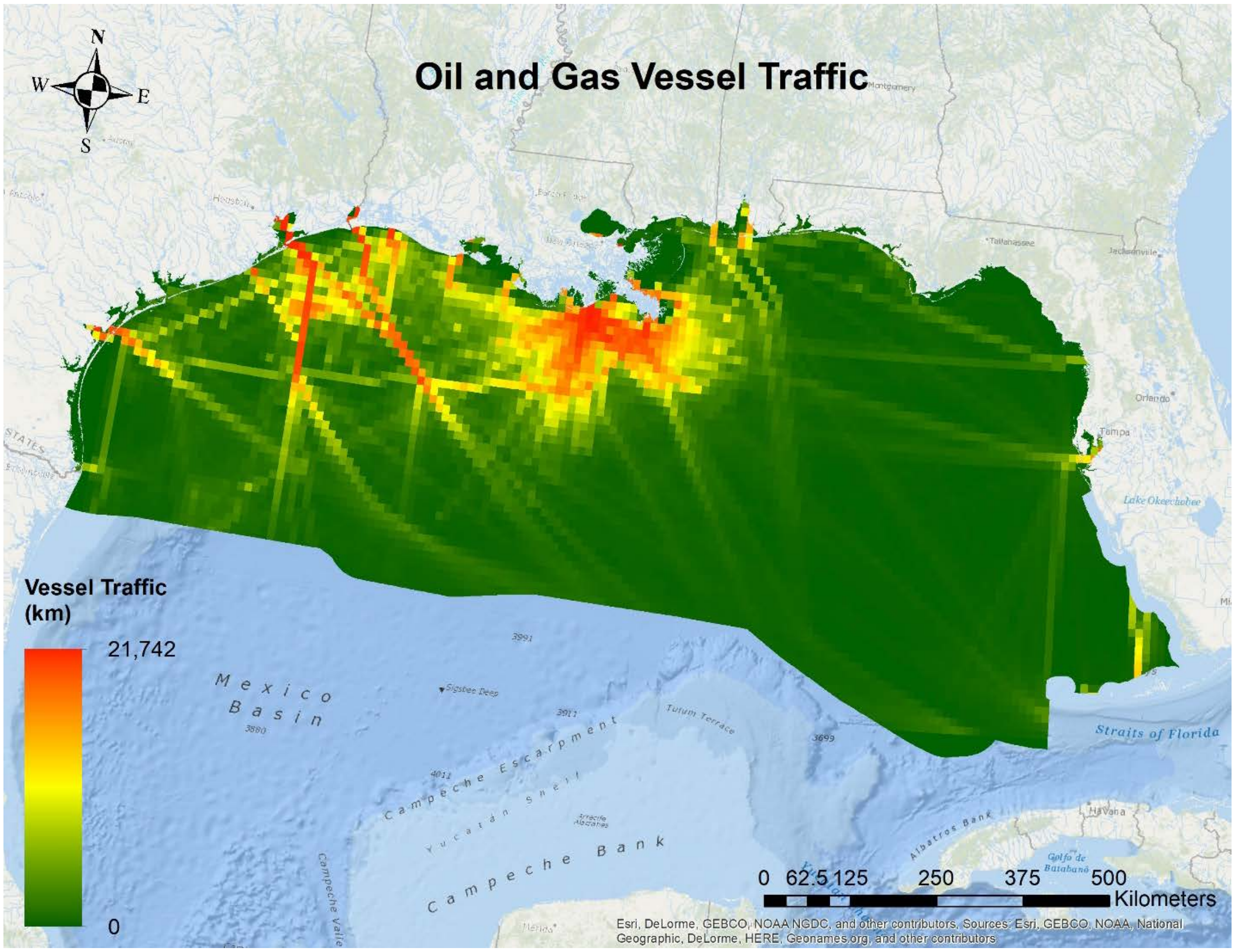


Figure 57. Oil and Gas Vessel Traffic in the Gulf of Mexico. Data represent annual average kilometers (km) of vessel traffic from oil and gas related vessels based on AIS data from 2014-2018.

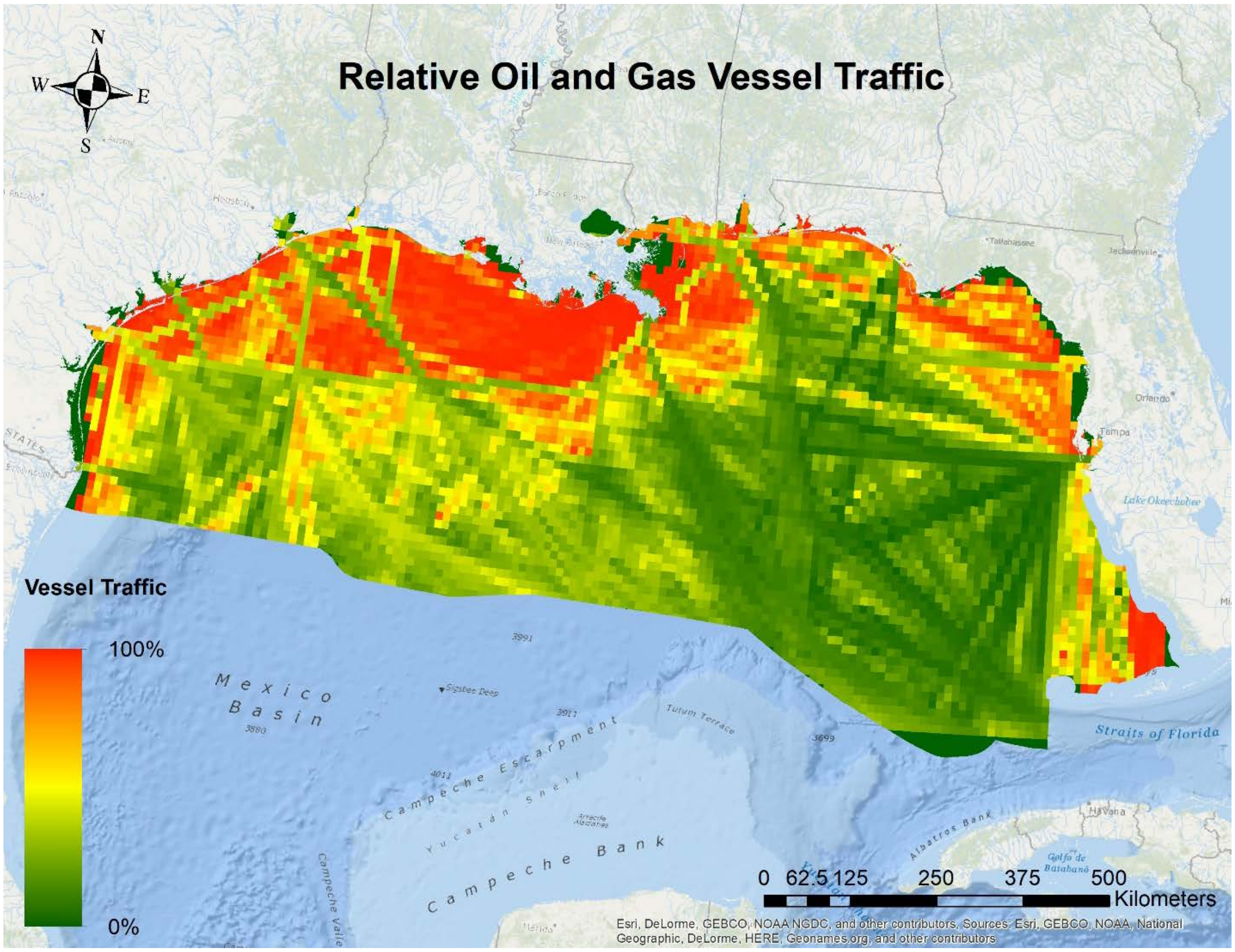


Figure 58. Relative Oil and Gas Vessel Traffic in the Gulf of Mexico. Data represent the percent oil and gas vessel traffic makes up of all vessel traffic in the Gulf of Mexico based on average kilometers (km) of vessel traffic from AIS data from 2014-2018.

Our exposure analysis has several important assumptions that deserve further consideration. First, it assumes that the AIS dataset we relied on (2014-2018) is representative of vessel traffic over the course of the next 50 years. Second, it assumes that our vessel strike rates calculated from data over a longer time period than the AIS data do not fluctuate significantly and are relatable to the vessel traffic data from 2014-2018. It is important to note that some of the identified categories in **Appendix F** may be multi-use vessels used only in part by the oil and gas program. Given the available data, it is not possible to parse out the vessel type for which activity they are supporting. This may mean that several of the categories are slightly overestimated for oil and gas, but we think that this is balanced out by the underestimations described both in Section 8.1.1, and in the following paragraphs. In regards to the first assumption, we currently have no information to suggest vessel traffic patterns will be significantly different in the future and our reliance on the maximum percent vessel strike risk to estimate exposure is conservative for the species. Furthermore, if vessel traffic does change significantly in ways that would alter vessel strike risk, this could reflect a change in the proposed action or its effects on listed species and may trigger reinitiation of consultation. Regarding the second assumption, if incidents of vessel strikes in strandings data increase beyond those estimated here, that could also constitute new information that could trigger reinitiation. In addition, if the strike rates we relied on were not relatable to the AIS vessel traffic data (i.e., if the vessel traffic represented in the AIS data pose less or greater risk of vessel strikes than is reflected in the strike rates calculated based on a longer time period), this should be evidenced in incidents of stranded animals with evidence of vessel strikes. Thus, despite these assumptions and the limitations of this analysis, we have determined that our above vessel strike exposure analysis presents the best available information on the number of ESA-listed species likely to be struck by vessels associated with the proposed action.

It is important to note that the above AIS dataset does not monitor/report all vessel traffic, both that associated with the Oil and Gas Program as well as vessel traffic in the Gulf of Mexico overall. This is not only because the data were limited to those vessels that match to the IHS register, but also because not all vessels carry AIS equipment. However, we assume that any underestimate of vessel traffic due to these factors is equally represented in all vessel traffic and that associated with the proposed action similarly. That is, despite the absolute metrics (e.g., kilometers of vessel traffic in Figure 56 and Figure 57) being an underestimate, the relative proportion of oil and gas vessel traffic compared to vessel traffic in the Gulf of Mexico overall is not expected to be biased (i.e., that displayed in Figure 58). Nonetheless, because for some vessel types, BOEM and BSEE were uncertain whether or not the majority of vessels of that particular type were associated with the Oil and Gas Program, and in these few cases, the vessels types were not included as part of those associated with the proposed action, the relative proportion of oil and gas related vessel traffic compared to overall vessel traffic in the Gulf of Mexico (i.e., that displayed in Figure 58) is the best estimate that can be produced given the available information.

8.4.2 Whales

The majority of vessel strikes of large whales worldwide occur when vessels are traveling at speeds greater than approximately 10 knots (Conn and Silber 2013a; Jensen and Silber 2004c; Laist et al. 2001; Vanderlaan and Taggart 2007a). If an animal is struck by a vessel, responses can include death, serious injury, minor injury, and no apparent effects, with the associated response depending on numerous factors, most notably the speed of the vessel (Conn and Silber 2013a; Jensen and Silber 2004c; Laist et al. 2001; Vanderlaan and Taggart 2007a). In general, the probability of a vessel collision and the associated response depends, in part, on the size and speed of the vessel. It is important to note that many strikes may occur and go unnoticed, while others may occur and subsequently not get reported. For example, we are aware of at least one unpublished report from a protected species observer on a seismic vessel that suggests that strikes from Oil and Gas related vessels could be occurring in the Gulf of Mexico (detailed below). Both Gulf of Mexico Bryde’s whales and sperm whales are vulnerable to vessel strikes in the Gulf of Mexico. Based on NMFS most recent stock assessment reports, there is at least one confirmed vessel strike related mortality of a Gulf of Mexico Bryde's whale, which occurred in 2009 (Figure 59).

Figure 59. Photograph[55] of Bryde's whale on bow of cargo ship.

For sperm whales, there are no known recent strikes in the Gulf of Mexico but historically there is one possible lethal strike, which occurred in 1990, and we are aware of the possibility of at least one non-lethal vessel strike of a sperm whale based on photographs of likely vessel strike wounds (see further discussion and photo below (ACCOBAMS 2005)). In addition, the U.S. Navy USS BUCKLEY reported striking a whale in the Gulf of Mexico (report to NMFS on June 25, 2001). Due to the location of the event and the presumed size of the animal struck, it was believed to have been a sperm whale, the fate of which was unknown.

The lack of response by sperm whales to oncoming vessels suggest the whales may not hear or see ships approaching, or the whales are habituated to the high level of vessel operations activity in the Gulf of Mexico. On September 6, 2013, a protected species observer on a seismic survey vessel reported seven sperm whales directly ahead of the vessel. After a shallow dive of several minutes, the whales resurfaced near the same position of their dive about 1,500 meters off the vessel's bow. The whales continued to log and blow at the surface as the vessel approached within 500 meters. The vessel shut down its airgun array, but the whales continued to log directly off the vessel's bow. The vessel took evasive action and made a hard turn to port to avoid striking the group of sperm whales. The avoidance maneuver was successful and a strike was avoided as the whales were subsequently sighted 40 meters off the starboard side of the vessel.

[55] Source: http://www.professionalmariner.com/October-November-2013/whale-zones/ accessed June 26, 2019.

However, photographic evidence taken during the close approach indicated a healed injury on one of the whales that could have been the result of a vessel strike (Figure 60).

Figure 60. Photograph from the Keathley Canyon Area of the Gulf of Mexico of a sperm whale with a healed wound likely caused by a vessel strike. (Photo credit: RPS)

As described above in the status of the species section (6.2.1), vessel collisions are a threat to whales. NMFS' final ESA-listing of Bryde's whale as endangered under the ESA states that vessel collisions are a significant source of mortality for a variety of large coastal whale species (Laist et al., 2001, as cited in 81 FR 88639). The northern Gulf of Mexico is an area with a considerably high level of ship traffic, which increases the risk of vessel-whale collisions (Rosel et al., 2016). Several important commercial shipping lanes travel through the primary Bryde's whale habitat in the northeastern Gulf of Mexico, particularly vessel traffic from ports in Mobile, Pensacola, Panama City, and Tampa (see Figure 17; Rosel et al., 2016).

Gulf of Mexico Bryde's whales may be at higher risk for strike because they spend much of their time at night on the surface. Constantine et al. (2015) studied another critically small and endangered population of Bryde's whales in Hauraki Gulf, New Zealand and determined that vessel strike was a substantial threat to that population especially at night when the whales spend an increased amount of time close to the water surface (seven tagged whales stayed within nine meters of the surface for 91 percent of the time (Constantine et al. 2013)) yet cannot be visually observed. Using photo identification over several years, this New Zealand population of whales was shown to have high site fidelity (Tezanos-Pinto et al. 2017), also similar to Gulf of Mexico Bryde's whales who are found primarily in an area in the northeastern Gulf of Mexico. The authors also noted that passive acoustic monitoring was likely not an effective real-time detection method given the scarcity of vocalization detections (Tezanos-Pinto et al. 2017).

Diving behavior was the focus of a study by Soldevilla et al. (2017) in which a Gulf of Mexico Bryde's whale was suction tagged with an acoustic and kinematic data-logger in 310 meter water depth. A diel dive pattern with deeper dives during the day and shallower dives at night was recorded. This whale spent 47 percent of its time during daylight hours and 88 percent of its time during nighttime hours within 15 meters of the surface, with 70 percent of total time within 15 meters of the surface. The amount of time Bryde's whales spend at or near the water surface makes them vulnerable to being stuck by vessels. Bryde's whales are often characterized by field biologists as displaying erratic and strange behavior compared to other baleen whales because they surface for irregularly spaced time intervals and can unexpectedly change directions.

Vessel traffic will be associated with all three phases of the Oil and Gas Program. While we do not expect a high number of seismic airgun surveys within BOEM's eastern planning area, there will be some level of activity to include faster-moving support vessels, so we consider vessel strike as part of all oil and gas-related activities. Additionally, geospatial distribution of shipping and commercial fisheries tends to be more in the northwestern part of the Gulf of Mexico, but there are several shipping lanes that cross through the Bryde's whale biologically important area and some of the vessel densities within those lanes are moderate (Soldevilla et al. 2017).

BOEM and BSEE currently require oil and gas operators to take evasive actions to avoid hitting any marine mammal and report any strikes that occur in the Gulf of Mexico NTL 2016-G01 as required by previous biological opinions. Operators are also required to maintain a vigilant watch for marine mammals and sea turtles to avoid collision, and to report any injured or dead protected species. BOEM has proposed to continue this NTL for all oil and gas operations in the Gulf of Mexico and as such, we consider this aspect of the proposed action in our analysis of the effects of vessel strikes on ESA-listed whales. However, to our knowledge there are no data on NTL effectiveness or compliance, and a lack of reported or observed ship strikes of whales by Oil and Gas related vessels cannot be interpreted to mean that no strikes have occurred. Thus, while BOEM has mitigation measures (i.e., vessel strike NTL) to reduce vessel strikes of ESA-listed whales, for all of these measures except one (see Bryde's whale vessel strike analysis below) we do not have sufficient information that would allow us to quantitatively incorporate their effectiveness at reducing the number or severity of vessel strikes of whales in our analysis. Nevertheless, we agree with BOEM that they are likely appropriate measures that should be continued to be taken (and revised as new information becomes available) to decrease the likelihood of vessel strikes of ESA-listed whales.

8.4.2.1 Exposure

To estimate the number of vessel strikes of Bryde's and sperm whales that will result from the Oil and Gas Program, we combined information on vessel traffic from the aforementioned AIS dataset with data on Bryde's and sperm whale distribution and density as described in Section 8.1.2 in order to quantify the co-occurrence of whales and vessels, hereafter referred to as *vessel strike risk*. By taking into account the speed of vessel traffic we quantified the total expected number of vessel strikes, as well as the number expected to result in mortality or serious injuries.

Below we detail this process specifically for each species, but in general, our analysis follows the following basic steps.

1. Calculate the amount of *oil and gas* related traffic and *all* vessel traffic (kilometers of vessel traffic) in 10 x 10 kilometer grid cells within the action area (see Figure 56 and Figure 57 above)
2. Calculate the predicted abundance of Bryde's and sperm whales within the same grid cells within the action area (based on density data described in 8.1.2).
3. Multiply the total kilometers of *all* vessel traffic and *oil and gas* vessel traffic in each grid cell by the species abundance separately in order to derive a metric that quantifies *vessel strike risk* (i.e., co-occurrence of vessel traffic and animals) of each species based on both types (*oil and gas* and *all*) of vessel traffic.
4. Sum *vessel strike risk* associated with *all* vessel traffic and *oil and gas* vessel traffic across all grid cells in the action area to provide Gulf-wide measures of *vessel strike risk.* Importantly, these measures of *vessel strike risk* are spatially explicit and take into account the amount of vessel traffic (*oil and gas* related or *all*) and its geographic distribution relative to the distribution and abundance of the species.
5. Estimate the relative proportion of *vessel strike risk* of each species associated with *oil and gas* vessel traffic by dividing the estimated *vessel strike risk* associated with *oil and gas* vessels by the *vessel strike risk* associated with *all* vessels.
6. Using data on stranded animals where the cause of death was likely a vessel strike (assumed to be from strikes that resulted in mortality or serious injury), information on carcass recovery rates, and information on the relative proportion of strikes likely to result in death compared to minor/no injuries, estimate incidents of historic vessel strikes of each species.
7. Estimate the proportion of historic incidents of vessel strikes associated with *oil and gas* vessel traffic by multiplying the relative proportion of *vessel strike risk* associated *oil and gas* vessel traffic by the estimated historic incidents of vessel strikes and assume these historic estimates are representative of what is likely to occur in the future under the proposed action.

As detailed below for each whale species, all steps of the analysis where carried out per month, per year, and summarized annually, and no rounding occurred until the final estimates were produced. However, in order to estimate exposure in a way that is conservative for the species, final annual estimates were based on years in which the *vessel strike risk* associated with the proposed action was highest.

Several lines of evidence indicate that vessel's traveling faster than approximately 10 knots have an increased likelihood of causing serious injury or mortality of large whales (Conn and Silber 2013b; Pace and Silber 2005b; Silber et al. 2010a; Vanderlaan and Taggart 2007a). Thus, when estimating the number of vessel strikes likely to result in serious injury or mortality of sperm and Bryde's whales, we focused on vessel traffic traveling at speeds greater than 10 knots. There is a probabilistic relationship between vessel speed and risk of serious injury or mortality, and several such probabilistic relationships have been estimated in the literature (Conn and Silber 2013b; Pace and Silber 2005b; Vanderlaan and Taggart 2007a). As such, in considering the speed of vessel traffic for our exposure analysis of vessel strikes likely to result in serious injury or mortality, we examined information on the incidents of vessel strikes that resulted in serious injury or mortality as a function of speed. From the data presented in Conn and Silber (2013b); Jensen and Silber (2004b); Pace and Silber (2005b); Van Waerbeek and Leaper (2008); Vanderlaan and Taggart (2007a), vessels traveling equal to or less than 10 knots appear to be capable of causing serious injury or mortality, but such events represent a very small proportion of the known incidences of lethal vessel strikes. These studies cited above suggest the use of a 10 knot threshold for estimating vessel strikes likely to result in serious injury or mortality of sperm and Bryde's whales is reasonable. Furthermore, in using a 10 knot cut off we assume that all vessel strikes occurring at speeds of 10 knots or greater are likely to result in serious injury or mortality, despite known incidents of vessel strikes of large whales at speeds greater than 10 knots that did not result in serious injury or mortality (e.g., see Figure 2 in (Vanderlaan and Taggart 2007a). As such, while the use of a greater than 10 knot cut off to estimate instances of vessel strikes that are likely to result in serious injury or mortality may underrepresent such events at speeds equal to and below 10 knots, it also over estimates such events at speeds greater than 10 knots. Given this balance, we determined that 10 knots was an appropriate cut off speed for estimating the risk of serious injury or mortality to sperm and Bryde's whales from vessel strikes that are reasonably certain to occur as a result of the proposed action.

When estimating the number of vessel strikes likely to result in minor or no injuries, we used vessel traffic of all speeds since the available data suggest that vessel strikes that result in minor or no injuries occur both above and below 10 knots at reasonable levels, though clearly as vessel speed increase the chances of these less severe effects diminish (Pace and Silber 2005b; Vanderlaan and Taggart 2007a). In addition, since stranding data primarily provide information on lethal vessel strikes, we relied on literature reports of the proportion of all documented vessel strikes where the fate of the animal was known that caused minor or no injuries. We relied on Laist et al. (2001), Van Waerbeek and Leaper (2008), Peel et al. (2018), and a database of global vessel strikes of cetaceans from the IWC (2010), which based on our review of the literature provides the best available information on the percent of vessel strikes likely to result in minor or no injuries. A summary of these data are presented in Table 47 below. Van Waerbeek and Leaper (2008) and the IWC database included a category of vessel strikes that resulted in "indeterminate visible injury", which could be serious injuries or minor injuries. To be conservative, we included these in our calculations of the percent strikes of known fate resulting in minor or no injury. While this may seem somewhat counterintuitive in that to be conservative one may want to assume these incidents resulted in serious injuries, because we are estimating the incidents of strikes that resulted in minor or no injury from already derived estimates of strikes that resulted in mortality, excluding these cases would in fact produce a lower estimate of the number of strikes that resulted in minor and no injury, and in turn, total vessel strikes. Based on the average of these data, we assume that approximately 19.67 percent of documented vessel strikes resulted in minor or no injuries, and as such, use this value in our analyses below.

Table 47. Summary of studies reporting the percent vessel strike resulting in minor or no injuries.

Source	Percent strikes of known fate resulting in minor or no injury	Author Description of Fate
Peel et al. 2018 (assumed large whales)	25.00%	unharmed
Laist et al. 2001 (large whales)	21.00%	Minor injuries or no apparent effect
Van Waerbeek and Leaper 2008 (includes all cetaceans)	17.51%	Apparently minor external injury, Indeterminate visible injury
IWC 2010 Database (mysticetes and large odontocetes only)	15.18%	Apparently minor external injury, Indeterminate visible injury
Mean	**19.67%**	

Sperm Whales

As described above, the first step of our exposure analysis for sperm whales was to calculate the kilometers of vessel traffic (for both *oil and gas* and *all* vessel traffic for all vessel speeds and traffic greater than 10 knots) and abundance of sperm whales in each grid cell in the action area. To do so, we relied on the AIS data described above (e.g., Figure 56 and Figure 57) and the density estimates described in Section 8.1.2. Next we multiplied the kilometers of vessel traffic in each cell (for *oil and gas* and *all* vessel traffic and for all vessel speeds and speeds greater than 10 knots) by the abundance of sperm whales in each grid cell to quantify *vessel strike risk*. To illustrate this process, in Figure 61 and Figure 62 below we depict the average *vessel strike risk* to sperm whales associated with *oil and gas* vessel traffic of all speeds, and *oil and gas* vessel traffic greater than 10 knots respectively. To aid in visual interpretation, these data were scaled from 0 to 100 percent based on dividing each cells risk by the maximum risk calculated in the dataset. Hence, relative risk visualized in the following figures represents a cell's risk relative to the cell with the highest risk.

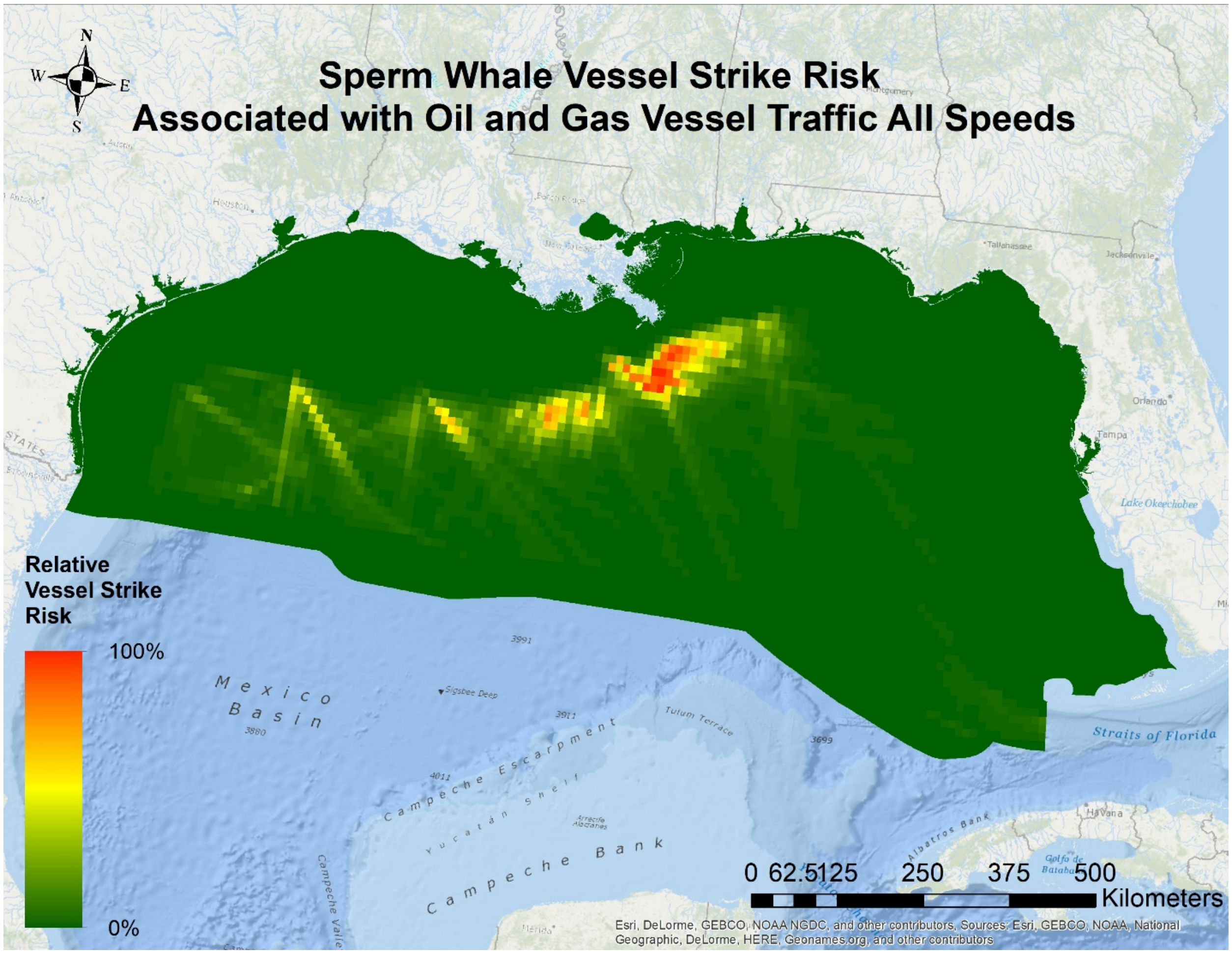


Figure 61. Relative vessel strike risk to sperm whales from oil and gas vessel traffic of all speeds.

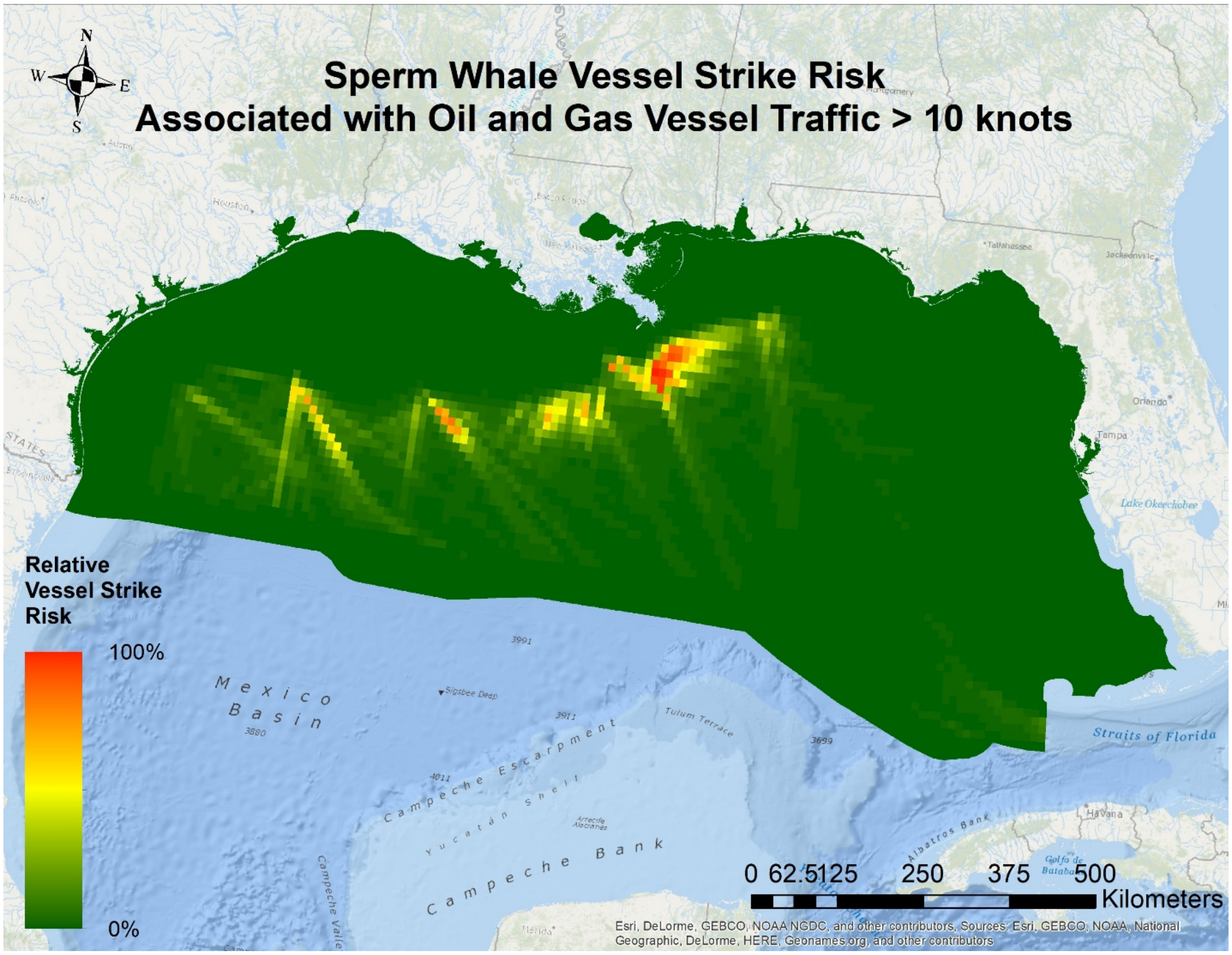


Figure 62. Relative vessel strike risk to sperm whales from oil and gas vessel traffic greater than 10 knots.

Following this, we summed the *vessel strike risk* for traffic of all speeds and that greater than 10 knots across grid cells for both *all* vessel traffic and *oil and gas* vessel traffic and calculated the proportion of *vessel strike risk* within the action area, per year, associated with oil and gas vessel traffic (Table 48). Based on these data, oil and gas vessel traffic accounts for between 33-42 percent and 26-30 percent of the *vessel strike risk* sperm whales face in the Gulf of Mexico from vessels traveling at all speeds and those traveling greater than 10 knots respectively. Importantly, this risk takes into account the geographic distribution of vessel traffic and sperm whale density, as well as the differential risks associated with vessels traveling at different speeds.

Table 48. Vessel strike risk of sperm whales associated with oil and gas vessel traffic.

Year	Vessel Strike Risk for All Vessel Traffic All Speeds	Vessel Strike Risk for Oil and Gas Vessel Traffic All Speeds	Proportion of Vessel Strike Risk due to Oil and Gas Vessel Traffic All Speeds	Vessel Strike Risk for All Vessel Traffic > 10 knots	Vessel Strike Risk for Oil and Gas Vessel Traffic > 10 knots	Proportion of Vessel Strike Risk due to Oil and Gas Vessel Traffic > 10 knots
2015	5,208,314	2,185,848	42%	3,999,863	1,219,086	30%
2016	4,913,358	1,720,959	35%	4,071,096	1,107,018	27%
2017	5,200,042	1,739,733	33%	4,305,804	1,105,719	26%
2018	5,715,401	1,904,878	33%	4,760,391	1,254,025	26%

As noted before, *vessel strike risk* is based on the co-occurrence of both whales and vessels, which has often been used in the literature to evaluate vessel strike risk of large whales (Redfern et al. 2013; Vanderlaan et al. 2009; Vanderlaan et al. 2008; Williams and O'hara 2010). There are likely other factors at play such as whale and vessel size and whale diving behavior, among others, that relate to the probability of an actual vessel strike occurring and some have attempted to account for such factors using encounter rate theory (e.g., Rockwood et al. 2017). However, for our purposes, such extensive modeling analyses were deemed unnecessary given that the goal of this portion of our analysis was only to estimate the relative risk associated with oil and gas vessel traffic, not to estimate historic incidents of vessel strikes, for which we rely on stranding data as discussed below.

The next step in our analysis was to estimate the historic incidents of vessel strikes of sperm whales in the Gulf of Mexico. As noted previously, we are aware of only one incident of a possible lethal vessel strike of a sperm whale in the Gulf of Mexico, which occurred in 1990. However, the vast majority of whales struck by vessels are likely not observed since they may sink, be eaten by scavengers, or be transported far away by ocean currents. As such, we divided this one known lethal strike by a carcass recovery rate of 3.4 percent as estimated by Williams et al. (2011), in order to correct for the unobserved lethal vessel strikes. This results in an estimated total of 29.41 vessel strikes between 1990 and 2018, which is the date range for the best available data of stranding records for sperm whales in the Gulf of Mexico, and an estimated annual rate of 1.01 lethal sperm whales vessel strikes per year. To estimate the proportion of this annual rate likely associated with oil and gas vessel traffic, we multiplied the annual rate of 1.01 by the maximum proportion of *vessel strike risk* due to oil and gas vessel traffic greater than 10 knots (30 percent, Table 48), which results in an estimated annual rate of 0.31 lethal sperm whale strikes per year being from oil and gas vessel traffic. Over the course of the 50 year program, this would amount to approximately 16 (rounded up) sperm whales being killed or seriously injured (as noted before, serious injuries are assumed to result in mortality and thus would be represented in stranding records), as a direct result of oil and gas vessel traffic.

To estimate the number of vessel strikes of sperm whales likely to result in minor or no injuries, we relied on our above estimate of the number of vessel strikes of sperm whales likely to result in serious injury or mortality and estimates of the percentage of vessel strikes likely to result in different types of injuries. Previously, we estimated 29.41 vessel strikes of sperm whales between 1990 and 2018 that likely resulted in serious injury or mortality and from our review of the literature, approximately 19.67 percent of documented vessel strikes result in minor or no injuries. From this information, we can estimate the number of vessel strikes likely to have resulted in no or minor injuries according to equation (1):

(1)

$$VS_{ni/mi} = \frac{VS_{si/m}}{1 - P_{ni/mi}} - VS_{si/m}$$

where $VS_{ni/mi}$ equals the estimated number of vessel strikes likely to have resulted in no injury or minor injury, $P_{ni/mi}$ is the percent of documented vessel strikes that resulted in minor or no injuries (19.67 percent), and $VS_{si/m}$ is the estimated number of vessel strikes likely to have resulted in serious injury or mortality (29.41). From this equation, we estimate that between 1990 and 2018 there were approximately 7.2 vessel strikes of sperm whales that likely resulted in minor or no injuries, which is an annual rate of approximately 0.25 strikes resulting in minor or no injuries of sperm whales per year. To estimate the proportion of this due to oil and gas vessel traffic, we multiplied this annual rate by the maximum proportion of *vessel strike risk* due to oil and gas vessel traffic of all speeds (42 percent, Table 48), which results in an estimated annual rate of 0.10 vessel strikes likely to result in no or minor injuries of sperm whale per year being from oil and gas vessel traffic. Over the course of the 50 year program, this would amount to approximately six (rounded up) sperm whales being struck by a vessel and experience minor or no injuries, as a direct result of oil and gas vessel traffic.

In sum, over the course of the 50 year program, the proposed action is likely to result in a total of 22 vessel strikes of sperm whales, with 16 strikes being likely to result in serious injury or mortality and six strikes likely to result in minor or no injuries. Based on a 72:28 female to male ratio in the Gulf of Mexico (Engelhaupt et al. 2009), and conservatively rounding all estimates up (i.e., summing estimates may equate to actual total estimates produced), we expect approximately 16 of these strikes to be of females (up to 12 serious injury and mortality and five minor or no injury) and seven to be of males (up to five serious injury and mortality and two minor or no injury). In addition, based on the DWH injury assessment, which estimated that calves make up approximately 11 percent of the population of sperm whales in the Gulf of Mexico (Trustees 2016), we estimate that three of these strikes will likely be calves (up to two serious injury and mortality and one minor or no injury), but we interpret this as a minimum estimate for calves since they spend considerably more time near the surface than do foraging adults and immature whales and if struck, may be more likely to be killed given their smaller size. As mentioned above, we did not have sufficient information to quantitatively incorporate mitigation effectiveness of BOEM’s proposed mitigation measures for sperm whales. However, we expect the requirement for vessel operators to look out for and avoid closely approaching sperm whales is likely to reduce instances of vessel strikes if sperm whales are observable from a distance.

Bryde’s Whales

As with our sperm whale vessel strike exposure analysis above, the first step of our vessel strike exposure analysis for Bryde’s whales was to calculate the kilometers of vessel traffic (for both *oil and gas* and *all* vessel traffic for all vessel speeds and traffic greater than 10 knots) and assumed abundance of Bryde’s whales in each grid cell in the action area. The same AIS data described above (e.g., Figure 56 and Figure 57) and used in our sperm whale analysis was used, along with the density estimates for Bryde’s whale described in Section 8.1.2. Next we multiplied the kilometers of vessel traffic in each cell (for *oil and gas* and *all* vessel traffic and for all vessel speeds and speeds greater than 10 knots) by the abundance of Bryde’s whales in each grid cell to quantify *vessel strike risk* based on both types of vessel traffic. Below is a visual representation of the resulting average *vessel strike risk* associated with all *oil and gas* vessel traffic (Figure 63), and *oil and gas* vessel traffic greater than 10 knots (Figure 64).

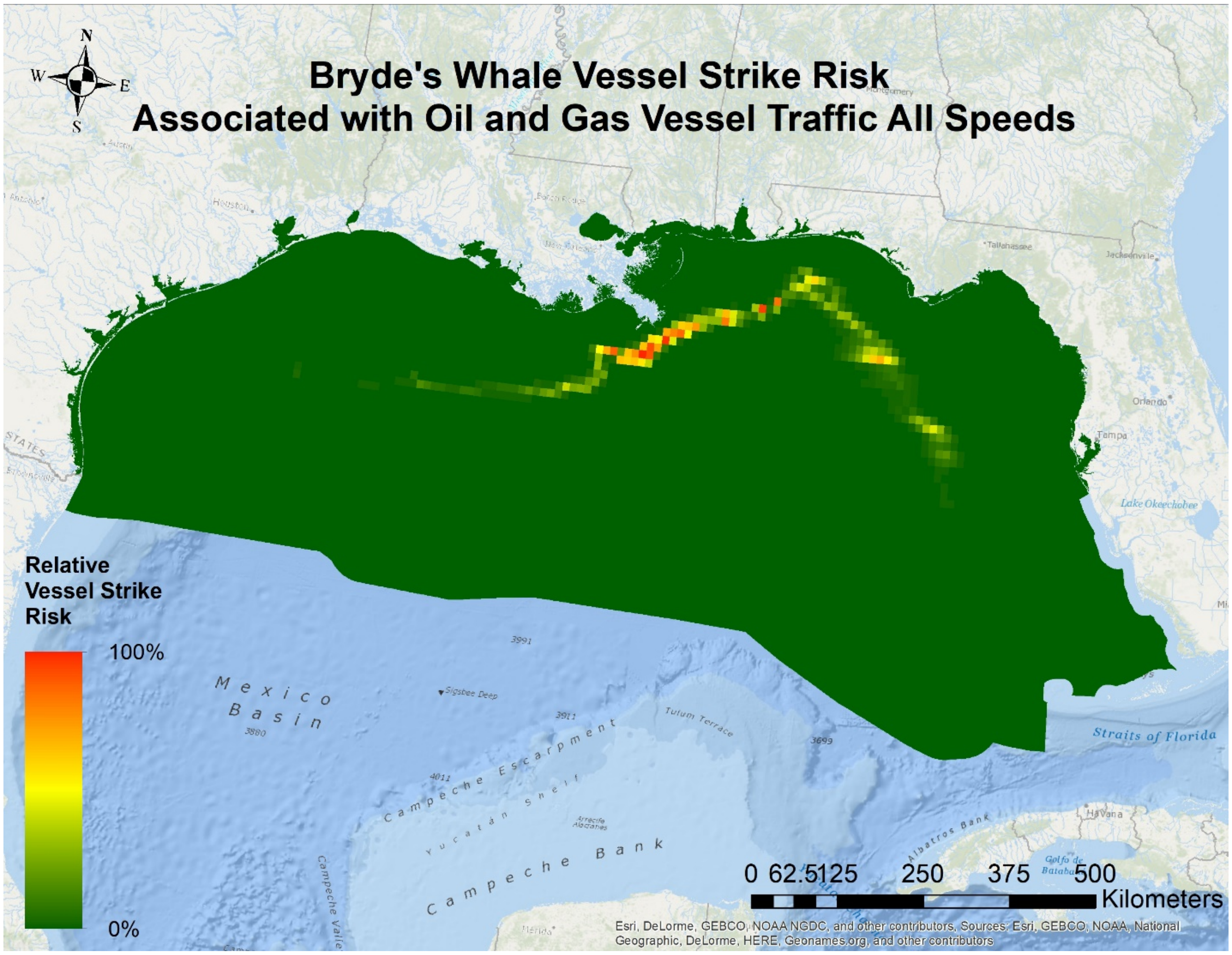


Figure 63. Relative vessel strike risk to Bryde's whales from oil and gas vessel traffic of all speeds.

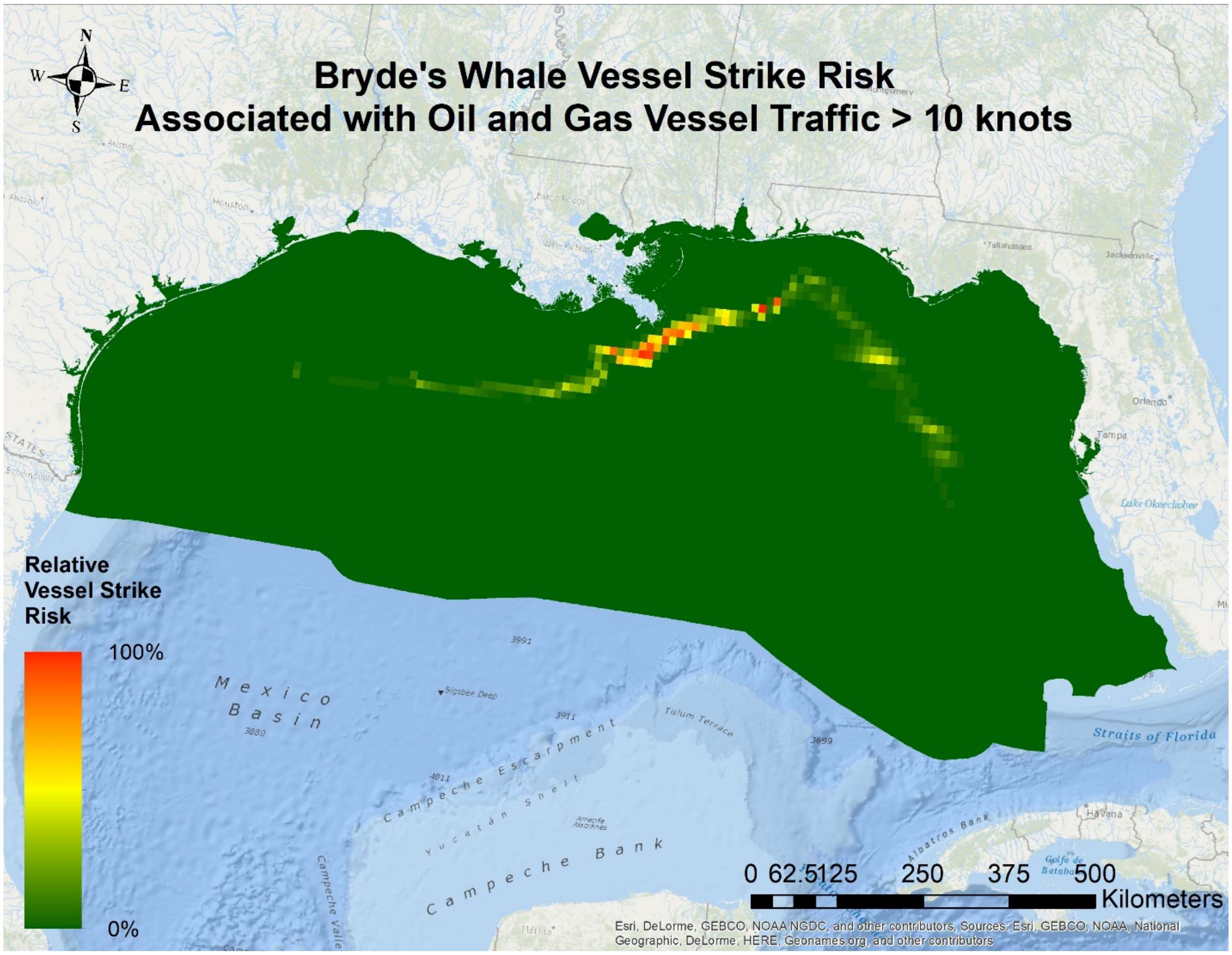


Figure 64. Relative vessel strike risk to Bryde's whales from oil and gas vessel traffic greater than 10 knots.

To calculate Gulf-wide *vessel strike risk,* we summed the *vessel strike risk* for traffic of all speeds and that greater than 10 knots across grid cells for both *all* vessel traffic and *oil and gas* vessel traffic, and then calculated the proportion of risk within the action area, per year, associated with oil and gas vessel traffic (Table 49). Based on these calculations, oil and gas vessel traffic accounts for between 32-39 percent and 21-28 percent of the vessel strike risk Bryde's whales face in the Gulf of Mexico from vessels traveling at all speeds and those traveling greater than 10 knots respectively. As with sperm whales above, this risk explicitly takes into account the geographic distribution of vessel traffic and Bryde's whale density, as well as the differential risk associated with vessels traveling at different speeds. As noted above with sperm whales, we recognize that there are likely other factors at play that determine the probability of an actual vessel strike occurring, such as whale and vessel size, whale diving behavior, among others. However, consideration of these factors does not invalidate our estimates below of the relative risk associated with oil and gas vessel traffic since we anticipate that these other factor would equally affect the probability of vessel strikes from oil and gas vessel traffic compared to all vessel traffic.

Table 49. Vessel strike risk of Bryde's whales associated with oil and gas vessel traffic.

Year	Vessel Strike Risk for All Vessel Traffic All Speeds	Vessel Strike Risk for Oil and Gas Vessel Traffic All Speeds	Proportion of Vessel Strike Risk due to Oil and Gas Vessel Traffic All Speeds	Vessel Strike Risk for All Vessel Traffic > 10 knots	Vessel Strike Risk for Oil and Gas Vessel Traffic > 10 knots	Proportion of Vessel Strike Risk due to Oil and Gas Vessel Traffic > 10 knots
2015	54,454	21,344	39%	37,937	10,649	28%
2016	51,882	16,376	32%	38,743	8,901	23%
2017	48,823	16,136	33%	35,813	7,882	22%
2018	61,024	19,501	32%	44,106	9,364	21%

The next step in our analysis was to estimate the historic incidents of vessel strikes of Bryde's whales in the Gulf of Mexico. As noted previously, we are aware of only one incident of a lethal vessel strike of a Bryde's whale in the Gulf of Mexico, which occurred in 2009 and was reported by a Florida port authority. In order to account for unobserved lethal strikes of Bryde's whale we sought information on carcass recovery rates. However, unlike for sperm whales, Williams et al. (2011) did not estimate carcass recovery rates for Bryde's whales in the Gulf of Mexico. Nevertheless, carcass recovery rates have been estimated for various other cetacean species including a rate of 17 percent for right whales, 6.5 percent for killer whales, less than five percent for grey whales, and 3.4 percent for sperm whales. In modelling ship strike mortality for three baleen whales species off the coast of California, Rockwood et al. (2017) used a high recovery rate of 17 percent based on right whales to produce minimum strike estimates and a five percent recovery (the mean of grey, killer and sperm whales) as a best estimate. The higher rate for right whales is based on them being a more buoyant species (Rockwood et al. 2017). In contrast, being a temperate and resident species, the Gulf of Mexico Bryde's whale likely has less blubber because they are non-migratory and live in warmer waters. Therefore, we conservatively divided the one known lethal vessel strike of Gulf of Mexico Bryde's whales by the Rockwood et al. (2017) five percent carcass recovery rate to account for unobserved vessel strikes for Gulf of Mexico Bryde's whales. In other words, if carcass recovery is five percent, then the observed strikes represent the five percent, then the other 95 percent go unreported (# strikes x inverse of the carcass recovery rate). This results in a total of 20 vessel strikes between 2002 and 2018, which is the date range for the best available data of stranding records for Bryde's whales in the Gulf of Mexico, and an estimated annual rate of 1.18 lethal Bryde's whales vessel strikes per year. To estimate the proportion of this annual rate associated with oil and gas vessel traffic, we multiplied the annual rate of 1.18 by the maximum proportion of *vessel strike risk* to Bryde's whales due to oil and gas vessel traffic greater than 10 knots (28 percent,

Table 50), which results in an estimated annual rate of 0.33 lethal Bryde's whale strikes per year being from oil and gas vessel traffic. Over the course of the 50 year program, this would amount to approximately 17 (rounded up) Bryde's whales being killed or seriously injured (as noted before, serious injuries are assumed likely to result in mortality and thus would be represented in stranding records), as a direct result of oil and gas vessel traffic.

The above estimate of 17 vessel strikes of Bryde's whales resulting in serious injuries or mortality is without considering the proposed RPA Bryde's vessel strike mitigation measures as described in Section 14. To re-estimate exposure in consideration of this proposed mitigation, we recalculated *vessel strike risk* to Bryde's whales due to oil and gas vessel traffic greater than 10 knots assuming that no such traffic would occur in the proposed mitigation area identified in Section 8.1.2.1 as the Bryde's whale area and proposed as a RPA in Section 14. As a result, *vessel strike risk* to Bryde's whales due to oil and gas vessel traffic greater than 10 knots in the Bryde's whale area is assumed to be zero (Figure 65). This results in a lower estimated proportion of *vessel strike risk* to Bryde's whales due to oil and gas vessel traffic greater than 10 knots within the entire action area between 16-20 percent (Table 50). In this process we did not explicitly take into account the nighttime vessel traffic restrictions proposed. While we anticipate the proposed nighttime restrictions will be effective in minimizing incidents of vessel strikes of Bryde's whale in the proposed mitigation area, there is some uncertainty in the effectiveness of the approach. We lack information to estimate the extent to which a nighttime restriction in the mitigation area would effectively minimize vessel strike risk in the proposed mitigation area (i.e., the proportion of strikes occurring at nighttime versus daytime).

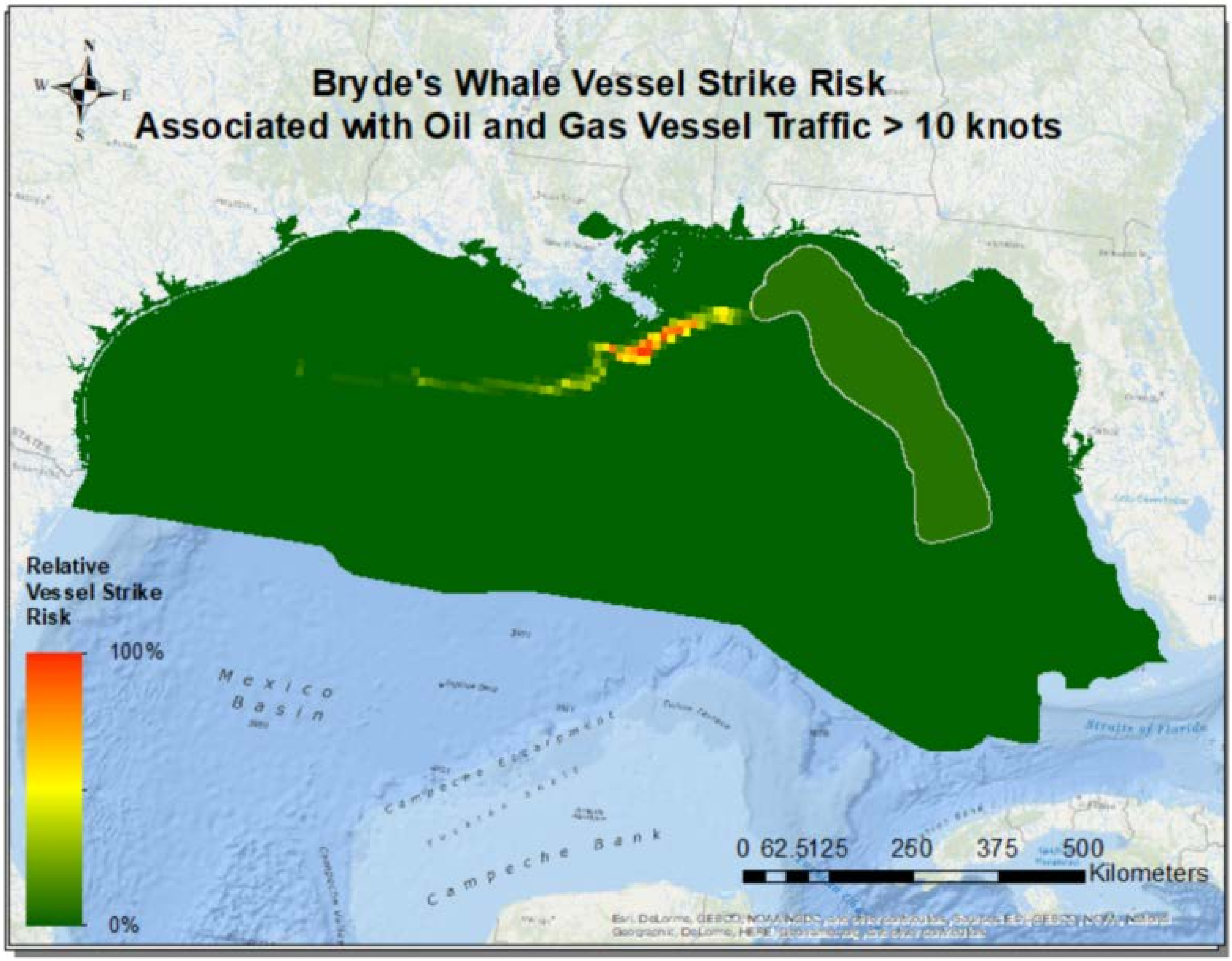


Figure 65. Relative vessel strike risk to Bryde's whales from oil and gas vessel traffic greater than 10 knots taking into account BOEM/BSEE proposed Bryde's whale mitigation assuming 100 percent effectiveness (i.e., 10 knot speed restriction and nighttime closure in the area lighter green than the background).

Table 50. Vessel strike risk of Bryde's whales associated with oil and gas vessel traffic accounting for the proposed RPA Bryde's whale mitigation in Section 14.

Year	Vessel Strike Risk for All Vessel Traffic > 10 knots	Vessel Strike Risk for Oil and Gas Vessel Traffic > 10 knots	Proportion of Vessel Strike Risk due to Oil and Gas Vessel Traffic > 10 knots
2015	37,937	10,649	20%
2016	38,743	8,901	17%
2017	35,813	7,882	16%
2018	44,106	9,364	17%

Using this modified estimate of the maximum proportion of *vessel strike risk* to Bryde's whales due to oil and gas vessel traffic greater than 10 knots of 20 percent (Table 49) results in a lower estimated annual rate of 0.24 lethal Bryde's whale strikes per year resulting from oil and gas vessel traffic. Over the course of the 50 year program with implementation of the proposed RPA Bryde's whale mitigation, this would amount to approximately 12 (rounded up) Bryde's whales being killed or seriously injured as are direct result of oil and gas vessel traffic.

In order to estimate the number of vessel strikes of Bryde's whales likely to result in minor or no injuries, we relied on the same approach as described above for sperm whales. From above, we estimated 20 vessel strikes of Bryde's whales between 2002 and 2018 that likely resulted in serious injury or mortality. Assuming the same 19.67 percent of documented vessel strikes that resulted in minor or no injuries as was assumed for sperm whales above, and using equation (1), we estimate that between 2002 and 2018 there were approximately 4.9 vessel strikes of Bryde's whales that likely resulted in minor or no injuries, which produces an annual rate of approximately 0.29 strikes per year resulting in minor or no injuries of Bryde's whales. To estimate the proportion of these strikes due to oil and gas vessel traffic, we multiplied this annual rate by the maximum proportion of *vessel strike risk* to Bryde's whales due to oil and gas vessel traffic of all speeds (39 percent, Table 50), which results in an estimated annual rate of 0.11 vessel strikes likely to result in no or minor injuries per year. Over the course of the 50 year program, this would amount to approximately six (rounded up) Bryde's whales being struck by vessels and experiencing minor or no injuries as a direct result of oil and gas vessel traffic.

However, the above estimate of vessel strikes likely to result in no or minor injuries does not take into consideration the proposed RPA Bryde's whale vessel strike mitigation measures described in Section 14. We were able to account for mitigation measures in our exposure analysis for vessel strikes likely to result in serious injury or mortality. However, it is not straightforward to adjust our estimate for these less severe vessel strikes to account for the proposed speed restrictions. Nonetheless, several lines of evidence suggest that reducing vessel speeds is likely to reduce the overall incidents of vessel strikes, including those likely to result in minor or no injuries.

For example, Gende et al. (2011) found that as vessel speed increases the distance at which whales encounter vessels decreases, with whales generally being seen at closer distances when vessels are traveling faster than 11.8 knots. Similarly, Currie et al. (2017) found that in Hawaii, when vessels were traveling at speeds of 12.5 knots or less there was a 3.4 fold decrease in the number of close encounters with humpback whales. These studies suggest that reducing vessel speeds likely reduces the number of incidents of vessel strikes. While the mechanism behind the relationship between vessel speed and distance at which whales are encountered is unknown, it is possible that traveling at slower speeds provides whales and or vessels more time to avoid one another. Regardless, Conn and Silber (2013b) explicitly examined the effects of vessel speed on both strike rate as well as likelihood that given a strike, it would be lethal or cause serious injury and found that reducing vessel speed reduces the likelihood of both events. Consistent with this, Vanderlaan and Taggart (2007a) found that the majority of documented vessel strikes of large whales occurred at higher speeds. From their Figure 2, approximately ten percent of all documented vessel strikes occurred at speeds less than ten knots and all of these resulted in either no injuries (approximately six percent) or minor injuries (approximately four percent).

Based on our review of this information on the relationship between vessel speed and vessel strike rate, we assume that a reduction in vessel speed to ten knots and below is likely to lead to a reduction in the number of all vessel strikes, regardless of severity. To quantitatively estimate this reduction, we applied a 90 percent reduction factor based on Figure 2 in Vanderlaan and Taggart (2007a), which indicates that approximately ten percent of documented vessel strikes of large whales occur at speeds less than ten knots. However, we did not apply the 90 percent reduction factor directly to the total 23 vessel strikes of Bryde's whale over the 50 year period estimated without consideration for BOEM's proposed vessel speed restrictions (17 strikes likely to result in serious injury or mortality and six likely to result in minor or no injuries). This is because the ten knot speed restriction is not proposed in all areas where there is *vessel strike risk* to Bryde's whales due to *oil and gas* vessel traffic of all speeds (see Figure 63). Instead, we only applied this 90 percent reduction factor to the proportion of *vessel strike risk* to Bryde's whales due to *oil and gas* vessel traffic of all speeds contained within the mitigation area (Table 51), which on average is approximately 35 percent. Thus, 35 percent of the *vessel strike risk* to Bryde's whales due to oil and gas vessel traffic of all speeds will be reduced by 90 percent (i.e., only ten percent of this risk will remain given the proposed ten knot speed restriction), which results in an overall reduction of *vessel strike risk* to Bryde's whales due to oil and gas vessel traffic of all speeds by approximately 31 percent.

Table 51. Percent vessel strike risk of Bryde's whales associated with oil and gas vessel traffic of all speeds within the Bryde's whale mitigation area.

Year	Vessel Strike Risk for Oil and Gas Vessel Traffic All Speeds	Vessel Strike Risk for Oil and Gas Vessel Traffic All Speeds in Mitigation Area	Percent of Vessel Strike Risk for Oil and Gas Vessel Traffic All Speeds in Mitigation Area
2015	21,344	8,195	38%
2016	16,376	5,453	33%
2017	16,136	6,376	40%
2018	19,501	5,497	28%

When applied to the total 23 vessel strikes of Bryde's whales estimated without considering the proposed RPA speed restrictions, we estimate that there will be a total of 17 (rounded up) vessel strikes of Bryde's whales over the 50 year period as a result of the proposed action. Given that above we estimated that with implementation of the proposed speed restrictions 12 vessel strikes of Bryde's whales are likely to result in serious injury or mortality, the remaining four are expected to result in no or minor injuries. We recognize that these new estimates do not align with the relative proportion of strikes likely to result in no or minor injuries from the literature discussed earlier (i.e., 19.67 percent discussed earlier versus here 4/16=25.0 percent). However, this is to be expected given that the proposed mitigation is specifically focused on reducing vessel strikes likely to cause more severe consequences and not all incidents of vessel strikes equally.

In sum, over the course of the 50 year program the oil and gas program, based on our vessel strike analysis without the implementation of the BOEM-proposed vessel strike mitigation is likely to result in a total of 23 vessel strikes of Bryde's whales, with 17 of these strikes expected to result in serious injury or mortality and six strikes expected to result in minor or no injuries. However, with the implementation of the proposed RPA Bryde's whale vessel speed restrictions in Section 14, this is reduced to 16 vessel strikes of Bryde's whales over 50 years, with 12 of these strikes expected to result in serious injury or mortality and four strikes expected to result in minor or no injuries. Given that we lack sufficient demographic information on Bryde's whales in the Gulf of Mexico, we are unable to further break down these estimates into age-sex classes.

8.4.2.2 Response

Above we estimated the total number of sperm and Bryde's whales likely to be struck by vessels associated with the proposed action, and in doing so alluded to the likely responses based on estimating *vessel strike risk* associated with vessels traveling different speeds. In general sperm and baleen whales are expected to exhibit a range of responses to vessel strikes ranging from instantaneous mortality in the most severe cases to no injuries and perhaps a short-term behavioral reaction in response to being merely "bumped" by a vessel. Many factors likely affect the ability of whales to detect and avoid oncoming vessels and these same factors likely influence a whale's response. The amount of time an animal spends at the surface, its awareness of an approaching vessel, reaction time, and behavioral response, or lack of a response, are important factors to consider. In some cases, animals may respond to an oncoming vessel in ways that allow it to entirely avoid being struck. Any avoidance of vessels by whales is considered an advantageous response to avoid a potential threat, such as may occur in response to a predator such as killer whales.

If a whale does not respond with avoidance and ends up being struck by a vessel, severity of the response is likely to vary with a variety of factors related to the vessel and animal in the particular circumstance, but most notably vessel speed as discussed above. Researchers have found that the lethality of the collision increases with ship speed. Vanderlaan and Taggart (2007b) found the probability of a lethal strike increased from 20 percent to 100 percent at speeds between nine and 20 knots, and that lethality from ship strike increased most rapidly between 10 and 14 knots. Similar results were reported by Pace and Silber (2005a) and Conn and Silber (2013b). In addition, Silber et al. (2010b) found that increased vessel speed increased the hydrodynamic draw of vessels that could result in right whales (and likely other species) being pulled towards vessels making them more vulnerable to collisions and increasing the magnitude of impact. Therefore, slowing vessel speeds in areas occupied by whales is a practical mitigation measure to reduce the severity to whales of collisions with ships.

8.4.3 Sea Turtles

All species of ESA-listed sea turtles within the action area are at risk of being struck by vessels associated with the proposed action. However, compared to the threat of vessel strikes to large whales, much less is known about vessel strike risk for turtles, despite it being considered an important source of injury and mortality of sea turtles within the action area (Lutcavage et al. 1997b).

Based on behavioral observations of turtle avoidance of small vessels, green turtles may be susceptible to vessel strikes at speeds as low as two knots (Hazel et al. 2007b). Sea turtles may be injured or killed by collisions with vessels. Lethal and nonlethal vessel-strike injuries observed include cracked and crushed carapaces, animals cut in half, missing limbs, propeller cuts, and scars (Chaloupka et al. 2008a; Foley et al. 2008b). Although there have been hundreds of thousands of vessel trips that have been made in support of offshore operations during the past 40 years of OCS oil and gas operations, there have been no reports of OCS-related vessels having struck sea turtles. This is most likely because a strike with a turtle would probably go undetected by larger vessels and strikes are not reported. Despite the lack of on-water reporting, stranding records show that interactions between vessels and turtles in the action area are quite common (see Table 52, below). Vessel strike is an increasing concern for sea turtles, especially in the southeastern United States, where development along the coasts is likely to result in increased recreational boat traffic. In the United States, the percentage of strandings of loggerhead sea turtles that were attributed to vessel strikes increased from approximately 10 percent in the 1980s to a record high of 20.5 percent in 2004 (NMFS and USFWS 2007f).

As mentioned above in our vessel strike exposure analysis for whales, BOEM and BSEE currently require oil and gas operators to maintain a vigilant watch for sea turtles to avoid collision, and to report any injured or dead protected species. Because BOEM proposes to continue this NTL for all oil and gas operations in the Gulf of Mexico, we consider this aspect of the proposed action in our analysis of the effects of vessel strikes on ESA-listed turtles. However, to our knowledge there are no data on NTL effectiveness or compliance, and a lack of ship strikes of sea turtles by oil and gas related vessels cannot be interpreted to mean that no strikes have occurred. Thus, while BOEM has proposed mitigation measures to reduce vessel strikes of all ESA-listed sea turtles, we do not have sufficient information that would allow us to assess their effectiveness at reducing the number or severity of sea turtle vessel strikes. Nevertheless, we agree with BOEM that they are appropriate measures that should be taken to decrease the likelihood of vessel strikes of ESA-listed sea turtles.

8.4.3.1 Exposure

To estimate the number of vessel strikes of sea turtles that will result from the Oil and Gas Program, we took the same general approach as described for Bryde’s and sperm whales above. We combined AIS data with information on the distribution and density of sea turtles described in Section 9.1.3 in order to quantify the co-occurrence of sea turtles and vessels, which we again refer to as *vessel strike risk*. As noted above and further discussed below, the available data indicate that sea turtles may be susceptible to vessel strikes at speeds as low as two knots (Hazel et al. 2007b) and even vessels traveling at low speeds pose a substantial risk of mortality (Sapp 2010; Work et al. 2010). Accordingly, in our exposure analysis of vessel strikes of sea turtles we did not differentiate vessel traffic by speed, and considered all vessel traffic to pose a risk of mortality to sea turtles. Because the same approach was taken for all sea turtle species, we present our vessel strike exposure analysis for sea turtles as a group below.

For large sea turtles (i.e., those greater than or equal to 30 centimeters in diameter), our exposure analysis involved the following steps:

1. Calculate the amount of *oil and gas* related and *all* vessel traffic (kilometers of vessel traffic) in 10 x 10 kilometer grid cells within the action area (see Figure 56 and Figure 57 above)
2. Calculate the predicted abundance of large sea turtles within the same grid cells within the action area based on density data described in Section 8.1.2. Note that this was done separately for the density estimates shallower than 200 m and greater than 200 m in order to rely on the best available density estimates in different water depths, but results were combined for the overall analysis. Monthly and/or seasonal density estimates for large sea turtles were used in some cases, as available.
3. Multiply the total kilometers of *all* vessel traffic and *oil and gas* vessel traffic in each grid cell by large sea turtle abundance separately in order to derive a metric that quantifies *vessel strike risk* (i.e., co-occurrence of vessel traffic and animals) of each sea turtle species based on both types (*oil and gas* and *all*) of vessel traffic.
4. Sum *vessel strike risk* associated with *all* vessel traffic and *oil and gas* vessel traffic across all grid cells in the action area to provide Gulf-wide measures of *vessel strike risk.*
5. Estimate the relative proportion of *vessel strike risk* of each species associated with *oil and gas* vessel traffic by dividing the estimated *vessel strike risk* associated with *oil and gas* vessels by the *vessel strike risk* associated with *all* vessels.
6. Using information on the prevalence of non-lethal vessel strikes, data on stranded sea turtles where the cause of death was likely a vessel strike, and correction factors for unobserved vessel strike mortalities, estimate incidents of historic vessel strikes that were lethal and non-lethal of each species.
7. Estimate the proportion of historic incidents of vessel strikes of large sea turtles associated with *oil and gas* vessel traffic by multiplying the relative proportion of *vessel strike risk* associated with *oil and gas* vessel traffic by the estimated historic incidents of vessel strikes and assume these historic estimates are representative of what is likely to occur in the future under the proposed action.

As detailed further below, all steps of the analysis where carried out per month, per year, and summarized annually, and no rounding occurred until the final estimates were produced. However, unlike with our whale analysis, since monthly and/or seasonal density estimates for large sea turtles were available in some cases, we paired the appropriate abundance estimate with the monthly AIS vessel traffic metrics to quantify *vessel strike risk* based on temporal changes in both vessel traffic and species density. As for whales, in order to estimate exposure in a way that is conservative for the species, final annual estimates were based on years in which the *vessel strike risk* associated with the proposed action was highest.

From steps 1 and 2 above in our vessel strike exposure analysis for large sea turtles, we calculated the kilometers of vessel traffic (for both *oil and gas* and *all* vessel traffic for all vessel speeds) and density of large sea turtles of each species in each grid cell in the action area. The same AIS data described previously was used (e.g., Figure 56 and Figure 57), along with the density estimates for large sea turtles described in Section 8.1.2. Where density data were available for hardshell turtles as a group only (i.e., in water depths greater than 200 meters), we proportioned the abundance of hardshell turtles in each grid cell to green, hawksbill, Kemp's ridley, and loggerhead sea turtles based on the relative abundance of each species within the action area calculated from data where species specific density estimates were available. Next we multiplied the kilometers of vessel traffic in each cell by the abundance of each sea turtle species in each grid cell to quantify *vessel strike risk* based on both types of vessel traffic. Below are visual representations of the resulting *vessel strike risk* associated with all *oil and gas* vessel traffic for large sea turtles of each sea turtle species (Figure 66, Figure 67, Figure 68, Figure 69, and Figure 70).

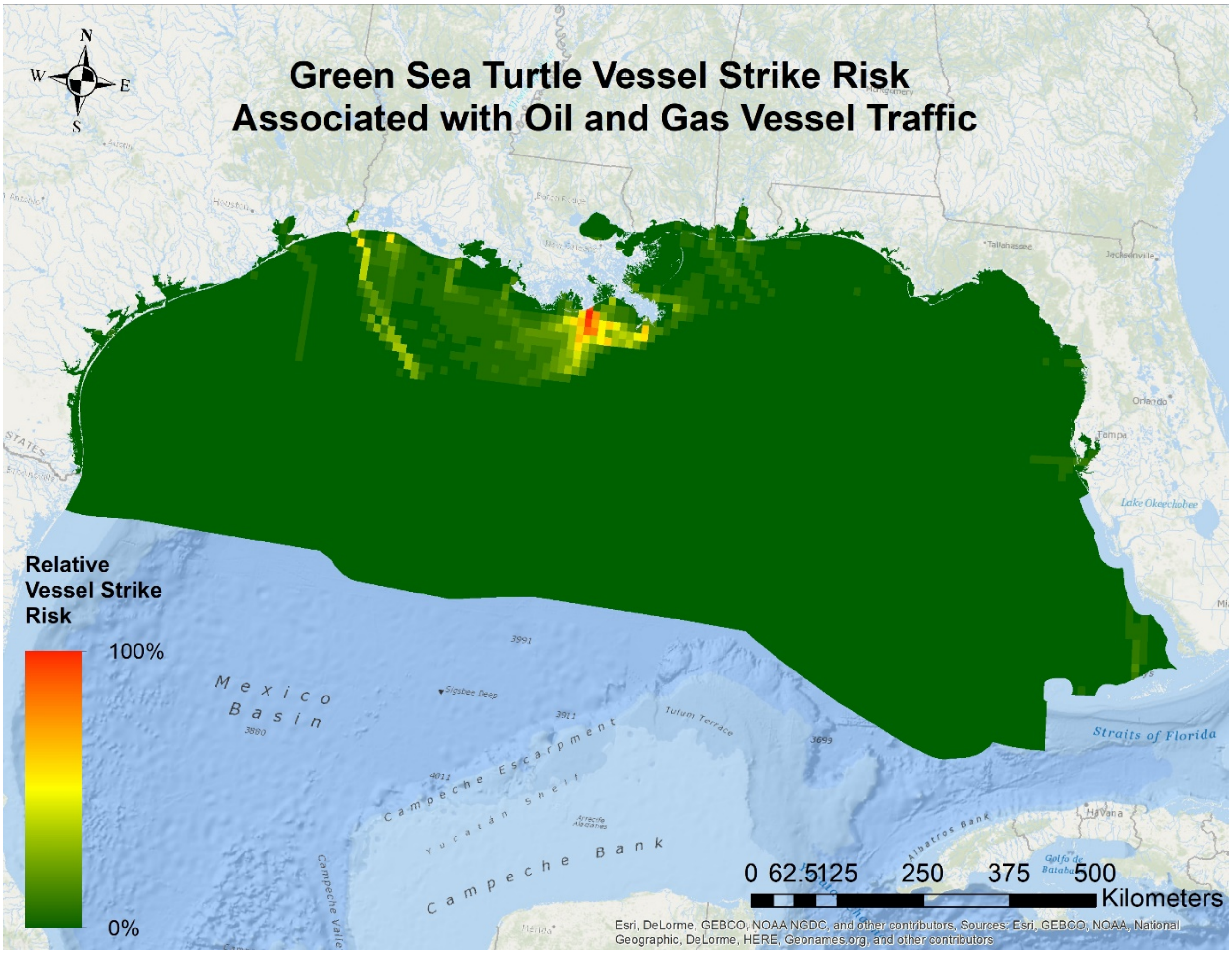


Figure 66. Relative vessel strike risk to large (greater than or equal to 30-centimeter diameter) green sea turtles from oil and gas vessel traffic.

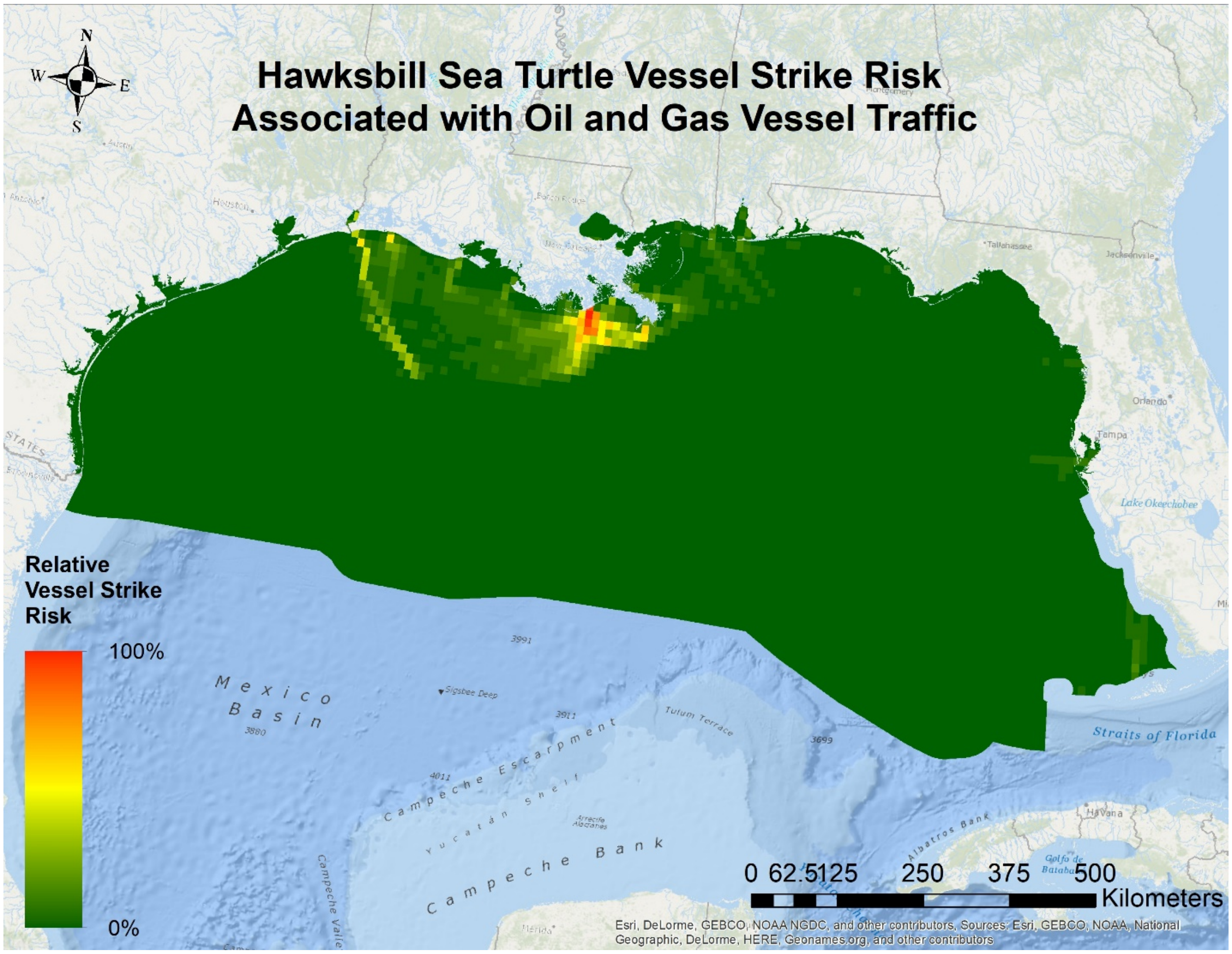


Figure 67. Relative vessel strike risk to large (greater than or equal to 30-centimeter diameter) hawksbill sea turtles from oil and gas vessel traffic.

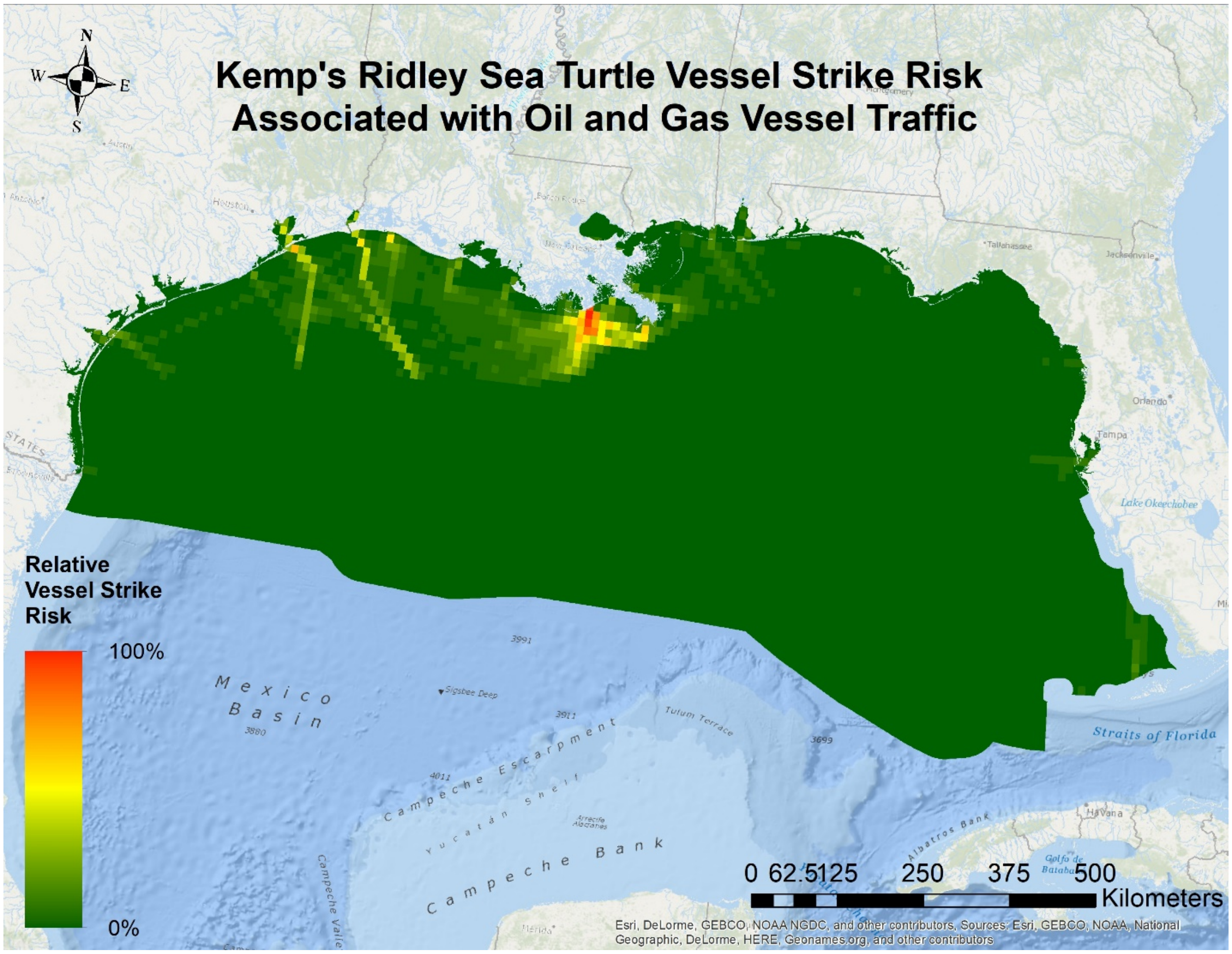


Figure 68. Relative vessel strike risk to large (greater than or equal to 30-centimeter diameter) Kemp's Ridley sea turtles from oil and gas vessel traffic.

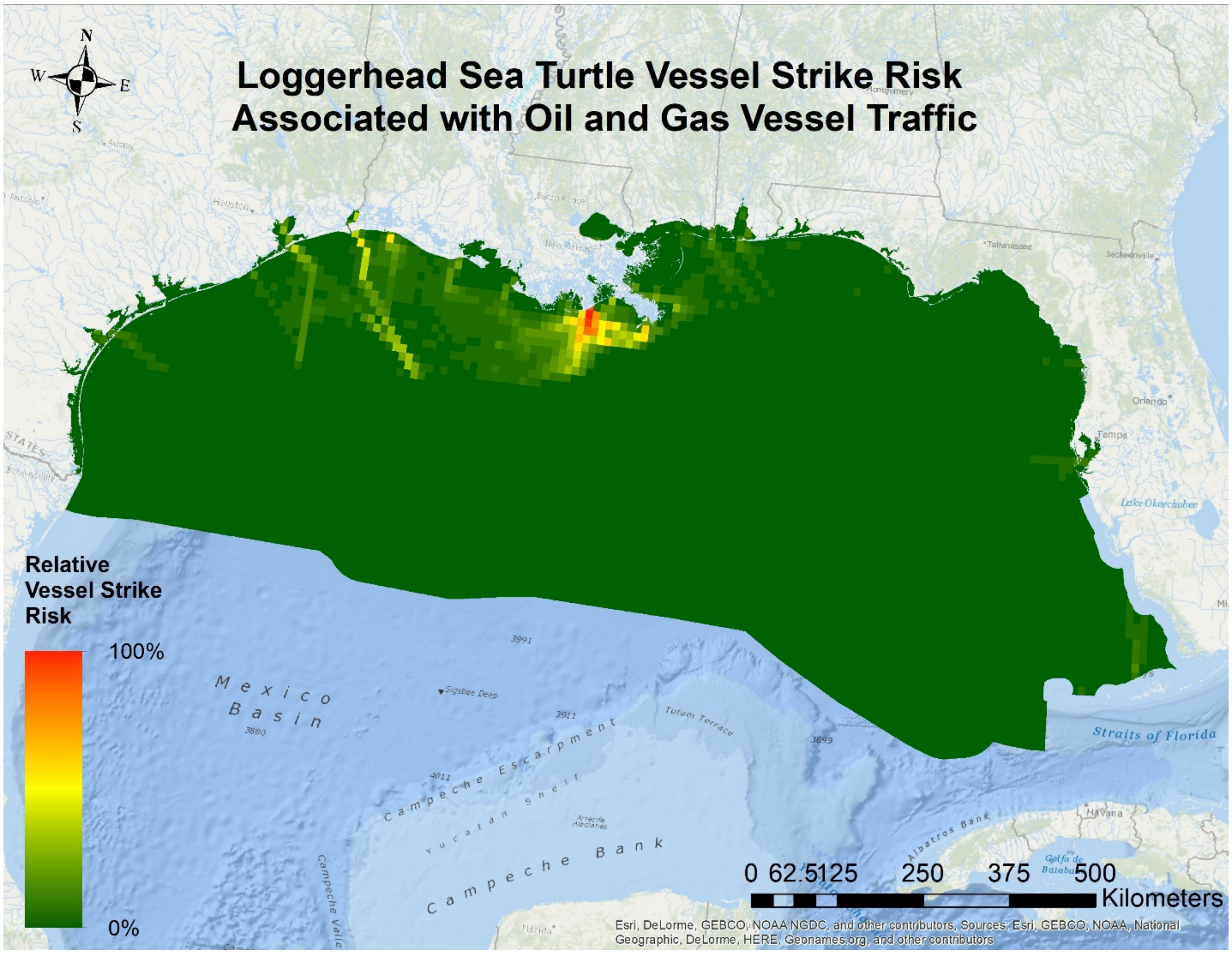


Figure 69. Relative vessel strike risk to large (greater than or equal to 30-centimeter diameter) loggerhead sea turtles from oil and gas vessel traffic.

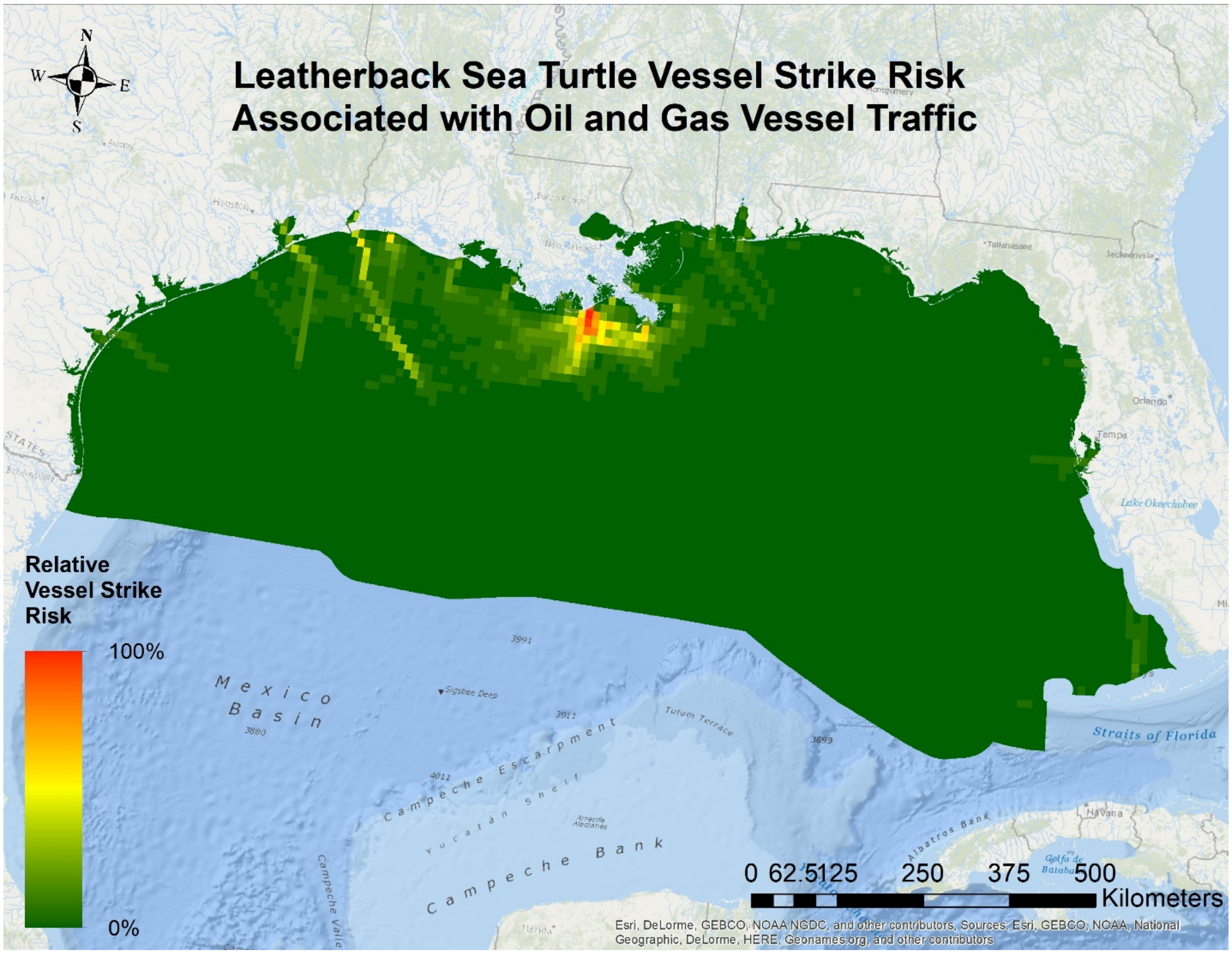


Figure 70. Relative vessel strike risk to large (greater than or equal to 30-centimeter diameter) leatherback sea turtles from oil and gas vessel traffic.

Following this, we summed the *vessel strike risk* for traffic of all speeds for both *all* vessel traffic and *oil and gas* vessel traffic and calculated the proportion of *vessel strike risk* for large sea turtles of each species within the action area, per year, associated with oil and gas vessel traffic (Table 52). As for whales, we recognize that there are likely other factors at play that affect the probability of an actual vessel strike occurring, such as sea turtle and vessel size, turtle diving behavior, among others. However, consideration of these factors does not invalidate our estimates below of the relative risk associated with oil and gas vessel traffic since we anticipate that these other factor would equally affect the probability of vessel strikes from oil and gas vessel traffic compared to all vessel traffic.

Table 52. Vessel strike risk of large (greater than or equal to 30-centimeter diameter) sea turtles associated with oil and gas vessel traffic.

Species	Year	Vessel Strike Risk for All Vessel Traffic	Vessel Strike Risk for Oil and Gas Vessel Traffic	Proportion of Vessel Strike Risk due to Oil and Gas Vessel Traffic	Maximum Proportion of Vessel Strike Risk due to Oil and Gas Vessel Traffic
Green	2015	328,164,396	198,100,356	60%	60%
	2016	307,773,687	173,822,824	56%	
	2017	294,611,614	160,464,326	54%	
	2018	354,788,306	192,914,290	54%	
Hawksbill	2015	536,074,328	328,570,784	61%	61%
	2016	502,301,949	287,681,536	57%	
	2017	479,362,888	264,565,242	55%	
	2018	575,382,647	316,410,438	55%	
Kemp's Ridley	2015	1,979,461,190	1,100,077,638	56%	56%
	2016	1,865,315,233	977,154,631	52%	
	2017	1,813,405,540	921,315,129	51%	
	2018	2,219,999,177	1,139,287,282	51%	
Loggerhead	2015	1,288,527,103	729,290,493	57%	57%
	2016	1,206,223,114	643,904,359	53%	
	2017	1,164,368,207	602,041,109	52%	
	2018	1,415,732,620	735,794,261	52%	
Leatherback	2015	40,562,428	21,938,492	54%	54%
	2016	37,958,889	19,131,929	50%	
	2017	37,012,615	18,054,441	49%	
	2018	44,619,690	21,975,071	49%	

Having estimated the relative *vessel strike risk* to sea turtles as a result of oil and gas vessel traffic, we next reviewed information on the historic incidents of non-lethal vessel strike of large sea turtles. The occurrence of non-lethal vessel strike injuries observed in different study populations of sea turtles may provide a more accurate representation of the percentage of turtles struck by vessels and surviving than stranding data of dead or mortally wounded animals. Of the studies we reviewed that reported the percent of non-lethal vessel strikes in free-ranging sea turtles (Table 53), we determined that four studies best represent the expected strike risk in the action area. The study by Denkinger et al. (2013) around San Cristobal Island was determined not appropriate to use in calculations for an overall percentage of sea turtles likely to be non-lethally struck by vessels since it appeared to be an outlier compared to the other estimates, and likely represents site specific information only applicable to similar areas in very close proximity to busy vessel ports.

Table 53. Summary of the literature reporting the percent of live sea turtles observed with vessel strike injuries.

Region	Species Research	Percent of Observed Animals with Vessel-Strike Injury	Source
Florida east coast	Foraging loggerhead sea turtles	2.8%	Norem (2005)**
Florida east coast	Foraging green sea turtles	0.6%	Norem (2005) **
Gabon	Nesting leatherback sea turtles	2.8%	Deem et al. (2006)
Isabela Island, Ecuador	Nesting green sea turtles	3.7%	Denkinger et al. (2013)
San Cristobal Island*	Foraging green sea turtles' site near a busy port	19.4%	Denkinger et al. (2013)
Cayman Islands	Juvenile hawksbill foraging sites	2%	Blumenthal et al. (2009)

**Data for San Cristobal region excluded from analysis.*

*** Percentage in original source presented as 1.9 percent across all species studied. Species specific percentage derived from data presented in original source, assuming a constant capture-recapture rate for all species.*

All of the above studies occur outside of the action area; therefore the associated non-lethal vessel strike percentages are likely influenced by different environmental conditions, sea turtle distributions, and vessel traffic. However, because they represent the best available data on non-lethal vessel strikes for the species considered in this biological opinion, we relied on them for our exposure calculations. From these data, we assume that depending on the species, 1.9-3.7 percent of large sea turtles in the action area are likely to show evidence of a vessel strike at any given point in time. To calculate the number of large sea turtles that may be struck and injured (non-lethal) by vessels associated with the oil and gas program, we used equation (2):

(2)

$$N_{an\_nl\_og} = a * P_{nl} * C_f * P_{vsr\_og}$$

Where $N_{an\_nl\_og}$ equals the number of annual non-lethal vessel strikes of large sea turtles due to oil and gas vessels, a equals the abundance of sea turtles in action area, P_{nl} equals the percent of animals with non-lethal vessel strikes based on Table 53, C_f equals an annual correction factor (see below), and P_{vsr_og} the percent of *vessel strike risk* associated with oil and gas vessel traffic.

Each variable of the equation is further explained in the four steps below.

Step 1: we calculated the number of large sea turtles in the action area based on density data described in Section 8.1.2. As before, the hardshell turtle abundance was proportioned to the various hardshell turtle species according to their relative abundance in the action area.

Using these density data, we calculated seasonal abundance estimates for large sea turtles within the action area. The maximum total abundance calculated across seasons was used as the total abundance [a in equation (2)], since using the maximum accounts for seasonal increases in the population within the action area due to immigration. Given that in seasons other than that during which the maximum abundance occurs, large sea turtle density within the action area would be less than the maximum, this approach is conservative. The results of these calculations can be seen in Table 54 below.

Table 54. Abundance of large (greater than or equal to 30-centimeter diameter) sea turtles in action area.

Species	Abundance in Action Area
Green	83,195
Hawksbill	138,185
Kemp's Ridley	458,241
Loggerhead	321,084
Leatherback	10,475

Step 2: we calculated the number of large sea turtles expected to have non-lethal vessel-strike injuries at any given point in time from all vessels within the action area (i.e., not just oil and gas related vessels) by multiplying non-lethal vessel strike percentages [P_{nl} in equation(2)] in Table 53 by the abundance of large sea turtles of each species. For loggerhead, green, hawksbill, and leatherback sea turtles, species specific percentages were used according to Table 53 (a mean of 2.22 percent was used for green turtles). For Kemp's ridley, 2.3 percent was used based on the average of the four hardshell sea turtle percentages (excluding data from San Cristobal region as discussed above). The resulting calculated numbers in column three of Table 55 provide an overall estimate of the number of large sea turtles in the action area that at any given time are expected to have non-lethal vessel strike injuries, but includes non-lethal vessel strike injuries that would occur over multiple years and from all vessels. To determine an annual number of non-lethal vessel strike injuries of large sea turtles from oil and gas related vessels, two further calculations were required as detailed below in steps three and four.

Step 3: we calculated the annual number of large sea turtles in the action area that are expected to experience non-lethal vessel strike injury. The numbers in column three in Table 55 represent the total numbers of large sea turtles showing evidence of a non-lethal vessel strike at any given point in time, but they do not represent the number of strikes occurring each year that contribute to that total. That is, we would expect surviving turtles with injuries to be recounted for as many years as they remain alive, but individuals should only be counted once for the year in which the strike occurred when determining annual strike rates. Increases in sea turtle population numbers due to recruitment from younger age classes, and decreases in population numbers due to mortality can be used to discern the number of new injuries occurring annually. In order to estimate the number of non-lethal vessel strikes that occur annually, we applied survivorship probabilities in the population to estimate percent of sea turtles that leave the population each year through mortality and emigration, and those that will enter the population through recruitment from younger age classes and immigration. In taking this approach, we assume that the population is stable, the number of mortalities will be replaced with an equal number of individuals that are at risk of a non-lethal vessel strike, and that the percentage of the population with evidence of non-lethal vessel strikes is constant.

According to the recovery plans for loggerhead and Kemps' ridley sea turtles, annual survival probabilities for adults and neritic juveniles (i.e., here assumed to be large sea turtles) average 0.825 and 0.935 respectively, corresponding to an annual mortality rate of 17.5 percent for loggerhead and 6.5 percent for Kemp's ridley sea turtles. We do not have species-specific survivorship probabilities for the other species of sea turtles occurring in the action area, but we assume they are similar to large loggerhead and Kemp's ridley sea turtles. Thus, we conservatively applied the higher loggerhead sea turtle mortality rate of 17.5 percent to green, leatherback, and hawksbill sea turtles. This assumption is conservative and supported for at least green sea turtles by data on adult survival from outside the action area that found annual adult survival of approximately 0.85 using both a recovery model and an open robust design model (Troëng and Chaloupka 2007). Using these mortality rates as a correction factor [C_f in equation (2)] for population turnover, we calculated the estimated annual number of non-lethal vessel strikes of large sea turtles (Table 55, column four).

Table 55. Non-lethal vessel strike injuries of large (greater than or equal to 30-centimeter diameter) sea turtles in the action area.

Species	Percent with Non–lethal Vessel-Strike Injuries	Non-lethal Vessel Strike Injuries Observed in Population at Any Time Resulting from All Vessels	Annual Non-lethal Vessel Strike Injuries Resulting from All Vessels	Annual Non-lethal Vessel Strike Injuries Resulting from Oil and Gas Vessels
Green	2.22%	1,847	323	196
Hawksbill	2%	2,764	484	297
Kemp's Ridley	2.30%	10,540	685	381
Loggerhead	2.80%	8,990	1,573	891
Leatherback	2.80%	293	51	28

Step 4: we calculated the annual number of large sea turtles expected to experience non-lethal vessel strikes injuries due to oil and gas vessels as part of the proposed action by multiplying the estimated number of annual non-lethal vessel strikes of large sea turtles resulting from all vessels (Table 55, column four) by the maximum percent *vessel strike risk* associated with oil and gas vessel traffic for each species [P_{vsr_og} in equation (2), Table 52]. The resulting number of large sea turtles expected to experience non-lethal vessel strike injuries due to oil and gas vessels is given in column five of Table 55.

In order to evaluate the circumstances that result in mortality of sea turtles due to vessel strikes, we reviewed a study looking at the effect of vessel speed on lethal sea turtle injuries, as well as reported observations of sea turtle behavior in response to oncoming vessels. In tests of carapace damage resulting from vessel strikes of loggerhead sea turtles (Sapp 2010; Work et al. 2010), physical models simulating the shape and strength of loggerhead carapaces were placed in the water and struck at idle speed (3.8 knots), sub-planing speed (7.6 knots), and planing speed (21.6 knots). This study showed that vessel strikes at idle speed resulted in lethal damage to the carapace 25 percent of the time. Vessel strikes at planing speed resulted in 100 percent lethal damage. At sub-planing speeds (7.6 knots), the resulting large bow wave helped push the animal out of the way, resulting in no contact with the carapace 38 percent of the time. Oil and gas vessels may operate at different speeds, but some vessels reach high speeds that could cause death by blunt force trauma if the hull directly impacted a turtle as was tested in the study. The authors of the above studies noted that because the models were in a fixed position and directly hit in each test, the actual injury rate in free swimming sea turtles may be different due to the depth, orientation, and behavior of turtles in the wild. The studies also did not report the effect of vessel speed on propeller injury, and the results cannot be applied to all vessel-strike scenarios (Sapp 2010; Work et al. 2010). According to Hazel et al. (2007a), sea turtles cannot avoid boat collisions unless boats reduce their speed to 2.2 knots, increasing the likelihood that direct strikes on the carapaces from vessels operating at fast speeds will be lethal. Sea turtles struck by propellers have a greater chance of surviving than those that incur blunt force on the carapace, which can expose the body cavity.

To estimate the number of lethal vessel strikes of large sea turtles due to the proposed action, we relied on data from NMFS' Sea Turtle Stranding and Salvage Network (STSSN)[56], which consist of records of stranded sea turtles, primarily large ones, throughout the action area (Florida [Gulf coast]-Texas). We queried the STSSN database for records of stranded sea turtles with evidence of vessel strike (definitive, probable, and possible, based on standard database codes). While we recognize that some vessel strikes may be postmortem, the available data indicate that postmortem vessel strike injuries are uncommon in stranded sea turtles (Foley et al. 2019). Thus, even for those STSSN records of stranded sea turtles with evidence of vessel strike that did not undergo a full necropsy, the available data indicate that in most cases the cause of death was vessel strike. Furthermore, as detailed below, in our analysis we do not assume that every stranded sea turtle with evidence of a vessel strike was killed by a vessel strike. We evaluated all available information associated with the stranding event and estimated maximum, minimum, and mid-point values to incorporate the uncertainty associated with determining whether the cause of death was indeed a vessel strike.

To estimate the annual number of sea turtles that are killed by vessel strikes within the action area, we used the most recent complete 10-year, fully verified dataset from the STSSN, which consisted of data from 2006-2015. Using these data, we excluded cases in which a vessel strike was clearly not the cause of the stranding (as noted in the stranding event record) and those where the sea turtle was successfully released (i.e., the injury was non-lethal). Thus, only records in which the sea turtle was dead upon stranding, died soon after, or was deemed non-releasable (and thus was removed from the population) and had some evidence of vessel strike (definitive, probable, and possible) were considered in the analysis. Using these data, for each year we calculated the minimum annual number of observed lethal vessel strikes as the annual number of strandings with definitive and probable evidence of a lethal vessel strike, and then calculated the

[56] https://www.sefsc.noaa.gov/species/turtles/strandings.htm

maximum annual number of observed lethal vessel strikes as the annual number of strandings with definitive, probable, and possible evidence of a lethal vessel strike. We then calculated the mid-point of these annual minima and maxima and graphed the resulting values by species to inspect for temporal increases and/or decreases.

Since there were no clear, consistent temporal changes in the number of observed lethal vessel strikes over the 10-year period for any species (based in the mid-point values), we calculated the annual average number of observed lethal vessel strikes of each species within the action area as the average of the 10 annual mid-point values. Finally, since some records in the STSSN database were not identified to species, we attributed a portion of the total annual average number of observed lethal vessel strikes of "unknown" sea turtles to each "known" species based on the percentage each species made up of the estimated total annual average number of observed lethal vessel strikes of all species combined. The final estimates of the annual average number of observed lethal vessel strikes of each species can be seen in the second column of Table 56.

Table 56. Vessel strike mortalities of large (greater than 30-centimeter diameter) sea turtles in the action area.

Species	Annual Average Vessel Strike Mortalities (Observed)	Annual Average Vessel Strike Mortalities (Corrected)	Annual Lethal Vessel Strike Injuries Resulting from Oil and Gas Vessels
Green	109	643	389
Hawksbill	2	12	8
Kemp's Ridley	62	363	202
Loggerhead	100	590	334
Leatherback	3	17	10

The estimates in column two of Table 56 are only based on observed stranding records, which represent only a portion of the total at-sea mortalities of sea turtles within the action area. Although sea turtle stranding rates are variable, they usually do not exceed 20 percent of total mortality, as predators, scavengers, wind, and currents prevent carcasses from reaching the shore (Koch et al. 2013). Strandings may represent as low as five percent of total mortalities in some areas (Koch et al. 2013). Strandings of dead sea turtles from fishery interactions have been reported to represent as low as seven percent of total mortalities caused at sea (Epperly et al. 1996). Remote or difficult to access areas may further limit the amount of strandings that are observed. NRC (1990a) estimated boat-related mortalities of sea turtles numbered at about 400 per year for the U.S. Gulf of Mexico and Atlantic Coasts when one accounts for turtles that are not included in stranding records by assuming only 20 percent of sea turtles killed by vessels strand. Because of the low probability of stranding under different conditions, determining total vessel strikes directly from raw numbers of stranded sea turtle data would vary between regions, seasons, and other factors such as currents.

To correct the observed annual average vessel strike mortalities in Table 56 (column two) to include unobserved vessel strike mortalities, we relied on available estimates from the literature of the proportion of at-sea mortalities of sea turtles that are observed in stranding data within the action area. Based on data reviewed in Murphy and Hopkins-Murphy (1989), only six of 22 loggerhead sea turtle carcasses tagged within the South Atlantic and Gulf of Mexico region were reported in stranding records, indicating that stranding data represent approximately 27 percent of at-sea mortalities. In comparing estimates of at-sea fisheries induced mortalities to estimates of stranded sea turtle mortalities due to fisheries, Epperly et al. (1996) estimated that strandings represented 7-13 percent of all at-sea mortalities.

Based on these two studies, both of which occurred within or near the action area, stranding data likely represent 7-27 percent of all at-sea mortalities. While there are additional estimates of the percent of at-sea mortalities likely to be observed in stranding data for locations further outside the action area (e.g., Koch et al. 2013; Peckham et al. 2008), we did not rely on these since stranding rates depend heavily on beach survey effort, current patterns, weather, and seasonal factors among others, and these factors vary greatly with geographic location (Hart et al. 2006; Nero et al. 2013; Santos et al. 2018). Thus, based on the mid-point between the lower estimate provided by Epperly et al. (1996) of seven percent, and the upper estimate provided by Murphy and Hopkins-Murphy (1989) of 27 percent, we assume that the STSSN stranding data represent approximately 17 percent of all at sea mortalities.

To estimate the annual average vessel strike mortalities corrected for unobserved vessel strike mortalities, we divided the number of observed annual average vessel strike mortalities in column two of Table 56 by 0.17. The resulting, corrected annual average number of vessel strike mortalities of each species within the action area are given in column three of Table 56. In using the 17 percent correction factor, we assume that all sea turtle species and at-sea mortalities are equally likely to be represented in the STSSN dataset. That is, sea turtles killed by vessel strikes are just as likely to strand and be recorded in the STSSN database (i.e., 17 percent) as those killed by other activities, such as interactions with fisheries, and the likelihood of stranding once injured or killed does not vary by species.

Finally, to estimate the annual average number of vessel strike mortalities that are likely to be due to the proposed action, we multiplied column three by the maximum percent *vessel strike risk* associated with oil and gas vessel traffic for each species (Table 52). The final estimate of the annual number of lethal vessel strike injuries resulting from oil and gas vessels associated with the proposed action are given in column four of Table 56.

For small sea turtles [oceanic juveniles and hatchlings, considered to be less than 30 cm in diameter, hereafter small sea turtles (Epperly et al. 1995; NMFS 2011e)], there is very little information on the incidence of vessel strikes (lethal and non-lethal). While the STSSN dataset discussed above includes some records of stranded small sea turtles, these records comprise only a small proportion of the overall dataset (approximately seven percent) meaning the STSSN data primarily represent information on larger sea turtles. Given the lack of studies focused on vessel strikes of small sea turtles, we do not know if the strike rates of small sea turtles consistently differ from those of larger sea turtles; however, some studies of nearshore foraging areas show that older, benthic-stage juveniles are commonly struck (Blumenthal et al. 2009; Casale et al. 2012). Therefore, we conservatively assume vessel strikes are occurring in the surface-pelagic stage as well and rely on information on vessel strikes of large sea turtles to estimate exposure of small sea turtles to vessel strike from the proposed action.

For non-lethal vessel strikes of small sea turtles, we used again used equation (2) and relied on the same percentage of free swimming large sea turtles with non-lethal vessel strike injuries given in Table 53. For abundance of small sea turtles, we relied on the density information in Section 8.1.2, and as with adults, calculated abundance based on the month with the expected maximum abundance (Table 57, maximum abundance in July based the largest extent of *Sargassum* from (Gower and King 2008; Gower and King 2011b)).

Table 57. Abundance of small (less than 30-centimeter diameter) sea turtles in action area.

Species	Abundance in Action Area
Green	915,516
Hawksbill	27,342
Kemp's Ridley	779,688
Loggerhead	647,136
Leatherback	0

As before, we used correction factors derived from survival probabilities from the Kemp's ridley and loggerhead recovery plans. For Kemp's ridley sea turtles, the most recent recovery plan estimated a survival probability for hatchlings and pelagic stage sea turtles of 0.318 and for small juveniles of 0.815. These survival probabilities correspond to mortality rates of 0.682 and 0.185 respectively, and an average for small Kemp's ridley sea turtles of 0.4335. For loggerhead sea turtles, the most recent recovery plan estimated a survival probability for hatchling and post-hatchlings of 0.7 and for oceanic juvenile of 0.9. These survival probabilities correspond to mortality rates of 0.3 and 0.1 respectively, and an average for small loggerhead sea turtles sea turtles of 0.2. As was done above with larger sea turtles, we relied on the more conservative mortality rate (here 43.35 percent from Kemp's ridley sea turtles) for species that we lack survival probability estimates. Finally, rather than relying on the percent of *vessel strike risk* associated with oil and gas vessel traffic [P_{vsr_og} in equation(2)] calculated for large sea turtles (Table 52), for small sea turtles we took a simplified approach and instead relied on the maximum percent oil and gas vessel traffic makes up of all vessel traffic in the Gulf of Mexico (Table 46, 46 percent) for two reasons. First, for small sea turtles we lack location specific density estimates like we have for adult sea turtles so any calculations of small sea turtles and vessel traffic would be strictly driven by vessel traffic (i.e., because small sea turtle density is constant). Second, while Gower and King (2011a) show the general location and seasonal movement of *Sargassum* habitat in the Gulf of Mexico, this is not to say that at different times of the year *Sargassum* (and thus small hardshell sea turtles) are found elsewhere. In fact, the density estimates we relied on from Witherington et al. (2012a) were from *Sargassum* habitat outside the areas identified in Gower and King (2011a) and recently Hardy et al. (2018) demonstrated that there are measurable levels of *Sargassum* habitat year round in the eastern Gulf of Mexico, even relatively close to shore. Given these issues, we conservatively assumed that all vessel traffic in the Gulf of Mexico has the potential to overlap with *Sargassum* habitat and relied on 46 percent from Table 46 as a proxy for the proportion of *vessel strike risk* for small sea turtles associated with oil and gas vessel traffic [P_{vsr_og} in equation (2)]. Using these values in equation (2), we calculated the annual number of non-lethal vessel strikes of small sea turtles due to oil and gas vessels under the proposed action (Table 58).

Table 58. Non-lethal vessel strike injuries of small (less than 30-centimeter diameter) sea turtles in the action area.

Species	Percent with Non–lethal Vessel-Strike Injuries	Non-lethal Vessel Strike Injuries Observed in Population at Any Time Resulting from All Vessels	Annual Non-lethal Vessel Strike Injuries Resulting from All Vessels	Annual Non-lethal Vessel Strike Injuries Resulting from Oil and Gas Vessels
Green	2.22%	20,324	8,811	4,053
Hawksbill	2%	547	237	110
Kemp's Ridley	2.30%	17,933	7,774	3,576
Loggerhead	2.80%	18,120	3,624	1,668
Leatherback	2.80%	0	0	0

For lethal vessel strikes of small sea turtles, we relied on our estimates of lethal and non-lethal vessel strikes for large sea turtles provided in Table 55 and Table 56 and our estimates of the non-lethal strikes of small sea turtles in Table 58. Assuming the lethal to non-lethal vessel strike ratio for large sea turtles also applies to small sea turtles, we calculated the annual lethal vessel strikes of small sea turtles from all vessels (Table 59, column four) by multiplying the lethal to non-lethal ratio for large sea turtles (Table 59, column two) by the previously estimated number of annual non-lethal vessel strikes of small sea turtle (Table 59, column three). Then, to determine what proportion of these were the result of oil and gas vessel traffic, as above for non-lethal strikes of small sea turtles, we multiplied by 46 percent from Table 46 as a proxy for the proportion of *vessel strike risk* for small sea turtles associated with oil and gas vessel traffic. The final estimated annual number of lethal vessel strikes of small sea turtles that are due to oil and gas vessel traffic are given in Table 59, column five.

Table 59. Lethal vessel strike injuries of small (less than 30-centimeter diameter) sea turtles in the action area.

Species	Ratio of Lethal to Non-lethal for Large Sea Turtles	Annual Non-lethal Vessel Strike Injuries Resulting from All Vessels for Small Sea Turtles	Annual Lethal Vessel Strike Injuries Resulting from All Vessels	Annual Lethal Vessel Strike Injuries Resulting from Oil and Gas Vessels
Green	1.99	8,811	17,528	8,063
Hawksbill	0.02	237	6	3
Kemps Ridley	0.53	7,774	4,124	1,898

Loggerhead	0.37	3,624	1,358	625
Leatherback	0.34	0	0	0

In summary, sea turtle encounters with oil and gas vessels that result in injury or mortality are likely. Many sea turtles die as a result of being struck by moving vessels, although some injuries are likely not fatal, and individuals survive. It is generally not possible to determine what proportion of stranded sea turtle injuries were post or ante-mortem, there are also likely many unobserved and unreported vessel strikes of sea turtles. Furthermore, sea turtles do not appear to avoid vessels traveling faster than approximately 2.2 knots, and would therefore not evade the vast majority of oil and gas vessels.

8.4.3.2 Response

Collisions with vessels would likely result in blunt trauma, lacerations, or mortality. Although many sea turtles die as a result of their being struck by moving vessels, many also survive. For those species of sea turtles that sustain non-lethal injury, the severity of injury and time it takes to recover are not possible to determine, but expected to have some type of fitness consequence. We also assume some of these sea turtles would be compromised and sustain infection, have reduced foraging abilities, experience higher predation risks, or die some time later as a result of vessel strike injuries.

For example, injured male sea turtles that lose flippers as a result of vessel strikes may be at a disadvantage in completing proper mating postures with females. Missing flippers could lead to increased time and energy spent trying to mate, reduced reproductive success, or failure to reproduce depending on the nature and severity of the disfigurement. Other turtles may have difficulty swimming and diving that can lead to increased vulnerability to predation or decreased foraging success. Still other turtles may experience only temporary effects on their behaviors while the injuries heal and no long-term effect on the foraging or reproductive success of individuals would be expected. Female turtles that lose fore flippers may not be able to complete the beach crawl to a nest site above the high-tide line. Rear flipper loss may result in the excavation of shallow or incomplete nest cavities, or females may not be able to excavate a nest at all. Partial or complete rear flipper loss would also result in females' inability to adequately cover and camouflage a nest after having laid eggs. Inadequate nest chamber depths or poorly covered nests could result in increased predation on eggs in shallow nests. Eggs incubated in shallow nests could also become too hot and fail to develop or result in skewed sex ratios leading to all or predominantly female embryos in nests.

8.4.4 Gulf Sturgeon

There are little data available on vessel strikes of Gulf sturgeon. However, as mentioned previously, the last five year species review identified vessel strikes as an emerging threat for Gulf sturgeon and vessel strikes are a known threat to Atlantic sturgeon. Because of the similarity of these species and the lack of data specific to Gulf sturgeon, we relied on the information for Atlantic sturgeon as a surrogate for our effects analysis for Gulf sturgeon.

Specific to sturgeon, the term “vessel strike” indicates injury or mortality caused by entrainment through the propellers of vessels and direct collisions with vessel hulls.

A total of 28 mortalities of Atlantic sturgeon were reported in the Delaware River estuary between 2005 and 2008, 14 of which were determined to be the result of vessel strike (Brown and Murphy 2010). Similarly, in the James River in Virginia, 34 out of a total of 39 Atlantic sturgeon had injuries consistent with vessel strikes (Brown and Murphy 2007, Balazik et al 2012). The actual number of vessel strikes in both of these river systems in unknown; however, Balazik et al (2012) estimated up to 80 sturgeon were killed between 2007 and 2010.

Like Gulf sturgeon, Atlantic sturgeon are demersal fishes. Since sturgeon spend most of their time near the bottom of the water column, they are more likely to be struck by larger vessels. Based on the demersal behavior of sturgeon, the damage inflicted upon carcasses and the large numbers of deep draft vessels, Brown and Murphy (2010) concluded that interactions with large vessels such as tankers comprised the majority of the vessel strikes on Atlantic sturgeon, with a lower percentage likely resulting from interactions with small recreational or commercial fishing vessels equipped with outboard or inboard/outboard (stern drive) engines. Large vessels that transit through shipping channels, which are often located within suitable estuary habitat for sturgeoen, typically draft close to the bottom, thereby posing a threat of vessel strike to demersal sturgeon (Brown and Murphy 2010). As vessel size increases, the likelihood that sturgeon are killed during encounters with vessels also increases.Alternatively, sturgeon are known to frequently jump out of the water (Sulak et al. 2002). During jumping episodes, when sturgeon are located at or near the surface of the water, they may be more vulnerable to strikes from smaller vessels powered by outboards.

The Atlantic Sturgeon Status Review Team (ASSRT 2007) determined Atlantic sturgeon in the Delaware River are at a moderately high risk of extirpation in that system because of ship strikes and sturgeon in the James River are at a moderate risk from ship strikes. Since that time, managers have been concerned that ship strikes may also be threatening Atlantic sturgeon in the Hudson River. In these systems, which are similar to those found in the Gulf of Mexico where Gulf sturgeon reside, large ships movefrom the mouths of the river to ports upstream through narrow shipping channels. The channels are dredged to the approximate depth of the ships, usually leaving less than six feet of clearance between the bottom of ships and the benthos. Because of the size of the propellers used on large ships, everything along the bottom is sucked through the propellers. As shipping increases in the future, as predicted by the USCG (2017), more sturgeon are likely to be killed as a result of encounters with ships.

Available evidence suggests that larger sturgeon are more susceptible to the lethal effects of vessel strikes, as smaller sturgeon may pass through the propellers without contact and injury. Sixty-one percent of the Atlantic sturgeon mortalities reported in Brown and Murphy (2010) were of adult size and 50 percent of the mortalities resulted from apparent vessel strikes. The remainder of the mortalities were too decomposed to ascertain the cause of death, but the majority were likely the result of vessel strikes. By conducting an egg-per-recruitment analysis, which examines relative changes in recruitment as a function of adult female population size, Brown and Murphy (2010) also concluded that in the Delaware Estuary vessel-strike mortalities could be detrimental to the population if more than 2.5 percent of the adult female sturgeon are killed annually.

8.4.4.1 Exposure

There have been two reported definitive deaths of Gulf sturgeon from 2015-2017 due to vessel strike (Panama City FWS unpublished data). This is considered an underestimate of actual Gulf sturgeon deaths by vessel strike because many are likely to be unreported or sink to the bottom and are not observed. We have used the best available information and made reasonable, conservative assumptions in favor of the species to address uncertainty and produce an analysis that results in an estimate of the number of interactions between sturgeon and vessels that are reasonably certain to occur as a result of the proposed action.

The number of oil and gas vessels traversing Gulf of Mexico ports at any given time varies. Louisiana and Texas ports seem to have heavier traffic; however ports out of Mississippi, Alabama and Florida also sustain oil and gas vessel traffic. Based on this, Gulf sturgeon in the Pearl and Pascagoula River systems have a higher chance of being exposed than those in the other five river systems where they are found. That said, the Pearl and Pascagoula River Gulf sturgeon populations have fewer numbers of individuals relative to the Suwanee, Apalachicola, Yellow/Escambia, Black, and Choctawhatchee river populations.

If we use the documented rate of Gulf sturgeon mortality due to vessel strikes of two deaths every three years, then we calculate about seven deaths in ten years or 34 in 50 years due to vessel strike. This is an underestimate because it does not consider unobserved or unreported strikes, but there are no current studies that report on strike rates or carcass recovery rates for Gulf sturgeon. Without documented carcass recovery rates available for Gulf sturgeon, it is difficult to determine number of fish struck and unobserved. Fish bodies that are severed completely through would be expected to sink, and we know fish are being struck due to the healed wounds observed on other live sturgeon species.

Gutreuter et al. (2003) estimated mortality rates of a smaller species, shovelnose sturgeon, from towboat propeller entrainment in river channels at about 0.53 fish/km of towboat travel (80 percent confidence interval, 0.00-1.33 fish/km). A similar study looked at towboat entrainment of shovelnose sturgeon in the Upper Mississippi River and found about 38 sturgeon per square kilometer (0.38 fish per hectare) were injured or killed by towboat propellers, which according to the authors was likely a worst-case scenario because of the greater speed and power required to pull the tow nets.

Studies on Atlantic sturgeon carcass recovery rates are currently being conducted on the Delaware River. Preliminary results suggest that sturgeon carcasses that are on the beach may be more likely to be reported than those that sink.

Balazik et al. (2012) conducted a study in Virginia's James River on Atlantic sturgeon that suggested that less than a third of carcasses may be recovered. Therefore, we used a 33 percent carcass recovery rate and added 11 individuals to the calculated 34 Gulf sturgeon struck in 50 years to account for unobserved lethally struck animals (i.e., 45). Using 9.23 percent of vessel traffic as estimated above, five Gulf sturgeon deaths are expected from oil and gas related vessels over the time period covered under this opinion (45 x 0.0923 = 4.15 rounded up).

8.4.4.2 Response

We expect some Gulf sturgeon individuals will be injured or killed from vessel strike associated with the proposed action. Responses to vessel strikes can range from minor cuts/contusions to larger cuts to death. Injuries that are non-lethal could subsequently result in reduced fitness or death due to the potential of leaving a fish vulnerable to secondary stressors, such as disease or predation. There have been no reported observations of live Gulf sturgeon with evidence of previous vessel strike, however, there have been Atlantic sturgeon observed with apparent vessel strike injuries that were still alive, some of which sustained healed injuries, while others died shortly after capture or were expected to die shortly after release due to the extent of the injuries (NMFS unpublished data, evidence of four strikes in 210 live captures). Based on NMFS Atlantic sturgeon strike data, we would expect approximately two percent of the Gulf sturgeon struck to survive or approximately one non-lethal Gulf sturgeon strike in the 50 years over which the proposed action will occur.

8.4.5 Oceanic Whitetip Sharks and Giant Manta Rays

Vessel strikes of elasmobranch species, in general, are extremely rare. The small number of giant manta rays and oceanic whitetip sharks within the action area contributes to the very unlikely occurrence of a vessel strike to one of these species. We are not aware of any previous reports of a ship strike in theGulf of Mexico involving a giant manta ray or oceanic whitetip shark. Giant manta rays are found in open water,feeding over reefs, or visiting shallow water cleaning stations in certain areas. Oceanic whitetips tend to prefer the deeper ocean waters where there is no likelihood of vessel strike. Although oceanic whitetips have been observed in waters as shallow as 120 feet and along coastlines, they tend to only hunt in these waters if they are near a continental shelf where they still have access to deeper waters. Based on the best available information, we find that the a vessel strike of a giant manta ray or oceanic whitetip shark is extremely unlikely to occur due to their rarity in the action area and their lack of surface oriented behavior. Therefore, we find the effects to giant manta rays and oceanic whitetip sharks from vessel strikes to be discountable.

8.4.6 Summary of the Effects of Vessel Strikess

Based on the above analysis, we conclude that sperm whales, Bryde's whales, sea turtles and Gulf sturgeon will be adversely affected by vessel strikes associated with vessel traffic created by the Oil and Gas Program.

There is uncertainty regarding unconfirmed observations of Bryde's whales outside of the area where this species is primarily found. There has been one confirmed sighting in the western Gulf and unconfirmed observations west of their predominant habitat, termed in this opinion "the Bryde's whale area". Because of this uncertainty regarding unconfirmed observations, we were not able to use the information for Bryde's whales outside their main habitat towards our jeopardy analysis. This is described more in the *Integration and Synthesis* section 11.1. The estimated take numbers do not include traffic from tankers and barges that carry post-refining Gulf of Mexico-sourced oil, because, as noted previously, we are not able to determine what percentage of this tanker traffic would be attributed to the Oil and Gas Program. Injury or death may result from either blunt force trauma or propeller impacts. We also conclude that oceanic whitetip sharks and giant manta rays are not likely be adversely affected by vessel strikes.

We estimated that the following numbers of Bryde's whales, sperm whales, Gulf sturgeon and Kemp's ridley, loggerhead (Northwest Atlantic Ocean DPS), green (North Atlantic and South Atlantic DPSs), leatherback, and hawksbill sea turtles will be adversely affected by vessel strikes associated with the Oil and Gas Program over 50 years (Table 60).

Table 60. Number of takes by mortality and nonlethal injuries over the 50-year duration of the proposed action.

Species	Number of Nonlethal Strikes	Number of Lethal Vessel Strikes
	ADULTS AND NERITIC JUVENILES	
Kemp's ridley	19,050	10,100
Loggerhead	44,550	16,700
Green	9,800	19,450
Leatherback	1,400	500
Hawksbill	14,850	400
	OCEANIC JUVENILES	
Kemp's ridley	178,800	94,900
Loggerhead	83,400	31,250
Green	202,650	403,150
Leatherback	0	0
Hawksbill	5,500	150
	Nonlethal Strikes	**Lethal Strikes**
Sperm Whales	6	16
Bryde's Whales	6 (4)*	17 (12)*
Gulf sturgeon	1	5

**Number of strikes in parentheses considers Bryde's whale proposed RPA mitigation measures described in Section 14.*

8.5 Effects of Sound

There is a considerable body of scientific information on anthropogenic sound and its effects on marine life (Abgrall et al. 2008; Bowles 1994; Croll et al. 2001; Croll et al. 1999; Frankel and

Clark 2000; Gisiner 1998; Gordon et al. 2004; Greene and Moore 1995; McCauley and Cato 2001; Normandeau Associates Inc. et al. 2011; Norris 1994; NRC 1994; NRC 1996; NRC 2000; NRC 2003; NRC 2005a; OSPAR 2009; Popper and Hastings 2009a; Reeves 1992; Southall et al. 2007; Tyack 2007; Tyack and Clark 2000; Weilgart 2007a; Wright et al. 2007). Despite the large interest in this area of research and the numerous studies available, for many species we still lack sufficient information on how individuals use sound to communicate or precieve and interact with the environment. Furthermore, the mechanisms by which human-generated sounds affect the behavior and physiology (including non-auditory physiology) of marine mammals, and the circumstances that are likely to produce outcomes that have adverse consequences for individual marine mammals and marine mammal populations are not completely understood. Although sound is believed to be relatively less important for sea turtles than it is for sperm whales or Bryde's whales, similar uncertainties remain regarding the effects of anthropogenic sound on these species. When we consider exposure to different types of sound in the exposure categories, we must always consider the frequency content of the sound and duration of the sound source. For example, the reaction of animals exposed to disturbing levels of sound would be expected to differ for brief, infrequent sound and sound that is repeated over long periods of time. Such is the case with the use of explosives to decommission oil and gas structures that result in short periods of sound. We will discuss the effect of brief exposures to sound in the effects analysis for decommissioning later in this section.

The following sections on the effects of human-made sound on listed species as a result of the proposed action are divided into three subsections, which consider the effects of each category of activity:

1) Geological and Geophysical Activities
2) Decommissioning
3) Construction Sound

Specific information relevant to these activities and the methods to determine which effects may occur is summarized in each of the three sound subsections of this opinion. This introductory section is intended to first provide a brief background on acoustics, and then an overview of the effects of sound on sperm whales, Bryde's whales and sea turtles. We then discuss acoustic thresholds, and use those thresholds to estimate sperm whale, Bryde's whale, and sea turtle exposure and response levels for each of the sound sources associated with the proposed action. Finally, we evaluate the effects of sound on the fish species (Gulf sturgeon, oceanic whitetip sharks, and giant manta rays) considered in this opinion.

8.5.1 Overview of Sound

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in hertz (Hz) or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the “loudness” of a sound and is typically described using the relative unit of the decibel (dB). A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is one micro Pascal (μPa)), and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of one meter from the source decibels relative to one μPa, and thus is written as dB re: 1 μPa at 1 m, while the received level is the SPL at the listener’s position (i.e. zero m from the listener) and thus is written as dB re: 1 μPa with no distance.

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. Rms is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick 1983). Rms accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005b). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

Sound exposure level (SEL; represented as dB re: 1 μPa^2-s) represents the total energy contained within a certain time period and considers both intensity and duration of exposure. For a single pulse (e.g., single airgun shot), it may be written as SEL_{ss}, whereas cumulative sound exposure levels over multiple pulses may be written as SEL_{cum}. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-pk) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source, and is represented in the same units as the rms sound pressure. Another common metric is peak-to-peak sound pressure (pk-pk), which is the algebraic difference between the peak positive and peak negative sound pressures. Peak-to-peak pressure is typically approximately six dB higher than peak pressure (Southall et al. 2007).

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources), as is the case for pulses produced by the airgun arrays considered here. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

The addition of sound to the marine environment is recognized as a risk by the scientific community (Payne 1971), that could harm marine mammals or significantly interfere with their normal activities (NRC 2005a). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (NRC 2003; NRC 2005a), there are many unknowns in assessing impacts such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007).

Sounds are often considered to fall into one of two general types: impulsive and non-impulsive, which differ in the potential to cause physical effects to animals (see Southall et al. (2007) for in-depth discussion). Impulsive sound sources produce brief, broadband signals that are atonal transients and occur as isolated events or repeated in some succession. They are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury. Non-impulsive sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous. Some can be transient signals of short duration but without the essential properties of pulses (e.g., rapid rise time). The duration of non-impulsive sounds, as received at a distance, can be greatly extended in a highly reverberant environment. The proposed action involves both impulsive (e.g., seismic airguns) as well as non-impulsive sounds (e.g., vessel sound).

Other sources from the Oil and Gas Program include; oil platform construction, MODUs, oil and gas extraction activities, vessel dynamic positioning, and platform destruction and removal (including underwater explosives).

Impact pile driving creates repetitive impulsive sound. An impact pile driver generally operates in the range of 36 to 50 blows per minute. Vibratory pile driving creates a nearly continuous sound made up of a series of short duration rapid impulses at a much lower source level than impact pile driving. The sounds are emitted both in the air and in the water.

Underwater explosions would occur after decommissioning and during equipment removal and secondarily from swimmer defense airguns. The shock wave and blast sound from explosions are of concern to marine animals. Depending on the intensity of the shock wave and size and depth of the animal, an animal can be injured or killed. Further from the blast, an animal may suffer non-lethal physical effects. Outside of these zones of death and physical injuries, marine animals may experience hearing related effects with or without behavioral responses.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss).

Effects to ESA-listed species

Having provided a broad background on acoustics, we now provide an overview of the potential effects of sound exposure to ESA-listed species, mainly sperm whales, Bryde’s whales, and sea turtles.

Depending on the type and location of a sound, potential effects of anthropogenic sound include interference with communication (i.e., masking), disruption or changes in behavior, hearing impairment (i.e., permenant or temporary hearing threshold shifts), or other non-auditory physical and physiological effects such as hematomas and injuries to the lungs, intestines, and other internal organs. In cases of extreme exposure (e.g., high peak pressure levels from underwater explosives), stunning or death could occur from external and internal injuries. Death is also possible due to indirect effects that may result in reduction of fitness (e.g., increased energetic demands, increased susceptibility to predators or other anthropocentric stressors).

Like many marine animals, sea turtles, Bryde’s whales and sperm whales, likely rely on sound to detect prey, predators, and habitat types, and to navigate and communicate. Sperm whales use echolocation to find prey and navigate, and also use clicks known as codas to communicate with conspecifics. While Bryde’s whales do not echolocate to find prey, they use sound to communicate and perhaps for other ecological reasons. The use of sound by sea turtles is less clear, but it may be important in certain life stages (Lavender et al. 2014) and/or used to detect cues or threats in the environment.

The passage of sound waves through the ears results in hearing detection, but overly loud or persistent sounds can result in adverse effects on hearing. Effects on hearing ability can impair or limit an animal’s ability to detect sound in its environment. Underwater environments in the Gulf of Mexico can be turbid or dark where light does not reach deeper waters. In these types of low-visibility habitat, marine animals rely on other senses, including hearing, to detect the surrounding environment. Persistent sounds in the environment can mask important sounds or limit the distance over which an animal can detect sound or communicate. Increased ambient sound levels can impact marine mammals by changing communication space, altering behavior and causing stress (Hatch et al. 2012; Parks et al. 2013a; Parks et al. 2013b; Pirotta et al. 2013; Rolland et al. 2012).

Stress responses occur when an animal is exposed to a stressor that triggers a behavioral, nervous system, endocrine, or immune response. Stress resulting from sound exposure has been observed in a number of vertebrate species in both laboratory and free-living animals (Holberton et al. 1996; Hood et al. 1998; Jessop et al. 2003; Krausman et al. 2004; Lankford et al. 2005; Reneerkens et al. 2002; Thompson and Hamer 2000). There is some evidence suggesting that persistent ship sound may be a source of chronic stress in baleen whales (Rolland et al. 2012), inferred from a correlation between the presence of stress hormones and presence of ship sound. (Jansen 1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (for example, elevated respiration and increased heart rates). Jones and Broadbent (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper et al. (1998) reported on the physiological stress responses of osprey to low-level aircraft sound while (Krausman et al. 2004) reported on the auditory and physiological stress responses of endangered Sonoran pronghorn to military overflights. Smith et al. (2004a); (2004b) identified sound-induced physiological stress responses in hearing-specialist fish that accompanied temporary and permanent hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Stress responses can have adverse effects on immune response, reproduction, and metabolism, and can change normal behaviors. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg 1987; Rivier 1985) and altered metabolism (Elsasser et al. 2000), reduced immunity (Blecha 2000) and increased stress hormones in marine mammals (Romano et al. 2004). Adverse stress responses could also occur when an animal does not have sufficient energy reserves to meet the energetic costs of a stress response. In such cases, energy resources must be diverted to the stress response which imposes a cost to other important biological functions. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal’s reproductive success and its fitness will suffer. Studies of other marine animals and terrestrial animals would lead us to expect some marine mammals experience stress responses to loud or chronic exposure to sound.

When considering the effects of sound exposure on the behavior of whales, a spectrum of responses could be expected depending on the life history stage, sex, habitat, or time of year. In general, more severe consequences of sound exposure occur at close ranges. Injury and disturbance typically occur in relatively close proximity to the source of sound, while the general detection of the sound extends to farther distances. Detection of the sounds produced does not necessarily equate to an adverse effect. Species have different lifestyles, sound-detection capabilities, and behavioral responses that must be considered in addition to the season, location, habitat, and life stage that may be affected. Examples of adverse consequences that could occur include a shift in an animal’s attention away from normal behaviors, such as foraging, as a result of exposure to a sound source. If a sound source captures an animal’s attention, the animal may respond by ignoring the stimulus at non-disturbing levels assuming a “watch and wait” posture, or be disturbed and respond accordingly (Cowlishaw et al. 2004). Most of the published literature suggests that moving sources coming towards an animal will increase the amount of time animals will dedicate to being vigilant, and less time resting or foraging (Gill et al. 2001; Stockwell et al. 1991). Types of responses may also include the classical “fight or flight” response which includes an overt behavioral response, such as avoidance, that may be accompanied by a cardiovascular, gastrointestinal, exocrine, and adrenal responses that produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with stress. These short-term responses are usually advantageous when an animal identifies and assesses a threat and takes immediate actions to defend itself or young, or avoids the threat altogether. Although "flight or fight" can be advantageous to avoid a threat, evasive behaviors could have some negative consequences on animals if they are driven out of important habitats or otherwise result in some harm to animals.

Injury to hearing can result if the sound causes a permanent reduction in hearing abilities, also known as permanent threshold shifts (PTS). PTS will permanently impair an animal's ability to detect and use certain frequencies of sound or could completely deafen an animal if auditory structures are severely damaged or altered by injury (e.g., by exposure to explosions). Temporary hearing loss, also known as a temporary threshold shift (TTS), is a short-term hearing impairment resulting from exposure to loud sounds that is recoverable with time (hours to days). Temporary hearing loss is not considered physical injury but will cause auditory impairment to animals over the short period in which the TTS lasts. The consequences of hearing impairment would be greater in sperm whales and Bryde's whales as compared to sea turtles. This is because all available data suggest that sea turtles are much less sensitive to anthropogenic sound than cetaceans, which may be in part due to the fact that sea turtles appear to be less reliant on sound than cetaceans (Gomez et al. 2016; Nelms et al. 2016; Nowacek et al. 2007; Popper et al. 2014; U.S. Navy 2017). Sperm whales are constantly echolocating during foraging dives, listening to the vocalizations of calves and other whales within their group, and listening for the sounds of predators and other acoustic signals in the marine environment. Bryde's whales are vulnerable mainly because the majority of the sound energy that oil and gas activities, especially G&G, produce is in the lower frequency range, which may interfere with their communication, including potential matting calls.

Acoustic Thresholds

To analyze the effects of sound on sperm whales, Bryde's whales, and sea turtles, we rely on information concerning the sound levels at which animals are expected to respond in a manner that may result in adverse effects. In this section, we discuss what is known about sperm whales, Bryde's whale, and sea turtle hearing and detail the information used to determine the acoustic thresholds that if met or exceeded, are expected to result in adverse effects. We focus on thresholds for impulsive acoustic sources such as seismic airguns and pile driving, as of all the acoustic sources associated with the proposed action, they are likely to have the greatest overall impact on ESA-listed species. We address explosive and continuous sounds below in the individual sections associated with the activities that generate these types of sound.

As mentioned in Section 8.1, for Bryde's and sperm whales we are relying on the MMPA definitions of harassment for this consultation: harassment means any act of pursuit, torment, or annoyance that has the *potential to injure* a marine mammal or marine mammal stock in the wild (Level A harassment); or that has the *potential to disturb* a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering, but does not have the potential to injure a marine mammal or marine mammal stock in the wild (Level B harassment). For Level B harassment under the MMPA, NMFS has historically relied on an acoustic threshold of 160 dB re: 1 µPa (rms) for impulsive sounds to determine the received sound level at which animals are expected to be harassed. This value is based on observations of behavioral responses of mysticetes (Malme et al. 1983; Malme et al. 1984; Richardson et al. 1986b; Richardson et al. 1990), but is used for all marine mammal species. However, recent data suggests that this threshold may not be appropriate in all circumstances. For example, whether or not changes in behavior can harm an animal depend on the context of the sound exposure: the species, life history stage, or what behavior the animals were engaged in at the time of exposure (Ellison et al. 2012). In order to focus on the types of sounds that have the greatest potential to cause disturbance, we considered the use of steps of decibel increases in which increasingly more severe consequences of exposure can be expected. Our analysis considers that behavioral harassment or disturbance is not limited to the 160 dB threshold that has been traditionally used as the benchmark for the onset of behavioral disturbances. Disturbance may in fact be dependent on a number of sound source characteristics including the frequency content, duration or repetitive nature of the sound, the depth of the source, and whether or not the source is moving. In addition, individuals may respond in a variety of ways, some of which have more significant fitness consequences than others.

To determine the levels of sound that could potentially disturb sperm whales, we relied on data from a controlled exposure experiment (CEE) for sperm whales (Jochens et al. 2008). For assessing sound levels that are expected to disturb Bryde's whales, we relied on studies of other baleen whale reactions to seismic sounds (Richardson et al. 1986a). To our knowledge, there are no studies on the response of Bryde's to seismic sounds. However, there are several controlled studies on the responses of other related baleen whales to seismic airguns. Given that all baleen whales hear at low frequencies, and that they have similar anatomy and behavior, we consider data on the responses of other baleen whales the best available science to inform our understanding of the level at which Bryde's whales are likely to be disturbed. For both sperm and Bryde's whales, we compare these controlled studies to a recently proposed probabilistic approach to predict disturbance of marine mammals to sound (Wood et al. 2012b). The Wood et al. (2012) approach predicts the probability of disturbance of animals at different received levels of sound in an step-wise fashion (i.e., a step-function). The model proposes that with the exception of migrating baleen whales, beaked whales, and harbor porpoises, marine mammals will generally show a behavioral response to weighted levels of sound (with emphasis on sound frequencies for the accumulated exposure of a marine mammal species based on its hearing sensitivity, termed M-weighting) according to the following:

- 10 percent of animals will respond at 140 dB rms
- 50 percent of animals will respond at 160 dB rms
- 90 percent of animals will respond at 180 dB rms

Although the model proposed by Wood et al. (2012) allows us to estimate the percent of animals that may respond with increasing sound levels under the proposed action, the model is considered generally applicable to a variety of marine mammal species and not be specific to the species considered in this opinion. As such, we further evaluated these thresholds with data most relevant to sperm whales and Bryde's whales.

A CEE study on sperm whales was completed as part of the SWSS that helps put predicted exposures into better context (Jochens et al. 2008). Adult sperm whales were intentionally exposed to seismic survey sound from airguns up to 147 dB (rms) and their behavior and vocalizations recorded on tags attached to eight whales. The results of the CEE (Jochens et al. 2008; Jochens et al. 2006b; Miller et al. 2009a) provided the following conclusions regarding the response of sperm whales to airgun sound:

- There was no detection of horizontal avoidance of the seismic source found at exposure levels of less than 147 dB (rms).
- None of the whales changed their behavioral state (one resting, seven foraging), but the one whale that rested through the exposure was approached the closest and may have delayed diving during the exposure period.
- In addition to this observed potential delay to foraging during exposure (Miller et al. 2008; Miller et al. 2009), Bayesian analysis suggested a 20 percent decrease in foraging activity was more likely than no change in foraging activity for the seven foraging whales that were exposed to lower levels of sound, with one whale showing a statistically significant decrease in click rate activity of 60 percent (Jochens et al. 2008).
- There was a 19 percent reduction in buzz rate of whales exposed to the sound of airguns less than 150 dB (rms); however, these foraging "buzz" rates were not statistically different than that of natural variation.
- Oscillations in pitch generated by swimming movements during foraging dives were on average six percent lower during exposure than during the immediately following post-exposure period, with all seven foraging whales exhibiting significantly less pitching.
- The study concluded that some effects to foraging may be occurring, but it was not statistically significant; therefore, no conclusions on the biological significance of the effects on animals could be made.

Based on the limited sample of eight animals, the SWSS showed that sperm whales may make minor changes to their diving behavior on foraging dives, but do not actively avoid the survey and are successfully foraging during seismic surveys (although one whale showed 60 percent decreased success possibly due to other reasons). Although statistically insignificant, the study suggested some small effect on foraging efficiency was occurring. Still, it could not be determined if the decrease in efficiency was the result of changes in sperm whale behavior, effects of the prey items (squid), or some other unknown factors. In another study, playback experiments of seismic airgun sound resulted in squid exhibiting changes in swimming speed, diving depth, and startle responses at levels of 151-161 dB (rms) (McCauley et al. 2000) which could account for some change in foraging efficiency if changes in prey density or distribution occur. Even so, the CEE study could not conclude that the responses observed in sperm whales at exposures up to 147 dB (rms) resulted in any adverse effects. The study did not expose whales to sound levels greater than 147 dB (rms), but sperm whales are very likely exposed to higher levels in the Gulf of Mexico.

While the SWSS study was only based on a sample of eight animals, and its reslts were somewhat inconclusive, it does suggest some disturbance at received levels of 150 dB (rms). This is consistent with the Wood et al. 2012 step function, which predictions 10 percent disturbance at 140 dB (rms) and 50 percent disturbance at 160 dB (rms), as 150 db (rms) resides between these two steps. As such, the step function proposed by (Wood et al. 2012b), appears to reasonably predict the percent of sperm whales showing some change in behavior that constitutes level B harassment.

There have been several CEEs conducted on baleen whale behavioral responses and the results are similar to the sperm whale CEE (Gomez et al. 2016). As mentioned previously, studies of other baleen whales are considered the best available data to inform our analysis of Bryde’s whale responses because all baleen whales have similar hearing abilities and share many behavioral traits. We are aware of only one study that provides a direct comparison to the Wood et al. 2012 step function. Malme et al. (1984) studied the response of gray whales exposed to varying sound levels from seismic airguns and found that a 10 percent response rate at approximately 154-155 dB (rms), a 50 percent response rate at approximately 160 dB (rms), and a 90 percent response rate at approximately 175 dB (rms). As mentioned previously, the Wood et al. 2012 step function estimates 10 percent response rate at 140 dB (rms), a 50 percent response rate at 160 dB (rms), and a 90 percent response rate at approximately 180 dB (rms). From this comparison, the Wood et al. step function appears to reasonably estimate the probability of response, and may even be somewhat conservative because10 percent response is estimated at lower received levels. However, it is important to note that the Wood et al. step function takes into account a species hearing ranges using auditory weighting functions, where as the Malme study does not. Nonetheless, other studies of baleen whale response to seismic activity further support the Wood et al. step function as being a reasonable approximation of the expected response probabilities. Other studies of gray whales found that they discontinued feeding and/or moved away at received sound levels of 163 dB re: 1 µPa (rms) (Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007; Malme and Miles 1985; Malme et al. 1984; Malme et al. 1986; Malme et al. 1988; Meier et al. 2007; Würsig et al. 1999; Yazvenko et al. 2007). Studies of humpback whales off the coast of Alaska found that individuals startled at 150 to 169 dB re: 1 µPa (rms) and showed clear evidence of avoidance at received levels up to 172 dB re: 1 µPa (rms) (Malme et al. 1984; Malme et al. 1985). (Richardson et al. 1986a) found that bowhead whales began showing subtle avoidance behavior during seismic surveys in the 150-160 dB (rms) range. There are several studies that suggest that migrating baleen whales likely respond at lower received levels than compared to baleen whales engaged in other activities. For example, migrating bowhead whales show strong avoidance reactions to received 120 to 130 dB re: 1 µPa (rms) exposures at distances of 20 to 30 km, but only changed dive and respiratory patterns while feeding and showed avoidance at higher received sound levels (152 to 178 dB re: 1 µPa [rms]) (Harris et al. 2007; Ljungblad et al. 1988; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995b; Richardson et al. 1999b; Richardson et al. 1986b). Migrating humpbacks altered their travel path (at least locally) along Western Australia at received levels as low as 140 dB re: 1 µPa (rms) when females with calves were present, or six to 12 km from the acoustic source (McCauley et al. 2000; McCauley et al. 1998). Importantly, Bryde's whales are resident to the Gulf of Mexico and do not exhibit migratory behavior. In summary, based on our review of the above studies, we also find that the step function proposed by (Wood et al. 2012b) reasonably predicts the percent of Bryde's whales showing some change in behavior that constitutes Level B harassment.

Based on our evaluation of the studies above, the probabilistic (step) function proposed by (Wood et al. 2012b) provides a reasonable characterization of the percent of whales that may harassed by sound. There is considerable uncertainty regarding the effects of higher sound exposures and different sound types on Bryde's and sperm whales. Some marine mammal species may show tolerance of some sound in certain frequency bands while different frequency contents may elicit stronger responses (Nowacek et al. 2004). However, we are not aware of any differential responses of whales to the sound sources considered in this opinion. A graded probability of response with exposures to different levels of sound (the step function) is useful to calculate the percent of animals in an area that may be disturbed over a period of time. For sounds that are persistent over long periods (hours, days, or weeks), the step function can model the daily levels of disturbance a population may be exposed to as a sound source and animals move around the area in which the activity occurs. Thus, the step function from Wood et al. (2012b) best predicts the onset of disturbance in Bryde's and sperm whales. In the G&G Final Programmatic EIS (BOEM 2017d), BOEM completed Bryde's and sperm whale exposure modeling from G&G sound sources using the step function proposed by (Wood et al. 2012b) and so we use BOEM's modeling as an estimate of disturbances from G&G activity. In the subsequent section on the effects of the action from sound, we will apply these methods and further consider the effects of the size of the ensonified area, frequency of the sound sources, and other factors that may affect the consequences of sound exposure on listed species.

For physiological responses to active acoustics, such as a TTS and PTS, we relied on NMFS' recently issued technical guidance for auditory injury of marine mammals (NOAA 2016)[57]. Unlike the Wood et al. 2012 Level B thresholds, these auditory thresholds differ by species hearing group (section 8.5.1). Furthermore, these thresholds are a dual metric for impulsive

[57] See www.nmfs.noaa.gov/pr/acoustics/guidelines.htm for more information.

sounds, with one threshold based on peak sound pressure level (0-pk SPL) that does not incorporate the duration of exposure, and another based on cumulative sound exposure level (SEL_{cum}) that does incorporation exposure duration. The two metrics also differ in regard to considering information on species hearing. The cumulative sound exposure criteria incorporate auditory weighting functions, which estimate a species group's hearing sensitivity, and thus susceptibility to TTS and PTS, over the exposed frequency range, whereas peak sound exposure level criteria do not incorporate any frequency dependent auditory weighting functions. The metric that results in a largest distance from the source (i.e., produces a largest field of exposure) is used in estimating exposure, because it is the more precautionary criteria.

In using these thresholds to estimate the number of sperm and Bryde's whales that may experience auditory injury, we classify any exposure equal to or above the threshold for the onset of PTS as auditory injury. Any exposure below the threshold for the onset of PTS, but equal to or above any of the Wood et al. 2012 thresholds is classified as Level B harassment. Among Level B exposures, we do not distinguish between those individuals that are expected to experience TTS and those that would only exhibit a behavioral response, as the exposure modeling results produced by BOEM in the G&G Final Programmatic EIS do not allow for such differentiation (BOEM 2017d).

To estimate sound levels that would be expected to result in a behavioral response that may be considered harassment under the ESA for sea turtles, we relied on the available scientific literature. Currently, the best available data come from studies by O'Hara and Wilcox (1990) and McCauley et al. (2000), who experimentally examined behavioral responses of sea turtles in response to seismic airguns. O'Hara and Wilcox (1990) found that loggerhead turtles exhibited avoidance behavior at estimated sound levels of 175 to 176 dB re: 1 µPa (rms) (or slightly less) in a shallow canal. McCauley et al. (2000) reported a noticeable increase in swimming behavior for both green and loggerhead turtles at received levels of 166 dB re: 1 µPa (rms). At 175 dB re: 1 µPa (rms), both green and loggerhead turtles displayed increased swimming speed and increasingly erratic behavior, which the authors suggested may indicate the turtles were in an agitated state (McCauley et al. 2000). Based on our evaluation of these behavioral responses, we assume that sea turtles would exhibit a behavioral response (e.g., increased swimming speed and increasingly erratic behavior) in a manner that constitutes harassment under the ESA when exposed to received levels of 175 dB re: 1 µPa (rms) and higher.We use this threshold to estimate the number of instances of adverse effects constituting behavioral harassment.

In order to estimate sound levels that would be expected to result in sound-induced hearing loss (i.e., TTS or PTS), we relied on acoustic thresholds for PTS and TTS for impulsive sounds developed by the U.S. Navy for Phase III of their programmatic approach to evaluating the environmental effects of their military readiness activities (U.S. Navy 2017). At the time our exposure analysis was conducted, we considered these to be the best available data since they rely on all available information on sea turtle hearing and employ the same statistical methodology to derive thresholds as in NMFS' recently issued technical guidance for auditory injury of marine mammals (NOAA 2016). Below we briefly detail these thresholds and their derivation. More information can be found in the U.S. Navy's Technical report on the subject (U.S. Navy 2017).

To estimate received levels from airguns and other impulsive sources expected to produce TTS in sea turtles, the U.S. Navy compiled all sea turtle audiograms available in the literature in an effort to create a composite audiogram for sea turtles as a hearing group. Since these data were insufficient to successfully model a composite audiogram via a fitted curve as was done for marine mammals, median audiogram values were used in forming the hearing group's composite audiogram. Based on this composite audiogram, and data on the onset of TTS in fishes, an auditory weighting function was created to estimate the susceptibility of sea turtles to TTS. Data from fishes were used since there are currently no data on TTS for sea turtles and fishes are considered to have hearing more similar to sea turtles than do marine mammals (Popper et al. 2014). Assuming a similar relationship between TTS onset and PTS onset as has been described for humans and the available data on marine mammals, an extrapolation to PTS susceptibility of sea turtles was made based on the methods proposed by (Southall et al. 2007). Based on these data and analyses, dual metric thresholds were established similar to those described above for marine mammals: one threshold based on peak sound pressure level (0-pk SPL) that does not incorporate the auditory weighting function nor the duration of exposure, and another based on cumulative sound exposure level (SEL_{cum}) that incorporates both the auditory weighting function and the exposure duration (Table 61).

Table 61. Impulsive acoustic permanent threshold shift and temporary threshold shift onset criteria be the species groups considered in this consultation.

Hearing Group	Generalized Hearing Range[58]	Permanent Threshold Shift Onset[59]	Temporary Threshold Shift Onset
Low-Frequency Cetaceans (Bryde's whales)	7 Hz to 35 kHz	$L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	$L_{pk,flat}$: 213 dB $L_{E,LF,24h}$: 168 dB
Mid-Frequency Cetaceans (sperm whales)	150 Hz to 160 kHz	$L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	$L_{pk,flat}$: 224 dB $L_{E,MF,24h}$: 170 dB
Sea Turtles	30 Hz to 2 kHz	232 dB re: 1 µPa SPL (0-pk) 204 dB re 1 µPa²·s SEL_{cum}	226 dB re: 1 µPa SPL (0-pk) 189 dB re 1 µPa²·s SEL_{cum}

From (NOAA 2016) (U.S. Navy 2017)

[58] Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on approximately 65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans Southall, B., A. Bowles, W. Ellison, J. Finneran, R. Gentry, C. Greene, D. Kastak, D. Ketten, J. Miller, P. Nachtigall, W. Richardson, J. Thomas, and P. Tyack. 2007. Aquatic mammals marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33(4):122.

[59] $L_{pk,flat}$: unweighted ($_{flat}$) peak sound pressure level (L_{pk}) with a reference value of 1 µPa; $L_{E,XF,24h}$: weighted (by species group; $_{LF}$: Low Frequency, or $_{MF}$: Mid-Frequency) cumulative sound exposure level (L_E) with a reference value of 1 µPa^2-s and a recommended accumulation period of 24 hours ($_{24h}$).

8.5.2 Effects of Sound from Geological and Geophysical Surveys

Geological and geophysical (G&G) surveys consist of subsea mapping of the sea bottom and sub-strata of both developed and undeveloped OCS areas to locate oil and gas reserves, monitor wells being drilled, conduct hazard assessment and archeological surveys, and conduct benthic sampling. Other potential stressors such as vessel and aircraft operations, emissions, and marine debris that are associated with G&G and other aspects of the proposed action are covered in separate subsections of this opinion. This section will predominantly focus on the sound sources used in acoustic surveys, but will also cover the use of other equipment to conduct the G&G surveys and sediment sampling (geotechnical surveys) (Table 3, above). Table 62 provides an overview of the analysis of different stressors to listed species.

Table 62. Overview of the geological and geophysical analysis of effects to listed species.

Source of Stressor	Bryde's and Sperm Whales	Sea Turtles	Loggerhead (NW Atlantic Ocean DPS) designated critical habitat	Gulf Sturgeon	Listed Elasmo-branchs**
Sound (Airguns and Boomers)	LAA	LAA	LAA	NE	NLAA
Sound (HRG Surveys)	LAA	NLAA	NE	NE	NLAA
Entanglement (OBN Surveys)*	NLAA	LAA	NE	NE	NLAA
Marine Activity (Deployment and Retrieval of Equipment)	NLAA	NLAA	NE	NE	NLAA

**Described later in Section 8.6. NE = No Effect, NLAA = Not Likely to Adversely Affect, LAA = Likely to Adversely Affect.*
***Includes oceanic whitetip sharks and giant manta rays in the Gulf of Mexico.*

This section will consider the effects of G&G on listed sperm whales, Bryde's whales, and sea turtles. The stressors for G&G activity types are shown in Table 63.

Table 63. The stressors created by geological and geophysical survey sounds considered in the analysis.

Stressor	Activity Types
Sound from airguns and boomers	2-D, 3-D NAZ, 3-D WAZ, Coil, 4-D (time-series), VSP, and OBC/OBN seismic surveys
Sound from sub-bottom profilers, side-scan sonar, multi-beam and single-beam echosounders	HRG surveys, archeological surveys, hazard surveys, AUV surveys

Other potential stressors from G&G activities such as entanglement or entrapment, vessel interactions, emissions, and marine debris are covered later in separate sections of this opinion.

As discussed above, in order to determine the likelihood of adverse effects occurring from G&G surveys, we use acoustic thresholds to define response categories to determine when adverse effects in listed species are likely to occur. If a sound source is below the threshold, there is minimal chance of any adverse effects occurring. For sound sources that exceed the thresholds, the sounds must be considered further for their potential to exposure listed species to levels of sound that can result in adverse responses of an animal. The loudness of G&G sound sources can be measured in different ways. As noted earlier, sound levels are described based on the "average" or "root-mean-square (rms) level over the duration of the pulse that are commonly used to measure the way an animal hears a sound and may behaviorally respond to it. The peak level (zero-peak) measures the rise in the pressure wave and is commonly used as the measure of concussive potential to injure the ears of animals. For comparison, the field measurement of peak pressure values for airgun pulses are typically about 10-15 dB higher than rms pressures. Sound exposure level (SEL) can also be used to characterize the effects that the duration of exposure may have on the ears of animals. The use of both the peak pressure and SEL metrics are what is referred to as the "dual criteria." When applying dual criteria, the metric with the greater potential to affect animals is used. Some acousticians believe that cumulative SEL is a better measure of the received levels of total energy marine animals might experience when exposed to multiple pulses from sources such as seismic airguns and sonar (Southall et al. 2007). However, the frequency of the sound source, how often the sound is "on," and the movement of both animals and the sound source can greatly affect whether or not SEL is a better measure of acoustic effects on the hearing of animals.

The first step of this exposure analysis is to determine the G&G sound sources that have a potential to expose listed species to sound levels that may result in adverse responses. We made two comparisons: (1) a comparison of the source level of each type of sound to the received levels of each response category, and (2) a comparison of the frequency content of each sound type compared to the hearing abilities of listed species. We reviewed G&G permits and compiled the common types of sound sources that are used in the Gulf of Mexico (Table 64). We compared the source level for each type of sound to the received level that defines the Wood et al. (2012) step function for behavioral disturbance and the TTS/PTS response categories in. If the source level is below the received level that causes the identified responses, the sound type is excluded from further analysis. We also compared the hearing ranges of Bryde's whales, sperm whales and sea turtles with the frequency range of the types of acoustic sources. If a G&G sound source falls outside the hearing range of a species, it is considered inaudible and so disturbance is considered highly unlikely, and therefore discountable. However, the consideration of TTS/PTS based on peak pressure levels associated with impulsive sounds is not frequency dependent (NOAA 2016). As such, even if an acoustic source falls outside of the hearing range of a particular species, we evaluated the possibility of TTS/PTS occurring based on the acoustic source levels. For the cases where an adverse response is possible (identified by an "X" in Table 65), we further considered the exposure and response of each species to the acoustic source below.

Table 64. Descriptions of geological and geophysical acoustic sources used in the Gulf of Mexico.

Type of Sound Source	Example	Source Level (dB re 1 µPa at 1m)	Pulse Durations (ms)	Operating Frequencies (kHz)
Airgun array	Various volumes and configurations	Up to 260 dB (zero to peak) and 250 dB (rms)	> 100 ms	0.01-20 (main energy < 2)
Boomer	Sercel GI-90 in^3 airgun	186 (p-p)	61-80 ms	0.10-2.5
Boomer	Applied Acoustics CSP201	208 dB (rms)	180 ms	0.5–1.5
	HRG Surveys			
Side-scan sonar	EdgeTech 4200	218 (210-226) dB (rms)	0.6-26 ms	6, 105, 200, 210, 240, 410, 540, 1,600
Side-scan sonar	Raytheon ProSAS PS-60	218 dB (rms)	Unavail.	60
Multi-beam Echosounder	Simrad EM2000	207 dB (rms) and 218 dB (peak)[a]	0.2 ms	200
Multi-beam Echosounder	Kongsberg EM 2040	208 dB (rms)	0.2 ms	200-400
Multi-beam Echosounder	R2 Sonic 2024	221 dB (rms)	Unavail.	200-400
Single Beam Echosounder	Teledyne Odom Hydrotrac	152 dB (rms)	.01 ms at 24 kHz, .1 ms at 200 kHz	24-340
Sub-bottom profiler	EdgeTech DW-216	160 dB (rms)	20 ms	2-16
Sub-bottom profiler	EdgeTech DW106	216 dB (rms)	40 ms	2-6
Sub-bottom profiler	Geopulse	186 (p-p)	20	3.5

NOTE: In most cases zero-to- peak pressure levels are not reported in G&G permits for non-airgun sound sources. For sources where the zero-to-peak pressure is not reported, the zero-to-peak pressure levels are estimated by adding 10 dB to the reported rms level.
[a] Peak pressure value from specification sheet found at: http://www.km.kongsberg.com/ks/web/nokbg0240.nsf/AllWeb/C75143F8AA145B48C12575E500276CA4

Table 65. Geological and geophysical acoustic sources considered in analysis.

	Sea Turtle Responses		**Bryde's Whale Responses**		**Sperm Whale Response**	
Source of Sound	**PTS/TTS**	**Disturbance**	**PTS/TTS**	**Disturbance**	**PTS/TTS**	**Disturbance**
Airguns	**X**	**X**	**X**	**X**	**X**	**X**
Boomers	**X**	**X**	**X**	**X**	**X**	**X**
Side-scan sonar	–	–	**X**	**X**	**X**	**X**
Multi-beam Echosounders	–	–	**X**	–	**X**	–
Single-beam Echosounder	–	–	–	**X**	–	**X**
Sub-bottom profiler	–	–	**X**	**X**	**X**	**X**

X indicates the sound may exceed the threshold level that defines the response category.

A dash (−) indicates the sound is either outside the hearing range (disturbance), or it does not exceed the threshold for the response category (PTS/TTS) and is not considered further in the analysis.

Based on the preliminary exposure analysis in Table 65, only airguns and boomers produce sounds that may effect sea turtles. For Bryde's and sperm whales, the acoustic sources that may effect these species can be categorized as those generally used for seismic surveys, and those generally used for HRG surveys. Below we detail our exposure and response analyses for these two categories of stressors separately as Sounds from Airguns and Boomers and Sounds from HRG and related Surveys.

8.5.2.1 G&G Sound from Airguns and Boomers

Whales

In this section, we will estimate adverse effects consituting harm (injury) and harassment of sperm and Bryde's whales that may result from exposure to sound associated with airguns and boomers. For injury (PTS), we rely on NMFS recently issued acoustic thresholds for assessing injury to marine mammals (NOAA 2016) and for harassment we rely on the probabilistic acoustic thresholds detailed above in the *Acoustic Thresholds* subsection of section 8.5.1, as originally proposed by (Wood et al. 2012b). Figure 72 provides a diagram to help illustrate how these different thresholds compare. Below we summarize our exposure analysis, which we have adopted based on BOEM's final 2017 PEIS. Importantly, NMFS Permits and Conservation Division also relies on BOEM's 2017 PEIS in estimating exposure of marine mammals for their rule. As such, the below exposure analysis is applicable to our programmatic evaluation of BOEM's action, as well our evaluation of NMFS Permits and Conservation Divisions's rule.

Table 66. Sperm whale and Bryde's whale and exposure thresholds for geological and geophysical surveys.

Definition	Response Categories		
	Bryde's Whale PTS (Injury)	Sperm Whale PTS (Injury)	Disturbance (Harassment)
Received level	219 dB (peak) 183 dB SELcum	230 dB (peak) 185 dB SELcum	Wood et al. 2012 step-function
Effect	Permanent hearing loss	Permanent hearing loss	10 percent disturbance at 140 dB (rms), 50 percent disturbance at 160 dB (rms), 90 percent disturbance at 180 dB (rms), and TTS

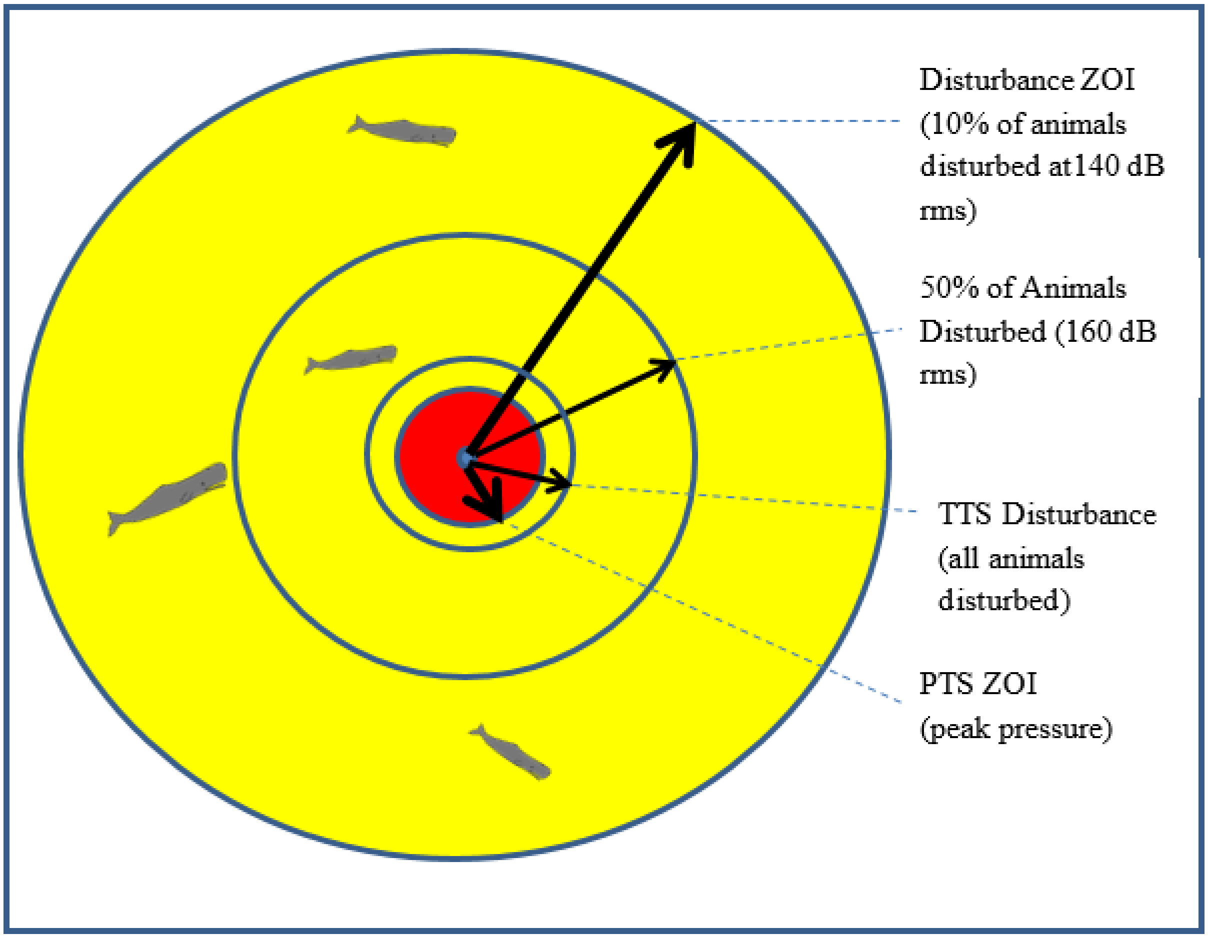


Figure 71. Example diagram showing theoretical distances to the acoustic thresholds. ZOI = zone of influence. Note that distances for PTS and TTS displayed are based solely on peak pressure, not SEL as the later involves knowledge of the duration of exposure and cannot be easily depicted graphically.

Here we first provide a brief overview of the modelling performed by BOEM in their 2017 PEIS, and then below detail our evaluation of this modelling effort for sperm and Bryde's whales separately. The acoustic modeling report can be found online as Appendix D of BOEM's PEIS for G&G in the Gulf of Mexico [https://www.boem.gov/Gulf-of-Mexico-Geological-and-Geophysical-Activities-Programmatic-EIS/] and also at https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-oil-and-gas.

To provide some spatial resolution to the projections of survey effort and to provide reasonably similar areas within which BOEM's acoustic modeling might be conducted, the geographic region where G&G activities would be conducted was divided into seven zones, largely on the basis of water depth, seabed slope, and defined BOEM planning area boundaries. Three primary bathymetric areas were defined as shelf (0-200 m water depth), slope (200-2,000 m), and deep (> 2,000 m). Using survey effort per zone and cetacean density data from Roberts et al. (2016a), Zeddies et al. (2015, 2017) modeled marine mammal exposures from representative G&G sources used in the model. The results from each zone were summed to provide GOM-wide estimates of exposure for each marine mammal species for each survey type for each notional year. To get annual aggregate exposure estimates, 24-hr average exposure estimates from each survey type were multiplied by the number of expected survey days from BOEM's effort projections. Because these projections are not season-specific, surveys were assumed to be equally likely to occur at any time of the year and at any location within a given zone. These modeled exposures are summed and represent the aggregate takes expected to result from future surveys given the specified levels of effort for each survey type in each year, and may vary according to the statistical distribution associated with these mean annual exposures.

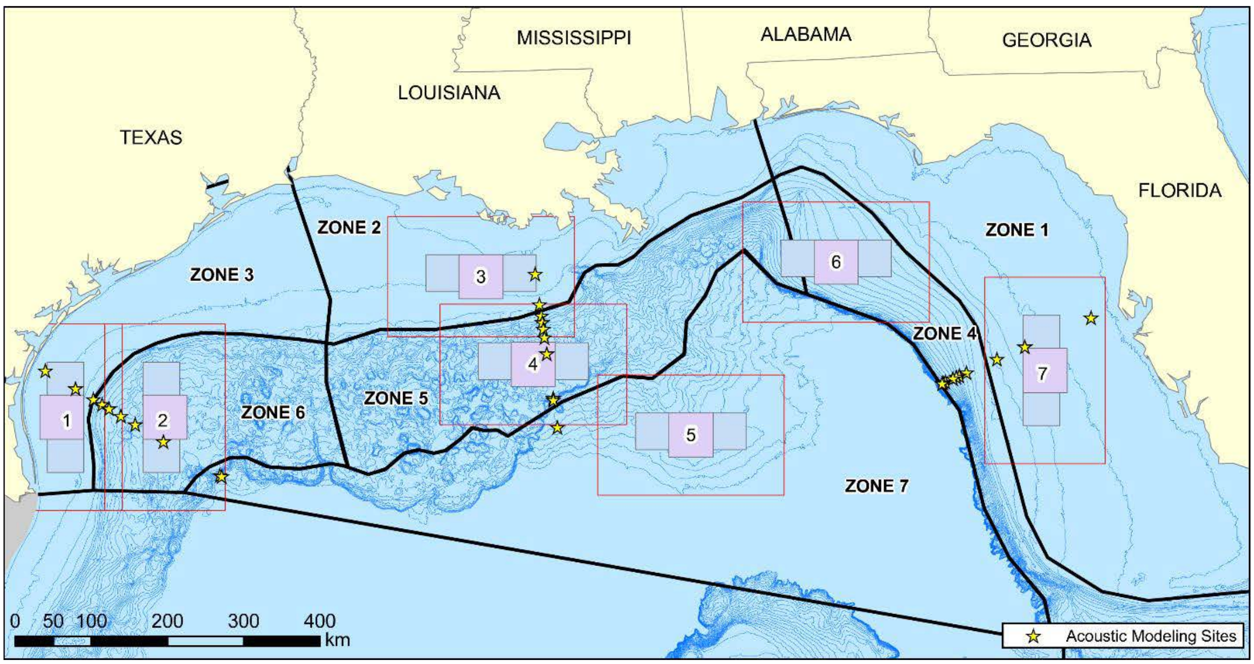


Figure 72. BOEM modeling zones. Zones 1-3 represent shelf area, Zones 4-6 represent slope area and Zone 7 is deepwater. Zeddies et al. (2015) Appendix D, (BOEM 2017e)

Exposure

We used BOEM's modeling to determine the number of instances in which sperm whales and Gulf of Mexico Bryde's whales will be exposed and adversely affected by sounds produced by seismic surveys in the Gulf of Mexico. The modeling provided by BOEM considered the level of activity resulting from the next 10 years of activity, Gulfwide. We have applied the 10-year average to our calculations to predict the number of exposures of whales over the 50 years of the proposed action. We revised the Opinion when the GOMESA area was removed from BOEM's proposed action, which essentially removed geophysical survey activity and related effects expected in that area. BOEM did not remodel exposures from geophysical surveys. Activity planned for that area would need a separate consultation. Although the exposures in this effects section include that area and are therefore elevated compared to what is expected as part of the proposed action, we will account for take from geophysical surveys in specific zones in the active leasing areas using BOEM's exposure scenarios as provided and manage/monitor take through the Incidental Take Statement, the use of activity level per zone as surrogate to measure take, and re-initiation triggers.

BOEM's estimate of the number of whales that might be exposed was determined by modeling the acoustic footprint from sound sources and modeling the number of exposures in each response category. The modeling used representative sound sources for each survey type based on the equipment used in Gulf of Mexico operations. Actual array output varies by seismic survey type and can be considerably higher or lower depending on the number of arrays and airguns used. Specific modeling of each of the following survey types was completed:

- 2D surveys
- 3D NAZ surveys
- 3D WAZ surveys
- coil surveys
- a single airgun (90 in^3)
- boomers

It is important to note that these calculations did not include or account for ancillary activities, such as some VSP surveys. Thirty sites were modeled among the planning areas to calculate acoustic propagation of the sound sources and determine received levels by whales moving around the sources. Therefore, the number of exposures provides a reasonable characterization of the number of animals that may be exposed to different sound levels from each source throughout the action area.

Sperm whales

Exposures to received levels of greater than or equal to 230 dB (peak), the PTS threshold for sperm whales that produced the largest distance, were not quantifiable using the model due to the single sound source assumption and the modeled sound levels not reaching a great enough distance to reach the far field, where the array acts more like a single directional acoustic source. The resulting measurement of 18.2 m from the sound source was within the near field of the acoustic array, and thus too small a distance to reflect a realistic distance to a particular sound level (Zeddies et al. 2015). Given this, received levels that meet or exceed this threshold for sperm whales in most cases are not expected to occur. This is because within the near field, the source levels used in the acoustic modelling are overestimated and not applicable. In fact, until one reaches a distance of approximately three or four times the maximum distance to the near field the average intensity of sound at any given distance from an array is still less than that based on calculations that assume a directional point source (Lurton 2002). Given this, using the distance to the maximum extent of the near field as the cut-off for where sound levels are considered lower than the estimated source level based on the directional point source assumption is a conservative approach since even beyond this distance the acoustic modelling still overestimates the source level that animals would actually receive. For example, the seismic airgun array used by the National Science Foundation on their R/V *Marcus G. Langseth* has an approximate maximum near field distance of 140 m at 1 kHz (NSF and USGS 2011). Field measurements of this array indicate that the source behaves like multiple discrete sources, rather than a directional point source, beginning at approximately 400 m (deep site) to 1 km (shallow site) from the center of the array (Tolstoy et al. 2009), distances that are actually greater than four times the 140 m maximum near field distance. Within these distances, the recorded received levels were always lower than would be predicted based on calculations that assume a directional point source, and increasingly so as one moves closer towards the array (Tolstoy et al. 2009).

Within the near-field, in order to explicitly evaluate the likelihood of exceeding any particular acoustic threshold, one would need to consider the exact position of the animal, its relationship to individual airguns, and how the individual acoustic sources propagate and their acoustic fields interact. While in some cases received levels at or in excess of a particularly threshold may be possible, we find this highly unlikely for several reasons. While the data are mixed as to whether or not sperm whales show avoidance of seismic activity more broadly (Barkaszi et al. 2012; Bowles 1994; Gordon et al. 2003; Jochens et al. 2008; Madsen et al. 2006; Madsen et al. 2002a; Mate et al. 1994a; Miller and Dawson 2009; Miller 2005; Potter et al. 2007; Southall et al. 2007; Southall et al. 2017), in most cases we do not expect sperm whales to come within 18.2 meters of active arrays since they would likely hear and see the array prior to this and avoid approaching it as such close range, particularly of such close exposure were to cause any pain. Nonetheless, PSO data from 2003-2008 indicate that at least three sperm whales approached an active airgun array to within 10 m, but if such a situation were to occur, we would expect the airguns to be shutdown based on the proposed shutdown requirements, which minimize the chances of PTS occurring. Furthermore, given that within the near field source levels would be below those used in the acoustic modelling, even if sperm whales are within within 18.2 meters of the array, the exceedance of a particularly threshold would only be possible under highly unlikely circumstances (e.g., a sperm whale would need to be in the exact right position, under a particular configuration of airguns, that fire at a particular time). For these reasons, we find that adverse effects to sperm whales consisting of PTS/injury is extremely unlikely, and thus discountable.

Table 67 displays the results of BOEM’s modeling of the annual number of instances in which a sperm whale is harassed, based on a 24-hour modeling period, in Gulf of Mexico federal waters. These instances of harassment would involve either disruptions in behavior (i.e., disturbance) or TTS, or both. In humans, sound-induced hearing loss has been shown to occur in a narrow range of frequencies of the sound, such as those from gunfire, power tools, explosions, and amplification of music (Sadhra et al. 2002; Win et al. 2015; Zhao et al. 2010). We expect that any temporary hearing loss in sperm whales would selectively occur in the frequencies of the main energy of seismic survey sound at 10-2,000 Hz. Importantly, the numbers in Table 67 do not necessarily represent individual animals given the 24-hour reset used in the modelling. In fact, we expect that some animals will be harassed more than once. The nature of the intermittent exposure to disturbance due to moving whales and seismic surveys could result in consecutive disturbances over days or weeks. BOEM's modelling suggests the average daily exposures from all surveys may be less than 30 minutes/day (Zeddies et al. 2015 in BOEM 2017e), the types of surveys using multiple vessels with active sound sources are likely to result in longer periods of disturbance than single vessel surveys.

Table 67. Annual number of sperm whale exposures by disturbance from seismic survey airgun and boomer sound (BOEM 2017e). The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

YEAR	Exposure of Sperm Whales*
	Sum of Instances of Harassment
1	43,504
2	36,832
3	36,576
4	27,271
5	33,340
6	33,805
7	30,668
8	26,651
9	27,657
10	25,716
10-Year Total	322,020
50-Year Total	1,610,100

*The number of exposures is not equal to the annual number of individuals exposed. The number of individuals exposed by harassment each day is summed over a one year period such that animals may be exposed multiple times from one survey or over the course of a year from different surveys.

Not all survey types will have the same potential to adversely affect sperm whales. The likelihood of disturbance responses from individual surveys largely depends on the survey type and array configuration, the duration of the survey, and the number of vessels used. These factors are reflected in the modeling results for each survey type (Table 68) and show that 3D NAZ surveys have the greatest potential to adversely affect sperm whales, followed by 3D WAZ, 2D surveys, and coil surveys.

Table 68. Number of daily harassment exposures to sperm whales from different geological and geophysical survey types, summed over ten years of proposed activities in the Gulf of Mexico (BOEM 2017e). The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

Type of Survey	Exposure of Sperm Whales to Harassment over 10 Years
2D (1 vessel)	8,441
3D NAZ (2 vessels)	200,876
3D WAZ (4 vessels)	88,326
Coil Survey (4 vessels)	24,374
90-cubic-inch airgun	2

Type of Survey	Exposure of Sperm Whales to Harassment over 10 Years
Boomer	2
10-YR Total	322,020
Annual Average	32,202

BOEM's modeling shows that sperm whales will be exposed to levels of sound that cause harassment up to 32,202 times on average annually (Table 68, above). This number reflects the number of instances (based on a 24-hour reset) in which a harassment event will occur, but is not equal to the number of individual sperm whales that will be harassed each year. There are an estimated 2,128 sperm whales in the northern Gulf of Mexico based on the density data used to estimate exposure (Roberts et al. 2016b). The total annual 32,202 occurrences of harassment is the sum of the number of instances of harassment, which greatly exceeds the population number. Therefore, individual sperm whales will be harassed multiple days annually.

Seismic survey activity occurring in deep water is proposed to occur mostly in the CPA, and to a lesser extent in the WPA and EPA. Proportionately, most of the predicted harassments will occur in deepwater areas of the CPA (200-2,000 m depths) and very deep waters greater than 2,000 m on the OCS. The majority of survey activity in very deep water will occur in the CPA because just a small area of the WPA has very deep regions greater than 2,000 m and relatively little survey activity is expected in the EPA. We analyzed the ten-year average of the number of survey days in deep water and found that 35.4 percent of survey activity occurred in the CPA, and 50 percent occurred in depths > 2,000 m across all planning areas, mostly the CPA (Table 69). Projecting these same survey distributions into the future, about 85 percent of all deep water seismic survey activities are projected to occur in the CPA.

Table 69. Average number of seismic survey days in deep water areas of the Gulf of Mexico where sperm whales are found.

Deepwater Area	Annual Number of Survey Days by Survey Type (10-Year Average)						Total Survey Days/Yr	Percent of Total Survey Activity
	2D	3D	WAZ	Coil	Boomer	VSP		
WPA (200-2,000 m)	0	1,251	147	63	0	0	1,461	9.8 percent
CPA (200-2,000 m)	121	2,803	1,632	700	1	20	5,277	35.4 percent
EPA (200-2,000 m)	148	489	42	18	0	0	697	4.7 percent
>2,000 m (primarily in the CPA)	283	4,143	2,107	902	2	26	7,463	50.1 percent
TOTAL	552	8,686	3,928	1,683	3	46	14,898	100 percent

Depending on the location of surveys and whales over the course of an entire year, individual whales can be harassed different numbers of days per year. For example, Figure 73 demonstrates that sperm whales are not uniformly distributed over the Gulf of Mexico, and nor are oil and gas activities.

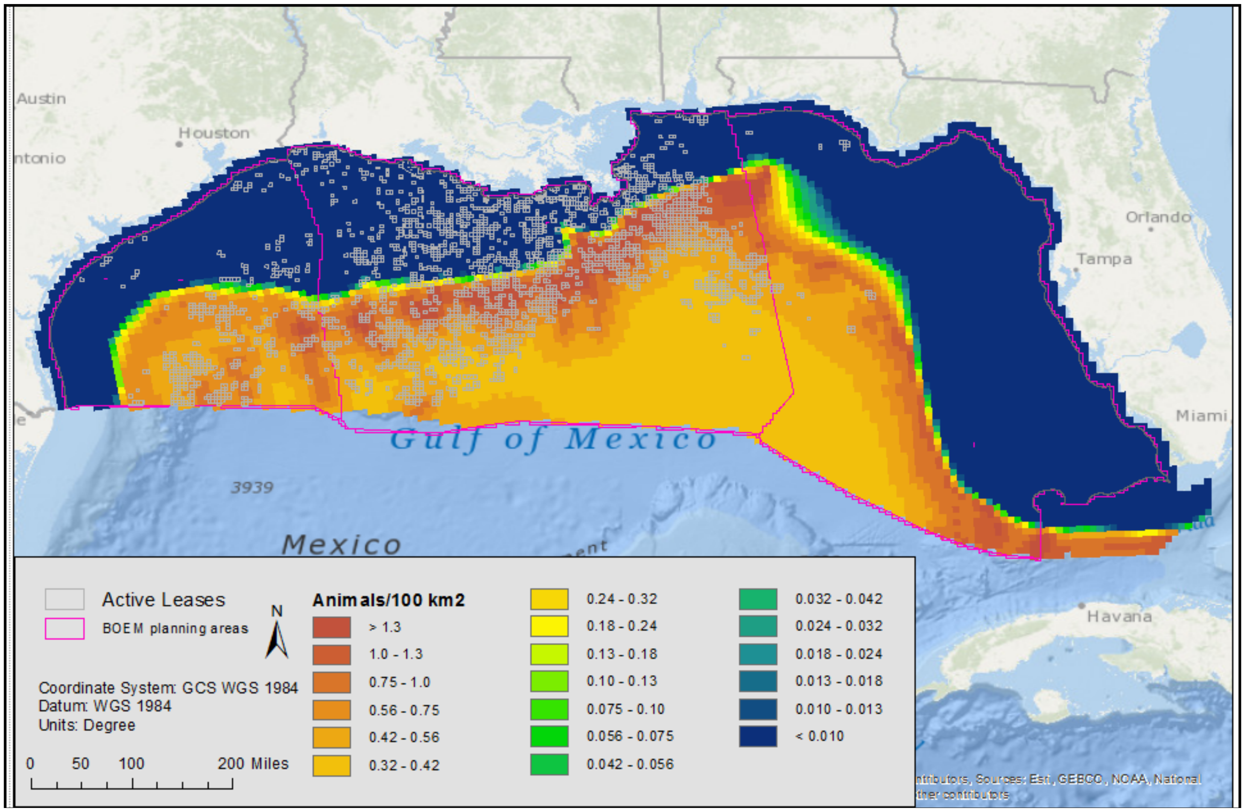
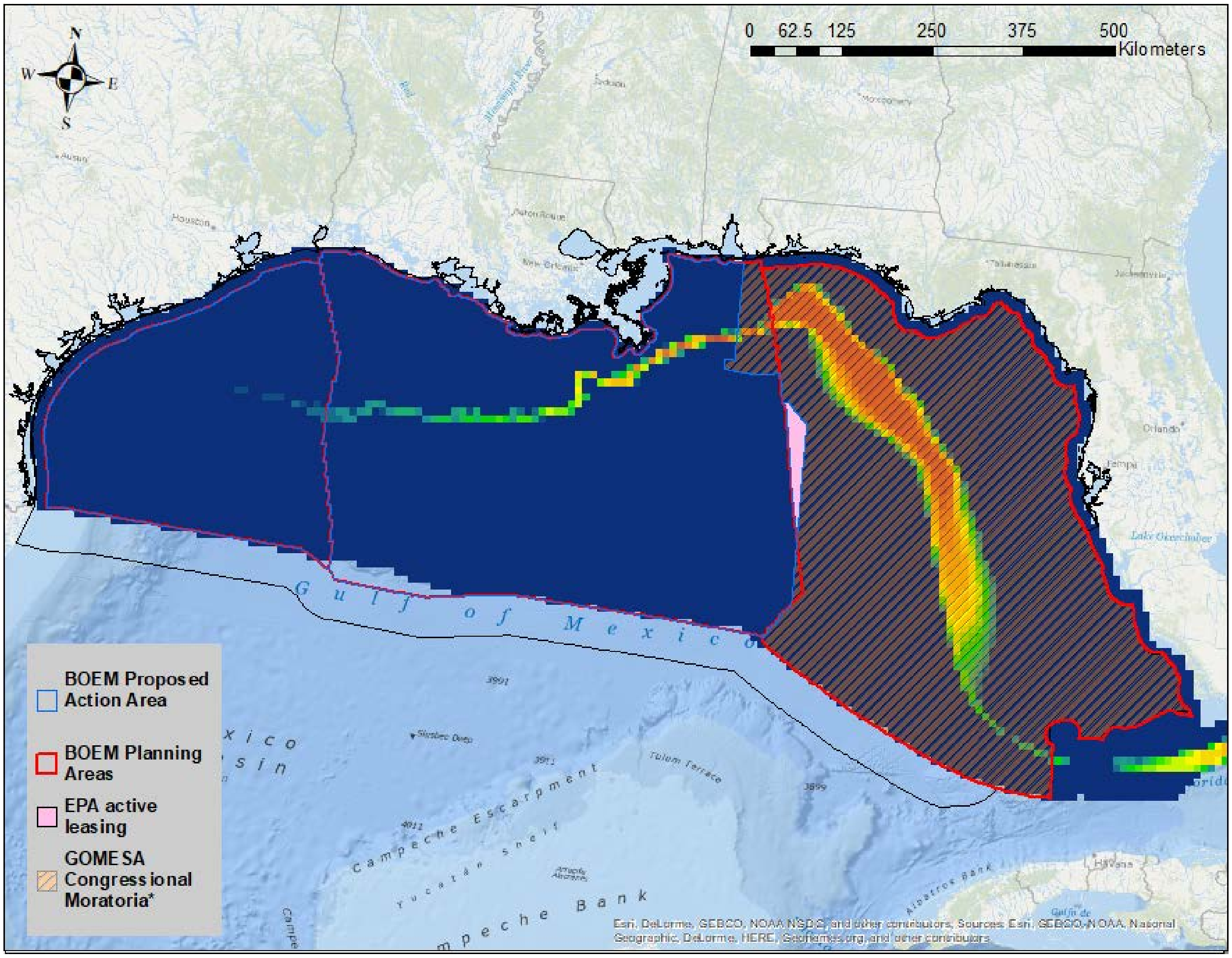


Figure 73. Predicted sperm whale mean year-round density based on habitat features in the Gulf of Mexico (Roberts et al. 2016b) overlaid with active oil and gas lease blocks.

Gulf of Mexico Bryde's Whale

BOEM determined in their BA supplemental information that there is a reasonable potential for seismic surveys to expose Gulf of Mexico Bryde's whales to sound levels that may cause adverse effects. This species is shy and responses would likely not be observable. The degree of displacement, if any, length of time involved, and types of behaviors interrupted would influence the significance of this disturbance. At higher received levels, auditory injury could occur resulting in some impairment of the whale's hearing sense and permanent loss of hearing abilities.

There are little available data for global Bryde's whales and less so for Gulf of Mexico Bryde's whales, especially on the effects of anthropogenic sound on this species. As such, we rely on information from other Bryde's whale populations as well as from other baleen whale species in conducting our effects analysis. Based on best available density estimates, we believe that individual Bryde's whales could travel outside the bounds of the closure area and may still be affected by G&G surveys.



**The light pink, filled-in polygon in the Eastern Planning Area is not restricted under the GOMESA moratorium, and where there is current active leasing. The remaining larger portion of the Eastern Planning Area is not part of the proposed action.*
***Source density data from Roberts et al. (2016b).*

Figure 74. Predicted Bryde's Whales Densities Based on Habitat Features and Sightings Data in the Gulf of Mexico.

As stated in the 2016 Status Review, one of the top factors threatening the Bryde's whale is modification or curtailment of habitat range. Bryde's whale distribution in the Gulf of Mexico is thought to generally be, based on existing detection data for the species to an area in the northeastern Gulf near De Soto Canyon, in waters between approximately 100 and 400 m depth along the continental shelf break. Bryde's whales have been consistently located in a the area along the shelf break in the northeastern GOM, with few whales sighted elsewhere despite a large amount of dedicated cetacean survey effort that covered both continental shelf and oceanic waters. Whales have been sighted in this area in all seasons, and all indications are that the whales inhabit this area year-round as a resident population. A tagged whale remained within this area for 38 days, the entire time the tag was active. Based on one confirmed sighting in the western GOM, and multiple unconfirmed sightings, it is possible that a small number of Bryde's whales occur outside this area, or that whales from this area occasionally travel outside the area.

However, it is the known density of whales in a relatively constricted area, forming what is believed to be a resident population, that provides the impetus to protect the specifically designated area as important habitat for the GOM Bryde's whale. Therefore, additional sightings of whales outside the area would not change the conclusion regarding the importance of protection for this specific habitat area. Spatial protection is key as the most effective method of avoiding acute effects to individual whales, but also as the only effective method of minimizing chronic effects and the potential for population-level impacts resulting from habitat degradation and/or curtailment of range. The Status Review details these threats as being moderately or very likely to contribute to the decline of the Bryde's whale if not addressed.

We are continuing to learn about the Gulf of Mexico's soundscape, specifically near where Bryde's whales are found. Wiggins et al. (2016) deployed a High frequency Acoustic Recorder Package (HARP) at five locations in the Gulf of Mexico during 2010 to 2013. One of the HARPs was in De Soto Canyon at 260 m water depth and the deepwater sites were similar to each other with their highest sound pressure levels below 100 Hz. As described in earlier sections of this opinion, De Soto Canyon is where the Gulf of Mexico Bryde's whales are consistently found. Of the five HARP sites, De Soto Canyon had the lowest sound spectrum level recorded; however, the Gulf of Mexico overall had a high average SPL for sounds below 60 Hz (90-95 dB re 1 μPa squared) at deepwater sites (Wiggins et al. 2016). Location of seismic surveys during the data collection was not clear, hence we do not know if there were G&G activities (i.e., seismic surveys) occurring near the HARP in the EPA during the data collection.

Sound emitted from seismic surveys is of greater concern for baleen whales. These whales vocalize at similar low frequencies to air gun pulses, so may be more vulnerable to adverse effects from acoustic sources that produce sound at those frequencies. There is potential for behavioral harassment and acoustic injury depending on the distance from the source and the duration of exposure. Thomas et al. (2016) made note of several publications describing the potential for human activities causing threats to baleen whales. Habitat deterrence of gray whales from their usual calving areas of Guerrero Negro Lagoon, Mexico was attributed to salt barge traffic for some time in the 1950s and 1960s (Gard 1974 as cited in Thomas et al. 2016). Whale-watching boat "harassment" was thought to be jeopardizing Eastern Pacific gray whale recovery in the 1970s and there were also similar concerns for Hawaiian humpack whales around the same time (Reeves 1977; Thomas et al. 2016). Concerns for bowhead whale disturbance with the introduction of industrial activities (vessel traffic, seismic exploration and oil and gas development) to the Arctic and the impacts of oil and gas activities on the Sakhalin Island, Russia population of gray whales led to furthering studies for a better understanding of disturbance of baleen whales by underwater sound (Richardson et al. 1995a; Thomas et al. 2016; Weller et al. 2002).

BOEM conducted seismic airgun survey sound exposure modeling for all marine mammals in the Gulf of Mexico as part of their PEIS, as was previously described above. We evaluated this modeling, and determined it suitable for estimating the number of instances in which Bryde's whales will be exposed by sounds produced by seismic surveys in the Gulf of Mexico. The modeling provided by BOEM considered the Gulfwide level of activity resulting from the next ten years of actions. We have applied the ten-year average to our calculations to predict the number of exposures over the 50 years of the proposed action.

Once the BOEM acoustic modeling was finalized, there were some corrections made because Zone 6 had some results that were counterintuitive, so all Bryde's whale exposures in Zone 6 were removed from the exposure estimations. Because the activity levels were provided for all planning areas, in the ITS (section 15) we will account for the exposure level changes from the removal of the GOMESA area in the proposed action by using the activity level surrogates for determining exceedance of take in each zone.

BOEM's modeling predicts an annual average of 12 instances of Bryde's whale exposure to received levels of 183 dB (SEL) that would cause PTS (SEL produced a larger PTS estimates for Bryde's whales compared to peak pressure, given their hearing range), and an annual average of 451 instances of Bryde's whale exposure that would result in harassment. These numbers of exposures don't equate to the annual number of whales exposed, as individuals may be exposed multiple times (Table 70). As noted above, human sound-induced hearing loss has been shown to occur in a narrow range of frequencies of the sound source (i.e., music, gunfire, etc.). We expect the loss of hearing sensitivity in Bryde's whales due to sound-induced hearing loss would selectively occur in the frequencies of the main energy of seismic survey sound at 10-2,000 Hz.

Table 70. Number of Bryde's whale exposures to permanent threshold shift and harassment or temporary threshold shift from seismic survey airgun and boomer sound over ten years. The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

YEAR	PTS*	Harassment*
1	14	560
2	14	537
3	12	447
4	11	413
5	14	498
6	11	426
7	12	462
8	11	387
9	11	402
10	10	372
Annual Average	12	451

******The number of exposures is not equal to the annual number of individuals exposed. The number of individuals harassed each day is summed over a one-year period such that animals may be exposed multiple times from the same survey or over the course of a year from different surveys. All decimal numbers were rounded up to next whole number. These numbers do not consider the GOMESA area removal from the proposed action.*

Not all survey types will have the same potential to adversely affect Bryde's whales. The likelihood of PTS exposures and harassment from individual surveys largely depends on the survey type and array configuration, the duration and location of the survey, and the number of vessels used. These factors are reflected in the modeling results for each survey type (Table 71) and show that 3D NAZ surveys have the greatest potential to adversely affect Bryde's whales, followed by 3D WAZ, coil, and 2D surveys.

Table 71. Number of daily permanent threshold shift and harassment or temporary threshold shift exposures from geological and geophysical survey types expected to effect Bryde's whales, summed over ten and 50 years.

Type of Survey	Exposure of Bryde's Whales to PTS Sound Levels over 10 Years of Proposed Activities	Exposure of Bryde's Whales to Harassing Sound Levels over 10 Years of Proposed Activities
2D (1 vessel)	2	171
3D NAZ (2 vessels)	80	2,591
3D WAZ (4 vessels)	7	1,430
Coil Survey (4 vessels)	33	315
Ten-year Total	122	4,507 [a]
Annual Average	12	451
50-year Total	600	22,550[b]

Numbers are for relative comparisons, as they do not consider the GOMESA area removal from the proposed action.

[a] *This number is slightly less* than total in Table 70 *above due to rounding in an individual year.*

[b] *Sum extrapolated from ten-year total.*

Because Bryde's whales are cryptic, we do not expect that PSOs would be able to easily detect them during visual observation, although observations have been made including during active G&G surveys. Available information on baleen whale reactions to seismic survey sound suggests that they will avoid the sound source (Ellison et al. 2016; Gordon et al. 2003; Southall et al. 2007; Stone and Tasker 2006). To estimate the effect avoidance of seismic activity has on the likelihood animals are exposed to sound levels that may result in injury such as PTS, Ellison et al. (2016) modeled the exposure of bowhead whales to sound levels that may result in injury with and without avoidance. The model was parameterized based on empirical data on bowhead whale behavior. The results suggest that if animals show avoidance behavior there is approximately an 80 percent reduction in exposure of sound levels that may cause injury. Assuming that Bryde's whales would avoid being exposed to PTS levels of G&G-associated sounds, we rely on the Ellison et al. (2016) 80 percent aversion value (i.e., 80 percent of PTS exposures will be avoided) to estimate that up to 120 (of the total 600) individuals could be exposed to sound levels that cause hearing loss over the 50 years of the proposed action without the proposed closure. These PTS exposures could be reduced (to harassment level exposures) and perhaps avoided with a year-round closure in the area where Bryde's whales are primarily encountered.

BOEM's Gulfwide modeling shows that Bryde's whales will be exposed to levels of sound that cause harassment up to 451 times annually. The unmitigated number reflects the number of instances of harassment, but is not equal to the number of individual Bryde's whales that will be harassed each year. This number also does not account for the revision of the proposed action that omitted the GOMESA moratorium area. According to Roberts et al. (2016a), there are an estimated 44 Bryde's whales in the northern Gulf of Mexico. An unmitigated annual 451 instances of harassment greatly exceeds the population number, and as such, individuals would be expected to be harassed multiple times per year. We expect with geophysical surveys being omitted from the area under the GOMESA moratorium, that PTS would be avoided for the individuals that remain within the moratorium area and the annual number of harassment would be lessened, but given that animals may travel outside the bounds of the area, we believe it is still possible that some individual Bryde's whales would be harassed more than once a year.

Seismic survey activity occurring in deep water is proposed to occur mostly in the CPA, and to a lesser extent in the EPA. However, Table 69 displays the number of days (697 total combined for program) per year that each type of survey is projected in the EPA. Given the revised proposed action that removed the area under the GOMESA moratorium, it is unclear what level of activity would be expected in the EPA that is still under active leasing.

Depending on the location of surveys and whales over the course of an entire year, individual whales may be harassed different numbers of days per year. However, estimating such detailed exposures is not possible given the geographic scale (per zone) at which BOEM provided projections for surveys days. Nonetheless, based on the number of projected exposures per year and the number of Bryde's whales estimated in the Gulf of Mexico, animals venturing outside or near the edge of the moratorium area could be exposed multiple times in a year. Based on BOEM's modeling of seismic surveys using multiple source vessels, the number of harassment days per year is not expected to increase, but the duration of exposure each day can be prolonged when multiple source vessels are used or in the case of certain types of surveys, such as coil surveys. Approximately 35 percent of the total survey days proposed would involve up to four-vessel surveys. Therefore, the harassment resulting from multiple-vessel surveys can result in longer duration exposures per day that may have a more severe adverse effect on Bryde's whales.

Response

Sperm whales

To evaluate the impact that exposure at harassment levels would have on sperm whales, we reviewed studies on the responses sperm whales exhibit to seismic activity, as well as other anthropogenic sounds. Sperm whales may briefly respond to underwater sound by slightly

changing their behavior or relocating a short distance, in which case the effects can equate to take but are unlikely to be significant at the population level. Displacement, and frequency of being displaced, from important feeding or breeding areas over a prolonged period would likely be more significant, especially as frequency increases. Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012); this is reflected in a variety of aquatic, aerial, and terrestrial animal responses to anthropogenic sound that may ultimately have fitness consequences (Francis and Barber 2013). Animals generally respond to anthropogenic perturbations as they will predators, increasing vigilance, and altering habitat selection (Reep et al. 2011). Habitat abandonment due to anthropogenic sound exposure has been found in terrestrial species (Francis and Barber 2013). Because of the similarities in hearing anatomy of terrestrial and marine mammals, we expect it possible for sperm whales to behave in a similar manner as terrestrial mammals when they detect a sound stimulus. For additional information on the behavioral responses marine mammals exhibit in response to anthropogenic sound, see one of several reviews (e.g., Gomez et al. 2016; Southall et al. 2007).
Several studies have aided in assessing the various levels at which sperm whales may modify or stop their calls in response to sounds for airguns. Sperm whales, at least under some conditions, may be particularly sensitive to airgun sounds, as they have been documented to cease calling in association with airguns being fired hundreds of kilometers away (Bowles et al. 1994). Other studies have found no response by sperm whales to received airgun sound levels up to 146 dB re: 1 μPa (peak-to-peak) (Madsen et al. 2002b; McCall Howard 1999). Given the available data, we assume that some sperm whales exposed to seismic airgun sounds may cease calling or otherwise alter their vocal behavior. Sperm whales that are resting near the surface often produce communication clicks between each other called codas. Coda communication within groups is not likely to be affected by seismic survey sound at far distances, but a passing survey close to whales could disrupt communication while the vessel passes. It is believed that sperm whales passively listen to other whales' echolocation signals during foraging during dives. Females can listen to the sonar clicks of one another and use that information to determine the direction and distance of others in their group. This may be important for sperm whales to maximize their foraging efficiency and work cooperatively while foraging to maximize the group's feeding success. However, we expect that any responses involving changes in vocal behavior would be temporary and animals would resume or modify calling at a later time or location away from the seismic source.

Male sperm whales also produce loud, slow, low frequency clicks when accompanying a breeding group of females. These clicks differ from clicks in coda patterns in that they are much louder and not given in any repeatable pattern. It has been said that the loud, low frequency clicks of a sperm whale occur when with a breeding group of females (http://dosits.org/animals/use-of-sound/marine-mammal-communication/vocalizations-associated-with-reproduction/). It is unknown if males locate female groups by passive listening of female clicks during dives, listening to codas, or some other means. If males are passively listening to sonar clicks of foraging females, there could be some masking of those clicks by seismic survey sound. Masking occurs when a sound is a similar frequency and similar to or louder than the sound an animal is trying to hear (Clark et al. 2009c; Erbe et al. 2016). Masking of sonar clicks could decrease the distance over which males can detect females, resulting in increased energy expenditure by males to find females. However, due to the widespread distribution of sperm whales in the northern Gulf of Mexico, the mating success of whales is not likely to be adversely affected in the long-term by any masking that may occur.

Sperm whale behavioral response to airguns has thus far included mild changes in behavior (temporarily disrupted foraging, avoidance, cessation of vocal behavior) or no reaction. Several studies have found sperm whales in the Atlantic Ocean to show little or no response (Davis et al. 2000; Madsen et al. 2006; Miller et al. 2009b; Moulton et al. 2006a; Moulton and Miller 2005; Stone 2003; Stone and Tasker 2006; Weir 2008). Detailed study of sperm whales in the Gulf of Mexico suggests some alteration in foraging from less than 130 to 162 dB re: 1 μPa peak-to-peak, although other behavioral reactions were not noted by several authors (Gordon et al. 2006; Gordon et al. 2003; Jochens et al. 2006a; Madsen et al. 2006; Winsor and Mate 2006). This has been contradicted by other studies, which found avoidance reactions by sperm whales in the Gulf of Mexico in response to seismic ensonification (Jochens and Biggs 2003; Jochens and Biggs 2004; Mate et al. 1994b). Johnson and Miller (Johnson and Miller 2002) noted possible avoidance at received sound levels of 137 dB re: 1 μPa. Other anthropogenic sounds, such as pingers and sonars, disrupt behavior and vocal patterns (Goold 1999; Watkins et al. 1985; Watkins and Schevill 1975). Miller et al. (2009a) found sperm whales did not demonstrate horizontal avoidance to airgun exposure in the Gulf of Mexico, although foraging behavior may have been affected based on changes in echolocation rate and slight changes in dive behavior. Displacement from the area was not observed. Winsor and Mate (2013) did not find a non-random distribution of satellite-tagged sperm whales at and beyond five km from airgun arrays, suggesting individuals were not displaced or move away from the airgun array at and beyond these distances in the Gulf of Mexico (Winsor and Mate 2013). However, no tagged whales within five km were available to assess potential displacement within five km (Winsor and Mate 2013). The lack of response by this species may in part be due to its higher range of hearing sensitivity and the low-frequency (generally less than 188 Hz) pulses produced by seismic airguns (Richardson et al. 1995b). Sperm whales are exposed to considerable energy above 500 Hz during the course of seismic surveys (Goold and Fish 1998), so even though this species generally hears at higher frequencies, this does not mean that it cannot hear airgun sounds. Breitzke et al. (2008) found that source levels were approximately 30 dB re: 1 μPa lower at 1 kHz and 60 dB re: 1 μPa lower at 80 kHz compared to dominant frequencies during a seismic source calibration. Reactions of sperm whales to impulse sound likely vary depending on the activity at time of exposure. For example, in the presence of abundant food or during breeding encounters, toothed whales sometimes are extremely tolerant of sound pulses (NMFS 2006c).

To consider different scenarios where different proportions of the population of sperm whales are harassed by different amounts of G&G sound each year, Farmer et al. (2018b) developed a bioenergetics model to examine the impacts of lost foraging opportunities that may result from exposure to G&G sounds based on a 10-year period of activity. The model was parameterized for juvenile, mature, pregnant, lactating and post-breeding females, juveniles, and mature males and assumed a previously undisturbed population. Changes in body condition and associated energy reserve levels were tracked on a daily basis for disturbed and undisturbed foraging scenarios. During undisturbed foraging days, whales grew and were able to replenish depleted reserves, whereas during days of disturbed foraging, whales programmed to attempt to cover the caloric deficit from carbohydrate reserves. Remaining deficits were covered by lipid and protein reserves in the blubber, muscle and viscera, until terminal starvation occurred. Although recovery is minimally possible through refeeding, it is not likely that sperm whales could recover once terminal starvation has occurred (Farmer et al. 2018b).

Farmer et al. (2018b) suggests that sperm whales could reach terminal starvation between three weeks and two months depending on the level of disturbance and life stage. Figure 75 displays an undisturbed whale trajectory (left) compared with a disturbed whale trajectory (right). An undisturbed sperm whale makes substantial gains in reserves through time; the rate of these gains in reserves varies with life stage and reproductive status. Infrequent, minor disruptions in foraging are not fatal, but may result in reduced body reserves relative to an undisturbed individual (Figure 75; Note the depletion in carbohydrate energy in the disturbed animal, which in turn leaves the animal with lower lipid and protein reserves).

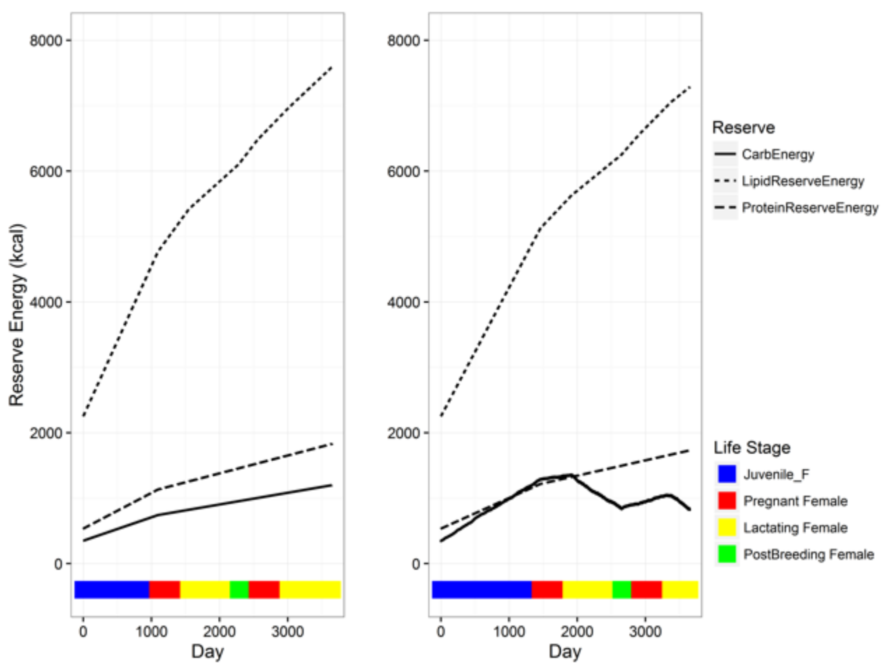


Figure 75. Modeled energy reserve levels of undisturbed (left) versus disturbed (right) sperm whales (Farmer et al. 2018b).

The 500 simulated sperm whales illustrate the ability to endure partial foraging disruptions for much longer time periods than full foraging disruptions (i.e., starvation), largely because partial foraging results in smaller daily caloric deficits (Figure 76). Lactating females and juveniles were the most susceptible life stages.

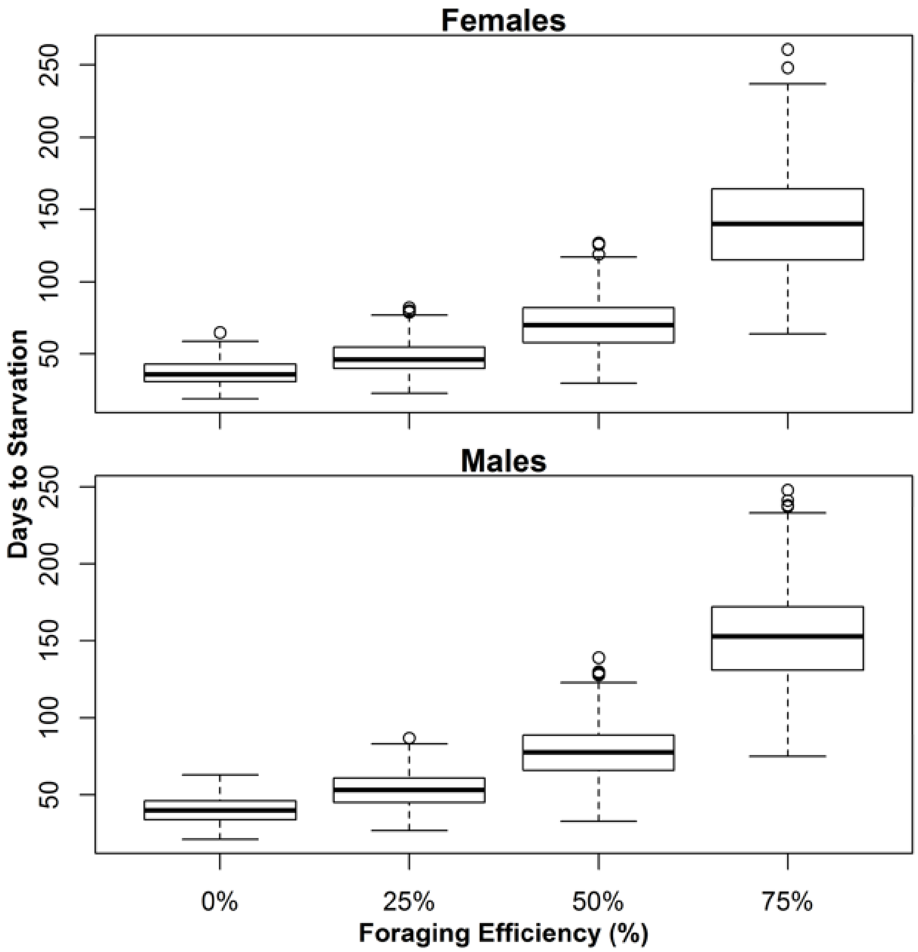


Figure 76. Foraging Efficiency and Starvation (Farmer et al. 2018b).

In a companion paper, Farmer et al. (2018a)utilized the results of the bioenergetics study to model the population consequences of disturbance from G&G for sperm whales in the Gulf of Mexico. In this study, Farmer et al. (2018a)found that foraging impairment from reactions to anthropogenic sounds could have consequences including individual fitness reduction, leading to miscarriage or stillborn, calf abandonment, or terminal starvation depending on the frequency and duration of exposures, the intensity of the behavioral response, and individual ability to compensate for prior foraging disruption through increased consumption and assimilation of prey. It is unclear whether whales can optimize the replacement of reserves (Farmer et al. 2018) or increase the amount of time spent foraging relative to other activities when prey availability or foraging efficiency is reduced (Boyd 1999; Crocker et al. 2006; McDonald et al. 2017a). For approximately three-quarters of the day, sperm whales are in the foraging dive cycle (Watwood et al. 2006). High levels of compensatory foraging might be unrealistic due to limits on food intake associated with constraints on prey acquisition and processing (Rosen et al. 2007).

When using exposure and disturbance based on the step function from Wood et al. (2012a) as used in this opinion[60], the population consequences of seismic sound exposure to sperm whales in the Gulf of Mexico were not significant when compared with the baseline (Figure 77). However, the majority of model scenarios indicated significant reductions in sperm whale body condition as a consequence of disturbance by G&G activities. Reduced body reserves have been implicated in lower reproductive potential (Le Boeuf et al. 2000; Lockyer 1987; Miller et al. 2011; Williams et al. 2013) and reduced calf size and fitness (Christiansen et al. 2014).

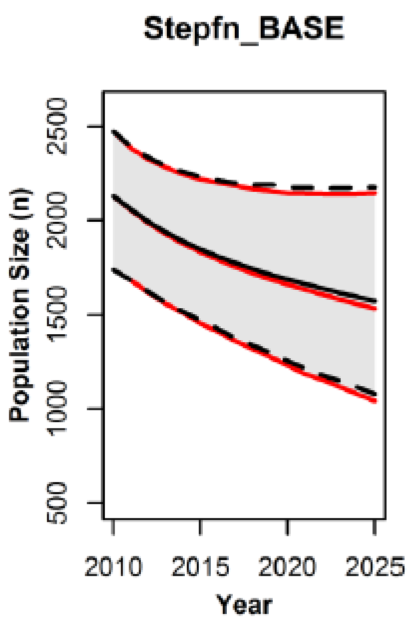


Figure 77. Demographic model representing baseline population trajectories (black lines) with 95% confidence limits (dashed lines), and behaviorally disturbed populations (red lines) (modified from Farmer et al. (2018a)).

As part of BOEM's PEIS, an Expert Working Group (EWG) was established to assess potential effects of anthropogenic disturbance on marine mammals, including sperm and Bryde's whales. This EWG was made up of private and academic scientists, with support from BOEM, NMFS and the oil and gas industry, to attempt to give more biological relevance to the way anthropogenic disturbance is currently measured. During their work, they had several realizations quoted here from their preliminary report (Southall et al. 2017):

- "Recognition that industrial activities occur within complex acoustic environments that include other human and natural sound sources;

[60] When analyzing using other dose-response functions (i.e., 160 dB or Nowacek et al.), the population consequences of behavioral disturbance are predicted to be far worse.

- Geographic scales over which assessments should occur are broader than previously considered;
- The probability of negative effects is strongly species-dependent and context dependent (especially for behavioral effects); and
- The relative magnitude of potential impacts must be evaluated within a biological-significance framework that incorporates key species-specific parameters such as population status, distribution patterns, adaptability, and variability and uncertainty in these and other parameters."

This group used these realizations and available information on anthropogenic disturbance and created an analytical framework and associated risk assessment to better estimate the impacts of behavioral disturbance on marine mammal populations. This framework was then applied to examine the potential acute effects of anthropogenic sound sources on marine mammals in the Gulf of Mexico, focusing on seismic airgun surveys. The framework had six iterative stages: 1. Describe and quantify survey activity; 2. Derive or obtain protected species distribution; 3. Calculate sound exposure for protected species; 4. Quantify potential exposures regarding sound impact criteria; 5. Evaluate biological significance and perform risk assessment; and 6. Assess overall conclusions. Results included quantitative exposure predictions for injury and disturbance and qualitative predictions as to the biological significance of these exposures. The EWG framework provided a qualitative approach with similar results to the Farmer et al. (2018a) results described above in this section (see draft EWG report here: *www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm*).

It is possible that sperm whales that have previous experience with seismic survey sound may be habituated to them. Habituation is often characterized by animals that appear to no longer respond or have a decreased sensitivity to a disturbance after repeated exposure to the disturbance (Lusseau et al. 2008; Rodriguez-Prieto et al. 2009; Watkins 1986). Animals are more likely to respond more dramatically to a novel sound and will more quickly recover from any disturbance from the exposure over time from repeated experience with the sound. But habituation becomes more rapid and pronounced after a series of habituation-recovery events.

Another form of non-response is tolerance, which is similar to habituation, but may have a different outcome. If a sperm whale is tolerant, or remaining in the area and, perhaps, foraging less efficiently, the effects could be adverse.

We believe that sperm whales are highly motivated to remain in areas that seismic surveys are occurring so that they can continue engaging in deep foraging dives. The SWSS study showed that although sperm whales were not showing lateral avoidance of surveys, some low-level disturbances to foraging (increased resting periods at the surface and lower "creak" rates) may have been beginning to occur at exposure to airgun sound < 150 dB (rms). We are not discounting the possibility that sperm whales will avoid seismic surveys at closer ranges where exposure will be considerable higher; however, habituated whales or whales that have experienced hearing damage from previous exposures to surveys may not show responses.

BOEM proposes the continued requirement for PSO monitoring of sperm whales and the shut-down of airguns when animals are sighted within 500 m of a vessel. The continued requirements will help limit the number of exposures by shutting down airguns when animals are sighted at the surface. Nonetheless, visual surveys are only effective at detecting animals at the surface and within relatively close proximity to a vessel during daylight hours. Sperm whales will continue to be exposed while they are unsighted when undergoing foraging dives, resting just beneath the surface, at night or times of poor visibility, or within an area of disturbance that extends beyond the 500-meter shut-down distance.

There is currently no way for vessels in the Gulf of Mexico to communicate sightings of whales to each other to reduce the possibility of multiple exposures on a day-to-day basis. Advances in PSO and PAM software and satellite communications could allow PSOs to communicate whale positions to other seismic surveys operating in the area (e.g., coil and azimuth types of surveys). With the current mitigation proposed, the disturbance of animals outside this zone or underwater inside the zone and long-duration disturbances of sperm whales from multiple vessel surveys is likely to occur and adversely affect sperm whales.

Gulf of Mexico Bryde's Whale

To understand how such harassment will impact Gulf of Mexico Bryde's whales we rely on data indicating that cetaceans may briefly respond to underwater sound by slightly changing their behavior or relocating a short distance, in which case the effects can equate to take but are unlikely to be significant at the population level. Displacement from important feeding or breeding areas over a prolonged period would likely be more significant. This has been suggested for humpback whales along the Brazilian coast as a result of increased seismic survey activity (Parente et al. 2007). Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012); this is reflected in a variety of aquatic, aerial, and terrestrial animal responses to anthropogenic sound that may ultimately have fitness consequences (Francis and Barber 2013). Animals generally respond to anthropogenic perturbations as they will predators, increasing vigilance, and altering habitat selection (Reep et al. 2011). Habitat abandonment due to anthropogenic sound exposure has been found in terrestrial species (Francis and Barber 2013). Because of the similarities in hearing anatomy of terrestrial and marine mammals, we expect it possible for Bryde's whales to behave in a similar manner as terrestrial mammals when they detect a sound stimulus. For additional information on the behavioral responses marine mammals exhibit in response to anthropogenic sound, including non-ESA-listed species, see one of several reviews (e.g., Gomez et al. 2016; Southall et al. 2007).

Several studies have aided in assessing the various levels at which whales may modify or stop their calls in response to sounds for airguns. Whales continue calling while seismic surveys are operating locally (Greene Jr et al. 1999; Jochens et al. 2006a; Madsen et al. 2002b; McDonald et al. 1993; McDonald et al. 1995; Nieukirk et al. 2004; Richardson et al. 1986b; Smultea et al. 2004; Tyack et al. 2003). However, humpback whale males increasingly stopped vocal displays on Angolan breeding grounds as received seismic airgun levels increased (Cerchio et al. 2014). Some blue, fin, and sperm whales stopped calling for short and long periods apparently in response to airguns (Bowles et al. 1994; Clark and Gagnon 2006; McDonald et al. 1995). Fin whales (presumably adult males) engaged in singing in the Mediterranean Sea moved out of the area of a seismic survey while airguns were operational as well as for at least a week thereafter (Castellote et al. 2012). Dunn and Hernandez (2009) tracked blue whales during a seismic survey and did not observe changes in call rates and found no evidence of anomalous behavior that they could directly ascribe to the use of airguns at sound levels of approximately less than 145 dB re: 1 μPa (rms). Blue whales may also attempt to compensate for elevated ambient sound by calling more frequently during seismic surveys (Di Iorio and Clark 2009). Bowhead whale calling rate was found to decrease during migration in the Beaufort Sea when seismic surveys were being conducted (Nations et al. 2009). Calling rates decreased when exposed to seismic airguns at received levels of 116 to 129 dB re: 1 μPa (possibly but not knowingly due to whale movement away from the airguns), but did not change at received levels of 99 to 108 dB re: 1 μPa (Blackwell et al. 2013). Given the available data, we assume that some Bryde's whales exposed to seismic airgun sounds at harassment levels may cease calling or otherwise alter their vocal behavior. However, we expect that such responses would be temporary and animals would resume or modify calling at a later time or location away from the seismic source.

While there few studies on Bryde's whales specifically, there are numerous studies on the behavioral responses baleen whales exhibit to airguns. Activity of individuals seems to influence response (Robertson et al. 2013), as feeding individuals respond less than mother and calf pairs and migrating individuals (Harris et al. 2007; Malme and Miles 1985; Malme et al. 1984; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995b; Richardson et al. 1999b). In bowhead whales, surface duration decreased markedly during exposure to airgun sounds, especially while individuals were engaged in traveling or non-calf social interactions (Robertson et al. 2013). In addition, migrating bowhead whales show strong avoidance reactions to received 120 to 130 dB re: 1 μPa (rms) exposures at distances of 20 to 30 km, but only changed dive and respiratory patterns while feeding and showed avoidance at higher received sound levels (152 to 178 dB re: 1 μPa [rms]) (Harris et al. 2007; Ljungblad et al. 1988; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995b; Richardson et al. 1999b; Richardson et al. 1986b). Nations et al. (2009) also found that bowhead whales were displaced during migration in the Beaufort Sea during active seismic surveys. In fact, as mentioned previously, the available data indicate that most if not all baleen whale species exhibit avoidance of active seismic airguns (Barkaszi et al. 2012; Castellote et al. 2012; Gordon et al. 2003; National Academy of Sciences 2016; Potter et al. 2007; Southall et al. 2007; Stone and Tasker 2006). Despite the above observations and exposure to repeated seismic surveys, bowhead whales continue to return to summer feeding areas and when displaced, appear to re-occupy within a day (Richardson et al. 1986b). We do not know whether the individuals exposed in these ensonified areas are the same returning or whether though they tolerate repeat exposures, they may still experience a stress response.

Gray whales respond similarly to seismic surveys as described for bowhead whales. Gray whales discontinued feeding and/or moved away at received sound levels of 163 dB re: 1 μPa (rms) (Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007; Malme and Miles 1985; Malme et al. 1984; Malme et al. 1986; Malme et al. 1988; Meier et al. 2007; Würsig et al. 1999; Yazvenko et al. 2007). Migrating gray whales began to show changes in swimming patterns at approximately 160 dB re: 1 μPa (rms) and slight behavioral changes at 140 to 160 re: 1 μPa (rms) (Malme and Miles 1985; Malme et al. 1984). As with bowhead whales, habitat continues to be used despite frequent seismic survey activity, but long-term effects have not been identified, if they are present at all (Malme et al. 1984). Furthermore, when strict mitigation measures are taken to avoid conducting surveys during certain times of the year when most gray whales are expected to be present and to closely monitor operations, gray whales may not exhibit any noticeable behavioral responses to seismic activity (Gailey et al. 2016).

Humpback whales exhibit a pattern of lower threshold responses when not occupied with feeding. Migrating humpbacks altered their travel path (at least locally) along Western Australia at received levels as low as 140 dB re: 1 μPa (rms) when females with calves were present, or six to 12 km from the acoustic source (McCauley et al. 2000; McCauley et al. 1998). A startle response occurred as low as 112 dB re: 1 μPa (rms). Closest approaches were generally limited to three to four km, although some individuals (mainly males) approached to within 100 m on occasion where sound levels were 179 dB re: 1 μPa (rms). Changes in course and speed generally occurred at estimated received levels of 157 to 164 dB re: 1 μPa (rms). Similarly, on the East coast of Australia, migrating humpback whales appear to avoid seismic airguns at distances of three km at levels of 140 dB re: 1 μPa^2-s. A recent study examining the response of migrating humpback whales to a full 3130 in^3 seismic array found that whales exhibited no abnormal behaviors in response to the active seismic array, and while there were detectible changes in respiration and diving, these were similar to those observed when baseline groups (i.e., not exposed to active seismic sources) were joined by another whale (Dunlop et al. 2017). While some whales were also found to reduce their speed and change course along their migratory route, overall these results suggest that the behavioral responses exhibited by humpback whales are unlikely to have significant biological consequences for fitness (Dunlop et al. 2017). Feeding humpback whales appear to be somewhat more tolerant. Humpback whales off the coast of Alaska startled at 150 to 169 dB re: 1 μPa (rms) and no clear evidence of avoidance was apparent at received levels up to 172 dB re: 1 μPa (rms) (Malme et al. 1984; Malme et al. 1985). Potter et al. (Potter et al. 2007) found that humpback whales on feeding grounds in the Atlantic Ocean did exhibit localized avoidance to airguns. Among humpback whales on Angolan breeding grounds, no clear difference was observed in encounter rate or point of closest approach during seismic versus non-seismic periods (Weir 2008).

Observational data are sparse for specific baleen whale life histories (breeding and feeding grounds) in response to airguns, including for Bryde’s whales. As noted above, the available data support a general avoidance response. Some fin and sei whale sighting data indicate similar sighting rates during seismic versus non-seismic periods, but sightings tended to be further away and individuals remained underwater longer (Stone 2003; Stone and Tasker 2006). Other studies have found at least small differences in sighting rates (lower during seismic activities) as well as whales being more distant during seismic operations (Moulton et al. 2006a; Moulton et al. 2006b; Moulton and Miller 2005). When spotted at the average sighting distance, individuals will have likely been exposed to approximately 169 dB re: 1 μPa (rms) (Moulton and Miller 2005).

In addition to having acute effects due to the immediate exposure of loud sounds from seismic activity, regular, ongoing seismic activity has the potential to significantly add to ambient ocean sound levels (Hildebrand 2009). Unlike sperm whales, Bryde's whales are expected to hear best and communicate at the same low frequencies that seismic airguns produce the most sound. As such, the effects of chronic seismic sound is more likely to have adverse effects on Bryde's whales when compared to sperm whales.

There is substantial frequency overlap between airgun array sounds and the vocalizations of baleen whales such as Bryde's whales. As such, the proposed seismic surveys could mask these calls at some of the lower frequencies for this species. Based on G&G predictions provided by BOEM, seismic activity is expected to occur fairly constantly within the action area. Modeling of chronic exposure to sound associated with BOEM's G&G activities program performed as part of BOEM's 2017 PEIS indicates that at least one location within the area where Bryde's whales are most often found is expected to remain relatively quiet (Matthews et al. 2015). This may be because of absorption of sound by soft, non-reflective sediments in this area and/or because the level of seismic activity within this area is expected to be relatively low. Nonetheless, we do not assume that this particular site necessarily best represents the levels of chronic sound from seismic activity across the entire range of Bryde's whales in the Gulf of Mexico. In fact, in other locations, Matthews et al. (2015) estimated substantial decreases in both listening space and communication space for Bryde's whales. Based on these results, we expect that all Bryde's whales would be chronically exposed to seismic sound due to the accumulation of sound across seismic surveys in the absence of the proposed EPA closure area.

Chronic exposure of Bryde's whales to high levels of anthropogentic sound, such as that produced by seismic activity, may result in chronic stress and masking of important biological sounds (Clark et al. 2009b; Hatch et al. 2012; Rolland et al. 2012). Masking could interfere with Bryde's whales ability to gather acoustic information about its environment such as the location of predators, prey, conspecifics, including potential mates, and other environmental cues (Richardson 1995).

The EWG's framework was introduced in the preceding section on sperm whales. For Bryde's whales, the EWG results were consistent with our effects analysis. The EWG found that Bryde's whales are highly vulnerable to injury and disturbance from G&G activities and also at risk of experiencing greater severity of disturbance and injury as compared to many other marine mammals in the Gulf of Mexico. As such, Bryde's whales were considered a high risk species in considering the effects of sound from G&G activities (see draft EWG report here: *www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm*).

In summary, based on the available data for other baleen whale species, Bryde's whales are expected to exhibit a wide range of behavioral responses as a consequence of being exposed to harassment levels of seismic airgun sound fields. Bryde's whales are expected to mostly exhibit avoidance behavior, and may also alter their vocalizations. These responses are expected to be temporary with behavior returning to a baseline state shortly after the seismic source becomes inactive or leaves the area. In addition, in the absence of the proposed closure, Bryde's whales are expected to be affected by chronic exposure to increased ambient sound as a result of seismic activity. Such chronic exposure is expected to negatively effect the fitness of individual Bryde's whales. With the implementation of a year-round closure in the Bryde's whale area (Figure 74) where they are primarily found, chronic exposure to seismic sound is expected to be reduced such that it would not affect the fitness of individual Bryde's whales that remain inside the area. Information is limited as to this species outside that area, so we are unable to determine at this time the effects to Bryde's whales that occur outside the Bryde's whale area (Figure 74).

Sea Turtles

Previously, in Section 8.2 we determined that only boomer and airgun G&G sound sources have the potential to affect sea turtle hearing and behavior. In this section, we analyze adverse effects on sea turtles that may result from exposure to sound associated with airguns and boomers. For injury (PTS), we rely on the acoustic thresholds recently derived by the U.S. Navy (U.S. Navy 2017), and for harassment we rely on information in the literature that suggests harassment occurs at exposure levels of 175 dB re: 1 μPa (rms) and above (McCauley et al. 2000) (Table 72).

Table 72. Sea turtle sound exposure thresholds.

Definition	Response Thresholds for Sea Turtles		
	PTS[a]	TTS[a]	Harassment Response[b]
Received Level	232 dB re: 1 μPa SPL (0-pk) 204 dB re 1 $\mu Pa^2 \cdot s$ SEL_{cum}	226 dB re: 1 μPa SPL (0-pk) 189 dB re 1 $\mu Pa^2 \cdot s$ SEL_{cum}	175 dB (rms)
Effect	Permanent hearing loss	Temporary hearing loss	Significant disruption of normal behavior patterns

[a] *Criteria for impulsive sound sources for PTS and TTS in sea turtles adopted from Navy Phase III modeling.*
[b] *Behavioral disturbance levels are derived from McCauley et al. (2000).*

Exposure

BOEM did not complete an exposure or response analysis for sea turtles to airguns and boomers under the proposed action. As such, we conducted our own independent analyses. For exposure, we relied on the predictions of G&G activity provided by BOEM in the same seven geographic zones used by JASCO for BOEM's marine mammal exposure modeling. Using these activity level estimates and information on the density of sea turtles, we multipled averaged zonal species density by the expected annual ensonified area to determine the number of animals that may be exposed to the different G&G sound sources. The exposure estimates in this section do not account for the revised proposed action omitting the area under GOMESA. Therefore the estimates represent Gulfwide exposures and are higher than would be expected under the revised proposed action. We account for this in the Incidental Take Statement (Section 15).

We estimated the number of sea turtles exposed to airgun and boomer sounds by first determining the estimated radial distance from the representative airgun array used in BOEM's 2017 PEIS modeling efforts to the various acoustic thresholds identified in (Table 73). The 8,000 in^3 airgun array was estimated to have a source level of 248 dB (peak) and 238 dB (rms) for an array and a 10 second shot interval.

Table 73. Distance to acoustic thresholds from the 8,000 cubic inches representative airgun array.

Response	Radial Distance (m)* to threshold
Pemanent threshold shift (PTS) [232 dB re: 1 µPa SPL (0-pk)]	6.3
Temporary threshold shift (TTS) [189 dB re 1 $\mu Pa^2 \cdot s$ SEL_{cum}]	196.2
Harassment [175 dB re: 1 µPa (rms)]	1,412.5

**Radial distances were calculated using a 20 LOGR spreading loss equation.*

We then used these distances to calculate Zones of Influence (ZOIs; km^2), conservatively relying on the acoustic threshold that resulted in the largest distance for PTS and TTS. ZOIs were calculated as the area that would be ensonified by an airgun array out to the radial distance on either side of a vessel track as the vessel moves through the water. As was done with marine mammals, we used BOEM's survey activity level projections estimated in days to calculate exposure. We assumed an average vessel speed of 4.5 knots to calculate the estimate distance covered in a single day (assuming 24-hour operations), and multiplied this by two times the radial distance to the acoustic thresholds to estimate the total ZOI per geographic zone. We then multiplied the zone specific daily ZOIs by the zonal average densities of each species of sea turtle species or guild to obtain the number of sea turtles exposed per zone per 24-hour day. Consistent with how annual marine mammal exposures were estimated by JASCO, we then multipled the expected 24-hour exposures of sea turtles by the predicted number of survey days per zone to scaleour exposure to estimate the annual number of sea turtle exposures per zone, which were then summed across zones to get the total annual exposure within the action area. Finally, annual averages exposures were calculated as an estimate of annual exposure of adult sea turtles to airgun sounds for the entire duration of the proposed action (Table 74). Importantly, these estimates represent instances of exposure at or above the specified threshold and not necessarily the number of individuals exposed. This is because on average, the estimated per year ensonified area in some cases (e.g., for harassment) is greater than the full extent of the action area, indicating that some areas will be ensonified more than once, perhaps even on the same day. Thus, our exposure estimates represent instances of exposure and we assume that some individuals will likely be exposed more than once within any given year.

As was the case with the PTS distance for sperm whales above, the PTS distance for sea turtles was within the near-field of the acoustic source. In fact, at 6.3 meters, a sea turtle would need to be directly under the array, in order to experience sound levels that would cause PTS. However, as noted above with sperm whales, within the near field, sound levels estimated assuming a point source are over estimated. Thus, for the same reasons we do not expect PTS of sperm whales, we do not expect any individual sea turtle to be exposed to sound fields that would result in PTS. That is, we do not expect sea turtles to come this close to active arrays because they would likely hear and see the array and avoid it. Furthermore, given that within the near-field and dimensions of the array source levels would be below the estimated 248 dB (peak) and 238 dB (rms), we believe exceedance of the PTS threshold is extremely unlikely, and therefore discountable.

Table 74. Annual number of adult sea turtles exposed to seismic airgun survey sounds above threshold.

Response	Annual Airgun Exposures of Adult Sea Turtles					
	Kemp's ridley	Loggerhead	Green	Leatherback	Hawksbill	Hardshell*
TTS	43,436	32,479	8,839	1,357	14,956	2,273
Harassment	312,709	233,827	63,634	9,767	107,672	16,364

*Hardshell turtles may be Kemp's ridley, loggerhead, green, or hawksbill.

The above analysis only estimates the exposure of adult sea turtles to sounds associated with airguns and boomers because the density data we relied on represents sea turtles of approximately 30 cm and greater (Epperly et al. 1995; NMFS 2011d). As such, we conducted an additional analysis to estimate the exposure of juvenile sea turtles to sounds associated with airguns and boomers.

Oceanic juvenile sea turtles typically do not dive very deep and thus, may not frequently enter the area of the loudest sound field produced from a downward pointing airgun array. Oceanic juvenile Kemp's ridley sea turtles (233 mm [about 9.2 inches] straight carapace length) with attached data recorders spend the bulk of their time at or within 1 m of the surface (Witherington et al. 2012b). Oceanic juveniles spent more than 93 percent of their time at the surface during the day, and when dives occasionally occurred, depths ranged from 1.7-3.7 m. At night, dive depths occurred between 6.3-12.8 m. According to BOEM, airguns are typically towed 8-12 m below the surface and the sound of airguns is directed downward. Although horizontal propagation is known to occur over many kilometers from the source, sound modeling for airgun arrays are not accurate above and lateral to arrays at distances less than 75-100 m from an array (Caldwell and Dragoset 2000) because the sound transmission is much lower and variable in the near field at the surface. Since the tow depths of airgun arrays and dive depths of oceanic juveniles are very similar, at least at night based on the Kemp's ridley data discussed above, it is possible that an oceanic juvenile will be located at a depth in which they would experience exposure to an airgun array as estimated by the acoustic modeling. However, since juveniles spend most of their time near the surface, in most cases exposure is expected to be less than that predicted by the acoustic modeling, since applying such modeling for near surface waters over-estimates sound exposure levels.

The above overview indicates that juvenile sea turtles may be at depths great enough to be considered below an airgun array, but in many cases, they will likely be closer to the surface where sound levels would be lower. In our exposure analysis for juvenile sea turtles, we take a conservative approach and assume that any sea turtle within the footprint of the ensonified area (i.e., within the area ensonified regardless of depth) may be exposed to sound levels that would result in adverse effects. This is in fact the same approach as was taken for adults since we did not discount our exposure estimates for the possibility that some adult sea turtles would be near the surface and thus be exposed to lower sound levels than predicted for deeper depths.

To estimate the total number of juvenile sea turtles that would be exposed to sounds from airguns at TTS and harassment acoustic thresholds, we followed the same general methodology used for adults. We first calculated the daily ensonified area at the TTS and harassment acoustic thresholds using the same methods identified above, and then multipled this by the total annual average number of survey days predicted by BOEM of 1,837. The total number of survey days was used because unlike for adults, we did not have zone specific density estimates for juvenile sea turtles. The resulting number, representing the total yearly ensonified area per acoustic threshold, was then multiplied by the juvenile sea turtle density estimates specified in Table 39 to obtain final exposure estimates in Table 75. PTS exposure was not calculated as in our adult analysis, it was determined that PTS was discountable.

Importantly, these estimates represent instances of exposure at or above the specified threshold and not necessarily the number of individuals exposed. This is because on an average, the estimated per year ensonified area in some cases (e.g., for harassment) is greater than the full extent of the action area, indicating that some areas will be ensonified more than once, perhaps even on the same day. Thus, our exposure estimates represent instances of exposure and we assume that some individuals will likely be exposed more than once within any given year.

Table 75. Annual number of oceanic juvenile sea turtles taken by exposure to seismic survey sound.

Response	Annual Airgun Exposures of Juvenile Sea Turtles				
	Kemp's ridley	Loggerhead	Green	Leatherback	Hawksbill
TTS	174,063	144,478	204,383	0	6,099
Harassment	1,253,128	1,040,139	1,471,411	0	43,906

Response

Given the above estimated exposure, ESA-listed sea turtles may exhibit a variety of different responses to sound fields associated with airguns, including hearing threshold shifts, behavioral responses, and non-auditory physical and physiological responses (Nelms et al. 2016).

Although all sea turtle species studied exhibit the ability to detect low frequency sound, the potential effects of exposure to loud sounds on sea turtle biology remain largely unknown (Nelms et al. 2016; Samuel et al. 2005). Only one study addressed sea turtle TTS, conducted by Moein et al. (1994), in which a loggerhead turtle experienced TTS upon multiple airgun exposures in a shallow water enclosure, but recovered full hearing sensitivity within one day. We assume that sea turtles will not move towards a sound source that causes them stress or discomfort. Some experimental data suggest sea turtles may avoid seismic sound sources (McCauley et al. 2000; Moein et al. 1994), but monitoring reports from seismic surveys in other regions suggest that some sea turtles do not avoid airguns and were likely exposed to higher levels of pulses from seismic airgun arrays (Smultea and Holst 2003). However, even if sea turtles are in close proximity, based on our exposure analysis we would only expect TTS to occur, no PTS, and in most cases, we expect sea turtles will move away from sounds produced by the airgun array. For those individuals that would experience TTS, the available data suggest hearing would return to normal within days of the exposure (Moein et al. 1994). Sea turtles that incur hearing impairment due to exposure to seismic surveys may experience an impaired acoustic awareness that may increase the risk of adverse effects to human activities on the OCS. Hearing impairment could result in sea turtles' no longer responding to the sounds of nearby airguns and not hearing the engine or propeller sound of approaching vessels. A lack of response to these auditory cues could result in an increased risk of vessel strikes. Sea turtles with auditory impairment could still rely on their vision to respond to and avoid potential threats, but avoidance to visual cues (Hazel et al. 2007a) would occur at much closer ranges to the threat than the warning an auditory signal could possibly provide.

It is likely that sea turtles will exhibit behavioral responses. Behavioral responses to human activity have been investigated for several species of sea turtles: green and loggerhead (McCauley et al. 2000; O'Hara and Wilcox 1990); and leatherback, loggerhead, olive ridley, and 160 unidentified turtles (hard shell species) (Weir 2007). The work by O'Hara and Wilcox (O'Hara and Wilcox 1990) and McCauley et al. (McCauley et al. 2000) on loggerhead turtles were previously discussed, as they formed the bases of our 175 dB re: 1 µPa (rms) threshold for determining when sea turtle would be harassed due to sound exposure because at and above this level loggerheads were observed to exhibit avoidance behavior, increased swimming speed, and erratic behavior. Loggerhead turtles have also been observed to move towards the surface upon airgun exposure (Lenhardt 1994; Lenhardt et al. 1983a). Loggerhead turtles resting at the ocean surface were observed to startle and dive as an active seismic source approached them, with the responses decreasing with increasing distance (Deruiter and Larbi Doukara 2012). However, some of these animals may have reacted to the ship's presence rather than the seismic source specifically (Deruiter and Larbi Doukara 2012). Monitoring reports from seismic surveys show that some sea turtles move away from approaching airgun arrays, although sea turtles may approach active airgun arrays within 10 m with minor behavioral responses (Holst et al. 2006; LGL Ltd 2005a; LGL Ltd 2005b; LGL Ltd 2008; NMFS 2006a; NMFS 2006b).

Observational evidence suggests that sea turtles are not as sensitive to sound as are marine mammals and behavioral changes are only expected when sound levels rise above received sound levels of 175 dB re: 1 µPa (rms). If exposed at such levels, based on the available data we anticipate some change in swimming patterns. Some sea turtles may approach the active airgun array to closer proximity, but we expect them to eventually turn away in order to avoid the active airgun array. As such, we expect only temporary displacement of exposed individuals from some portions of the action area as seismic vessels transit through. However, the effect of disturbance of sea turtles caused by exposure to seismic survey sound is expected to vary with life history stage. Oceanic juvenile turtles exposed to disturbing levels of sound will most frequently occur when *Sargassum* habitat is present within the disturbance distance ZOI (4,467 m) from an airgun array. Exposure within this distance could displace oceanic juveniles from *Sargassum* habitat needed for food and shelter. This disturbance could result in decreased foraging success, increased energy expenditure to find food and new shelter, and an increased risk of predation due to displacement from *Sargassum* habitats. Adult sea turtles disturbed in this way would need to relocate to an adjacent area and incur increased energy expenditure and stress levels.

Direct evidence of seismic sound causing stress is lacking in sea turtles. Animals often respond to anthropogenic stressors in a manner that resembles a predator response (Beale and Monaghan 2004; Frid 2003; Frid and Dill 2002; Gill et al. 2001; Harrington and Veitch 1992; Lima 1998; Romero 2004). As predators generally induce a stress response in their prey (Dwyer 2004; Lopez and Martin 2001; Mateo 2007), we assume that sea turtles may experience a stress response if exposed to loud sounds from airgun arrays. We expect breeding adult females may experience a lower stress response, because female loggerhead, hawksbill, and green turtles appear to have a physiological mechanism to reduce or eliminate hormonal response to stress (predator attack, high temperature, and capture) in order to maintain reproductive capacity at least during their breeding season; a mechanism apparently not shared by males (Jessop 2001; Jessop et al. 2000; Jessop et al. 2004).

Prey Species

G&G surveys could have indirect, adverse effects on sperm whales, Bryde’s whales and sea turtles by reducing the abundance or availability of prey or changing the structure or composition of the prey community. Sperm whales, Bryde’s whales and all species of sea turtles are likely to forage in the action area. Because fish and invertebrate species such as squid and jellyfish are pelagic prey for whales and sea turtles, such effects might have adverse consequences for individuals if foraging success is adversely affected due to adverse effects on prey.

A range of invertebrates (jellyfish, crustaceans, arrow worms, octopus, and squid) are reported to be sensitive to low-frequency (10–150 Hz) sound disturbances induced by sound waves or other sources (Western Australian Department of Industry Resources 2002). This sensitivity overlaps the dominant frequency range of seismic pulses. Available studies report responses to airgun shots as being limited to transient alarm responses such as tail-flicks (lobsters), and siphon closing (ascidians) (Western Australian Department of Industry Resources 2002). Mortality of giant squid in the Bay of Biscay may possibly have been linked to seismic airgun activity in the area (Guerra et al. 2004). McCauley et al. (2000) examined the effect of marine seismic surveys on captive squid and cuttlefish and reported a strong startle response or directed movement away from airguns during sudden, nearby start-ups at received levels of 174 dB (rms). Alarm responses in squid were detected during gradual ramp-up of airguns once levels exceeded 156-161 dB (rms). Squid in these trials appeared to make use of the sound shadow measured near the water surface. These responses for captive squid suggest that behavioral changes and avoidance of operating airguns would likely occur. The authors concluded squid significantly alter their behavior at an estimated distance of 2-5 km from an approaching large seismic source.

Studies of the behavioral responses of fish and fishing success to seismic sources report similar responses (Dalen and Knutsen 1986; Engås and Løkkeborg 2002; Hirst and Rodhouse 2000; Kenchington 1999; LaBella et al. 1996; Santulli et al. 1999; Thomson et al. 2001; Turnpenny and Nedwell 1994; Wardle et al. 2001). Whiting (hake) showed a sudden downward movement, changing their distribution from being dispersed between 25 m (80 ft) and 55 m (180 ft) depth, to forming a compact layer below 55 m (180 ft) in response to airgun sound (Chapman and Hawkins 1969). Toward the end of an hour-long exposure to the airgun pulses the fish had habituated to the sound and risen back upward in the water column, despite the continued presence of sound pulses. However, when the airgun resumed firing after a dormant period, the fish exhibited another downward response. In other airgun experiments, catch-per-unit-effort (CPUE) of demersal fish was reported to decline when airgun pulses were emitted (Dalen and Knutsen 1986; Dalen and Raknes 1985; Skalski et al. 1992). Fish behavior returned to normal minutes after the sounds ceased. In the Barents Sea, abundance of cod and haddock measured acoustically was reduced by 44 percent within 9.2 km (5 nmi) of an area where airguns operated (Engås et al. 1996). Actual catches declined by 50 percent throughout the trial area and 70 percent within the shooting area. This reduction in catch decreased with increasing distance until 30-33 km (16-18 nmi), where catches were unchanged. Eggs of several commercial fish species exposed to a single seismic airgun (300 in^3) have also been shown to experience a reduction in survival (Kostyuchenko 1973).

In a recent, fairly exhaustive review, Carroll et al. (2017) summarized the available information on the impact seismic surveys have on fishes and invertebrates. Seismic surveys could cause physical and physiological responses, including direct mortality, in fishes and invertebrates. In fishes, such responses appear to be highly variable, and depend on the nature of the exposure to seismic activity, as well as the species in question. Current data indicate that possible physical and physiological responses include hearing threshold shifts, barotraumatic ruptures, stress responses, organ damage, and/or mortality. For invertebrates research is more limited, but the available data suggest that exposure to seismic activity could result in anatomical damage and mortality in some cases. In crustaceans and bivalves, there are mixed results with some studies suggesting that seismic surveys do not result in meaningful physiological and/or physical effects, while others indicate such effects may be possible under certain circumstances. All available data on echinoderms suggests they exhibit no physical or physiological responses to exposure to seismic activity. Based on the available data, as reviewed by Carroll et al. (2017), we assume that some fishes and invertebrates may experience physical and physiological effects, including mortality, but in most cases, such effects are only expected at relatively close distances to the seismic source. However, recent evidence indicates that seismic airguns may lead to significant mortality of zooplankton out to approximately 1.2 km (McCauley et al. 2017).

McCauley et al. (2017) found that the use of a single airgun lead to a decrease in zooplankton abundance by over 50 percent and a two- to three-fold increase in dead adults in larval zooplankton when compared to control scenarios. Adverse effects to zooplankton were found out to 1.2 km, the maximum distance that the sonar equipment used in the study was able to detect changes in abundance. McCauley et al. (2017) note that for seismic activities to have a significant impact on zooplankton at an ecological scale, the spatial or temporal scale must be large in comparison to the ecosystem in question. This is in part because for such activities to have a measurable effect, they need to outweigh the naturally high turnover rate of zooplankton (McCauley et al. 2017). In particular, 3-D seismic surveys, which involve the use of multiple overlapping tracklines to extensively and intensively survey a particular area, are of concern (McCauley et al. 2017).

The prey of Bryde's whales, sperm whales, and sea turtles may also exhibit behavioral responses if exposed to active seismic airgun arrays. Based on the available data, as reviewed by Carroll et al. (2017), considerable variation exists in how fishes behaviorally respond to seismic activity, with some studies indicating no response and others noting startle or alarm responses and/or avoidance behavior. However, no effects to foraging or reproduction have been documented. Similarly, data on the behavioral response of invertebrates suggests that some species may exhibit a startle response, but most studies do not suggest strong behavioral responses. As with cetaceans and sea turtles, any such behavioral responses by fishes and invertebrates may also be associated with a stress response.

Based on the available data, we anticipate seismic surveys would result in a reduction in availability of prey for ESA-listed species near the airgun array immediately following the use of active seismic sources. This may be due to changes in prey distributions (i.e., due to avoidance) or abundance (i.e., due to mortality) or both. However, we do not expect this to have a meaningful *immediate* impact on sperm whales, Bryde's whales, and sea turtles since as described above, we believe that in many cases, sperm whales, Bryde's whales, and sea turtles will avoid closely approaching a seismic array when active, and as such will not be in areas where prey have been effected. However, even though we do not anticipate significant *immediate* adverse effects, this is not to say that *long-term*, aggregate effects to populations of prey are not possible if one considers the combined effect of all seismic surveys in space and time.

In their review on the impacts of seismic activity on fishes and invertebrates, Carroll et al. (2017) also examined whether or not seismic activity was associated with population level changes in abundance by examining studies that quantified fisheries catch before and after seismic activity. While a few studies found negative effects of seismic activity on catch rates, most found no effects, and a few even found that surprisingly seismic activity lead to an increase in catch rates. In a recent study, Richardson et al. (2017) scaled up the results of McCauley et al. (2017) to examine the effects of a hypothetical seismic survey on zooplankton off the coast of Australia. Based on their results, seismic surveys had a significant impact on the abundance of zooplankton within and near the survey area, but such effects were short-lived and minimized by ocean circulation.

Based on these studies, there is mixed evidence as to whether or not seismic activity can have population level effects to prey that may result in adverse effects to species at higher trophic levels. However, for several reasons we do not anticipate seismic activity associated with the proposed action will result in adverse effects to sperm whales, Bryde's whales, and sea turtles via indirect effects to prey species. First, extensive seismic activity has been occurring in the Gulf of Mexico for decades and current data do not suggest sperm whales, Bryde's whales, and sea turtles are prey-limited. Since 2000, we are aware of five cases of stranded sperm whales in the Gulf of Mexico that showed signs of emaciation, and at least one of which appeared to die of age related complications (NMFS stranding data). For Bryde's whales, little information exist on their foraging behavior but impacts to prey are not considered one of the major threats to the species. For sea turtles, while there remain gaps in foraging ecology information, there are little data that point towards prey availability being a threat to the species. However, oceanic stage juveniles associated with and foraging within Sargassum communities could experience localized, short term effects from prey reductions. Second, while the action area is likely to experience significant seismic activity, especially male sperm whale (Jochens et al. 2008) sperm whales and sea turtles (Girard et al. 2009) are not confined to the action area and likely to have access to prey outside of the areas exposed to seismic activity. Furthermore, sperm whales typically feed at great depths, far from where the highest sound levels from seismic activity would be, so impacts to sperm whale prey are less likely, although this does not discount indirect effects to their prey through lower trophic levels. While Bryde's whales range is more constricted, and they are less likely to leave the action area, the Bryde's whale area restriction is likely to provide substantial protection for Bryde's whale prey. Thus, while we expect some effects to the abundance and availability of prey for sperm whales, Bryde's whales, and sea turtles, these effects are not expected to have measurable impacts on individual sperm whales, Bryde's whales, and sea turtles, and are therefore insignificant and not likely to adversely affect these species.

8.5.2.2 High-resolution Geophysical Surveys and Related Surveys

Whales

Exposure

BOEM provided modeling for the exposure of Bryde's whales and sperm whales to HRG surveys under the proposed action. HRG surveys have a much smaller acoustic footprint than airgun and boomer surveys because they operate at higher frequencies. Higher frequencies attenuate faster and the sources are often towed at depths close to the sea floor that limits spreading of the sound. Some sonar sources are attached to the vessel at the surface, but most are deployed at depths 20-50 ft above the sea floor on a towfish or AUV which limits the directionality of the main power of the signals to deeper depths of the water column.

We reviewed G&G permits from the Gulf of Mexico from 2014-2015 and found the most common types of sound sources used for HRG surveys include side-scan sonars, echosounders, and sub-bottom profilers over a wide range of frequencies between 2-400 kHz. The survey distances indicated by the permits ranged from 17-927 miles and typically lasted for 45 days (3-60 days). Table 76 shows the annual number of exposures to HRG survey sounds that would cause a disturbance response was modeled as the percent of sperm or Bryde's whales disturbed over 24-hour periods using the Wood et al. (2012b) probabilistic (step) function discussed in section 8.5.1.

Table 76. Number of disturbance responses of sperm whales and Bryde's whales to high-resolution geophysical surveys calculated as the percent of animals responding over daily periods.

Year	Number of Survey Days/Year	Sperm Whale Total Harassment Exposures	Bryde's Whale Total Harassment Exposures
1	94	< 1	< 1
2	95	< 1	< 1
3	98	< 1	< 1
4	95	< 1	< 1
5	95	< 1	< 1
6	103	< 1	< 1
7	113	< 1	< 1
8	114	< 1	< 1
9	116	< 1	< 1
10	103	< 1	< 1
10-Year Total	1,026	0.53	0.000816
50-Year Total	10,260	5	0.04

Response

HRG sound sources include sub-bottom profilers, side-scan sonar, multi-beam and single-beam echosounders, some of which are within the hearing range of sperm and Bryde's whales, and as such, may be disturb these species. In addition, the source levels of some have the potential to cause PTS/TTS in Bryde's and sperm whales. However, TTS and PTS exposure levels resulting from HRG survey equipment are only possible at a very close distance to the source. Kremser et al. (2005) concluded the probability of a cetacean swimming through the area of exposure when such sources emit a pulse is small, as the animal would have to pass at close range and be swimming at speeds similar to the vessel in order to receive multiple pulses that might result in sufficient exposure to cause TTS. This finding is further supported by Boebel et al. (2005), who found that even for echosounders with relatively high source levels, TTS is only possible if animals pass immediately under the transducer. Burkhardt et al. (2013) estimated that the risk of injury from echosounders was less than three percent that of vessel strike. In addition, modeling by Lurton (2016) of multibeam echosounders indicates that the risk of injury from exposure to such sources is negligible, and even behavioral responses are unlikely. Thus, sperm and Bryde's whales would only be exposed to TTS and or PTS levels at very close ranges to the sound sources. However, we do not expect sperm whales and Bryde's whales to come this close to the sources for several reasons. First, animals are expected to hear the sounds (if audible) at much greater distances than the TTS or PTS distances, and in most cases avoid a close approach. In addition, PSOs and crew would be on the look out for these species not only to avoid acoustic exposure, but also to avoid vessel strikes. As such, if any whale were close, measure would be taken to stop acoustic sources and maximize distance from the animal. For these reasons, we find TTS and PTS of Bryde's and sperm whales resulting from HRG and similar acoustic sources to be discountable. In the remainder of this section, we analyze the potential for HRG surveys to cause harassment of sperm and Bryde's whales.

The HRG acoustic sources we evaluated are sound sources between 2-1,600 kHz. As noted earlier, Bryde's whales hearing range is up to 35 kHz and sperm whales' hearing range is between 150 Hz to 160 kHz. To our knowledge, there are no empirical studies of avoidance responses of Bryde's whales to sonar, but there are a few of sperm whales. In the Caribbean, sperm whales avoided exposure to mid-frequency submarine sonar pulses, ranging from 1,000 Hz to 10,000 Hz (Watkins et al. 1993).

Naval sonar exposures of sperm whales were part of a Norweigan CEE study that had received levels ranging from 120-169 SPL_{max} re 1 μPa, which led to foraging disturbance, including alteration or cessation of the production of foraging sounds (i.e., regular clicks and buzzes) and changes in the dive profile (Isojunno et al. 2016). In addition to changes in vocal behavior, sperm whales demonstrated avoidance, change in locomotion and/or orientation, change in dive profiles, cessation of foraging, and cessation of resting in response to naval sonar (Curé et al. 2016; Miller 2011; Miller et al. 2012; Sivle et al. 2012). Cessation of foraging did not extend beyond the duration of the exposure (Miller et al. 2012). Changes in the dive profile and production of foraging sounds (i.e. regular clicks and buzzes) were altered or stopped when exposures affected foraging activities (Curé et al. 2016). Changes in coda and slow click production rates were also observed in many exposure sessions (Curé et al. 2016). Sperm whales appear to respond more strongly and at lower sound levels to low frequency active sonar (LFAS; 1−2 kHz) than to mid-frequency active sonar (MFAS; 6−7 kHz).

Given that to our knowledge, no studies exist on the behavioral responses of Bryde's whales to HRG survey acoustic sources, we rely on information from other baleen whales. While Todd et al. (1992) found that mysticetes reacted to sonar sounds at 3.5 kHz within the 80 to 90 dB re: 1 μPa range, it is difficult to determine the significance of this because the sound source was a signal designed to be alarming and the sound level was well below typical ambient sound. Goldbogen et al. (2013) found blue whales to respond to 3.5 to 4 kHz mid-frequency sonar at received levels below 90 dB re: 1 μPa. Responses included cessation of foraging, increased swimming speed, and directed travel away from the source (Goldbogen et al. 2013). The response of a blue whale to 3.5 kHz sonar supports this species' ability to hear echosounders as well (Goldbogen et al. 2013). Maybaum (1990; 1993) observed that Hawaiian humpback whales moved away and/or increased swimming speed upon exposure to 3.1 to 3.6 kHz sonars. These studies suggest that some baleen whales are able to detect high frequency sonars and furthermore, exhibit a behavioral response.

Sea Turtles

We previously determined that the HRG sonar sources operating at frequencies above 2 kHz are above the hearing abilities of sea turtles and as such, are not expected to result in disturbance. In addition, the source levels of these sources are not high enough to result in PTS/TTS. Sea turtles that are exposed to those sound sources are not likely to respond to that exposure or experience any other auditory effects. As a result, sound sources associated with HRG surveys (survey sound sources above 2 kHz) are insignificant and therefore are not likely to adversely affect North and South Atlantic DPS green, hawksbill, Kemp's ridley, leatherback, or Northwest Atlantic loggerhead sea turtles.

8.5.3 Effects of Sound from Decommissioning

When we consider exposure to different types of sound in the exposure categories, we must always consider the frequency content of the sound and duration of the sound source. For example, the reaction of animals exposed to disturbing levels of sound would be expected to differ for brief, infrequent sound and sound that is repeated over long periods of time. Such is the case with the use of explosives to decommission oil and gas structures that result in short periods of sound.

BSEE regulations require lessees to remove all sea floor obstructions from their leases within one year of lease termination. These regulations require lessees to sever bottom-founded structures and their related components at least 5 m (15 ft) below the mudline to ensure that nothing would be exposed that could interfere with future lease activities or other oceanic activities in the area (e.g., shrimp trawling). The structures for removal are generally grouped into three main categories: (1) the structure (piles, jackets, caissons, templates, mooring devices, etc.), (2) the well (wellheads, casings, casing stubs, etc.), and (3) pipelines. The main sound-related aspect of decommissioning that could result in impacts to sea turtles, Bryde's whales and sperm whales is the use of explosives to sever or cut structures to be removed. Non-explosive methods are also used, but have very low impacts on the surrounding environment. BOEM has not provided any information on sound levels produced from non-explosive methods to remove structures. Based on our review of other oil and gas sounds, the sound produced from these non-explosive methods is likely to elicit some short-term behavioral responses that will be insignificant, and we have no evidence suggesting the sound levels produced are harmful to listed species. Explosive severance, however, is the primary severance method of concern during decommissioning because it could lead to the disturbance, injury, or death of listed species exposed to the shock waves from underwater explosions. BOEM and BSEE estimate 43-81 structures to be decommissioned annually will be removed with explosives. In the years 2004-2013, six structures were removed with explosives in depths greater than 200 m. BOEM expects no structures would be explosively removed in waters greater than 200 m. All removals with explosives are expected to occur in the CPA or WPA, and in depths shallower than 200 m.

Sperm whales are not likely to be adversely affected by pre-severance activities, non-explosive severance techniques, or the removal and transport of the offshore structure to shore. Given the mitigation measures in place, the probability that any sperm whale would be within the TTS, injury or mortality zone of an explosive severance operation is extremely low and the potential for TTS, injury, or mortality is discountable.

Due to their restricted range within the Eastern Planning Area, the likelihood of Bryde's whales being adversely affect by decommissioning activities is discountable because the proposed action does not include new leases and structures requiring decommissioning in this area.

We do not expect decommissioning to have adverse effects on Bryde's whales or sperm whales based on BOEM's projections that the 10-year period of new leases evaluated in this opinion will not include new leases in the Eastern Planning Area. Additionally, no explosive removals are expected in water depths greater than 200 meters, hence, sperm whales are not likely to be affected by explosive removal of structures. If new leases are offered in the Eastern Planning Area such that decommissioning of structures in that area would occur over the timeframe of this opinion, or should a structure in water depths greater than 200 meters be needed, reinitiation of consultation would be required.

8.5.3.1 Overview of Decommissioning and Effects of Underwater Explosions on Sea Turtles

In this section, we describe the probable risks of the structure removal activities on sea turtles (Table 77). We will first describe the particular aspects of decommissioning that may affect listed species and describe the routes of effects from those activities. In particular, we examine the major stages of decommissioning with emphasis on the use of explosives to sever structures from the ocean bottom. Our analysis will examine the possible effects to listed species from using underwater explosives, the exposure thresholds and areas that may be affected, PSO data from past decommissioning activities, and other available scientific and commercial data to determine the possible impacts that could be expected.

We will look at two stages of decommissioning in this section:

1. Pre-severance operations (reparation and cleaning of the structure to be removed)
2. Severance and removal of the structure (with explosives and other cutting methods)

In Section 9.6 (below) we evaluate the effects of site clearance activities, the third stage of decommissiong.

Table 77. Summary of actions and potential effects resulting from decommissioning.

Decommissioning Stage	Activities	Route of Effects
Pre-Severance Activities	Pipeline flushing, tank and deck cleaning, top-side cutting, equipment removal, pile jetting, survey work (sonar, diver, and/or ROV), deployment of work vessels, equipment, and personnel	Exposure to changes in water quality, air quality, vessel and construction sound, marine debris
Severance and Removal of Offshore Structures	Non-explosive cutting, explosive severance, PSO monitoring, vessel transport of structure to shore for salvage, or granting a variance for an alternative use for a state reef programs	Behavioral response to detonation sound, injury or death from pressure waves, vessel and construction sound, and vessel strikes
Site Clearance	Bottom trawling, diver surveys, sonar surveys	Capture, forced submergence, and retrieval in trawl nets

Pre-Severance and Severance Activities

Vessels are mobilized to the removal site to transport equipment and crew to and from the work site. Vessel discharges to marine waters include sanitary waste or sewage; domestic waste such as water from shipboard sinks, laundries and galleys; bilge and ballast waste; cooling water; and deck drainage. Although the aforementioned aspects are part of decommissioning process, we will consider the potential effects of vessel sound, air and water emissions, vessel strikes, and marine debris for all OCS oil and gas activities, in separate subsections of this opinion.

Pre-severance activities include vessel anchoring, jetting of sediments for below mudline (BML) severing, and removal of surface structures before the structure is cut. Jetting uses high-pressure water sprayed from inside or outside of a pile to excavate sediment and sand layers. Jetting could result in sound up to 170.5 dB re 1 µPa (peak) (Molvaer and Gjestland 1981) or about 160 dB (rms). This level of sound is not expected to result in any behavioral disturbance to sea turtles. Jetting sound would be short term and minor while preparing a structure for cutting from the seabed. Although jetting will temporarily increase the ambient sound levels in the area, the potential for jetting sound to harass ESA-listed species is so low, it is discountable.

Underwater Explosions

The largest concern with structure removals is the use of explosives for severance. Most of the structures to be severed with explosives are cylindrical metal structures protruding from the bottom sediment, such as support legs, piles, or well conductors. A variety of explosives are used to disconnect structures from their foundation under the sea floor, such as pentaerythritol tetranitrate, cyclonitrite (RDX), trinitrotoluene (TNT), Composition B, and C-4. Explosives are placed inside or outside of these structures such that the energy from a blast will sever the target by mechanically distorting (ripping), jet cutting, or fracturing the material. BSEE requires that explosives be used 4.6 m (15 feet) below the mud line for any charge used to sever a structural component. However, explosives are also used above the mud line to cut structures above the foundation.

Underwater detonations, like other loud sound-producing sources, have more severe impacts at closer distances to the detonation due to the pressure wave being more pronounced near the source (Figure 78). An underwater explosion is composed of an initial shock wave, followed by a succession of oscillating bubble pulses. A shock wave is a compression wave that expands radially out from the detonation point of an explosion. At a distance from a detonation, the propagation of the shock wave may be affected by several components including the direct shock wave, the surface-reflected wave, the bottom-reflected wave, and the bottom-transmitted wave. The direct shock wave results in the peak shock pressure (compression) and the reflected wave at the air-water surface produces negative pressure (expansion).

For an explosion underwater, a blast wave travels through the animal’s body and may cause internal injury to gas-filled organs (e.g., ears, lungs, intestines, and other organs), due to impedance differences at the gas-liquid interface. In the case of detonations, the pressure wave is very pronounced from the sudden release of high energy, and the resulting shock wave can have injurious or mortal impacts to animals closest to the site. The amount of explosives used is the primary factor affecting how large an area is impacted, but extent of impacts is also affected by the depth of the charge, type of explosive, and whether bulk or shape charges are used. Impacts of explosive severance on sea turtles could include death, injuries to internal organs, auditory damage, physical discomfort, and behavior disruptions.

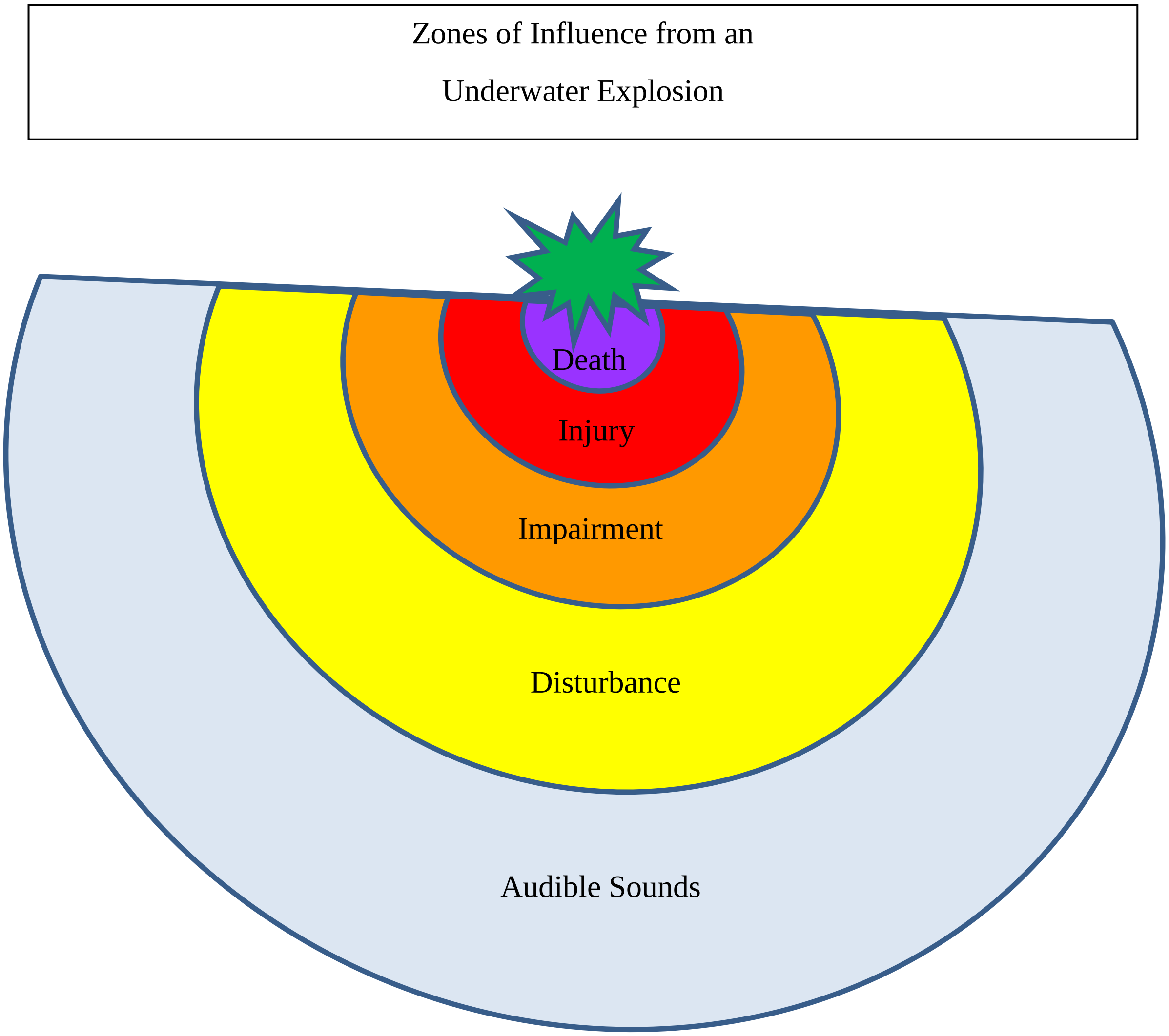


Figure 78. A generalized diagram showing one-half of the zones of influence associated with an underwater explosion.

Nature of Explosive Use in Severance Activities

Detonations from the explosive removal of oil and gas structures usually occur once per day, but may occur more frequently. Depending on the size of the structure or complex of structures, multiple charges are often used for each detonation event (Table 78). Charges are separated by a delay of about one second to prevent pressures from combining into a more deadly pressure wave; however, a detonation can last for as many seconds as there are charges. The number of detonation events per structure ranges from one to five per day depending on the complexity of the structure (Table 79).

Table 78. Number of charges per detonation event used to remove offshore structures in 2013.

	Number of Explosive Charges/Detonation Event									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10-16**
Number of Occurrences	77	9	14	18	13	6	4	5	1	5

Source: BOEM BA supplemental information.

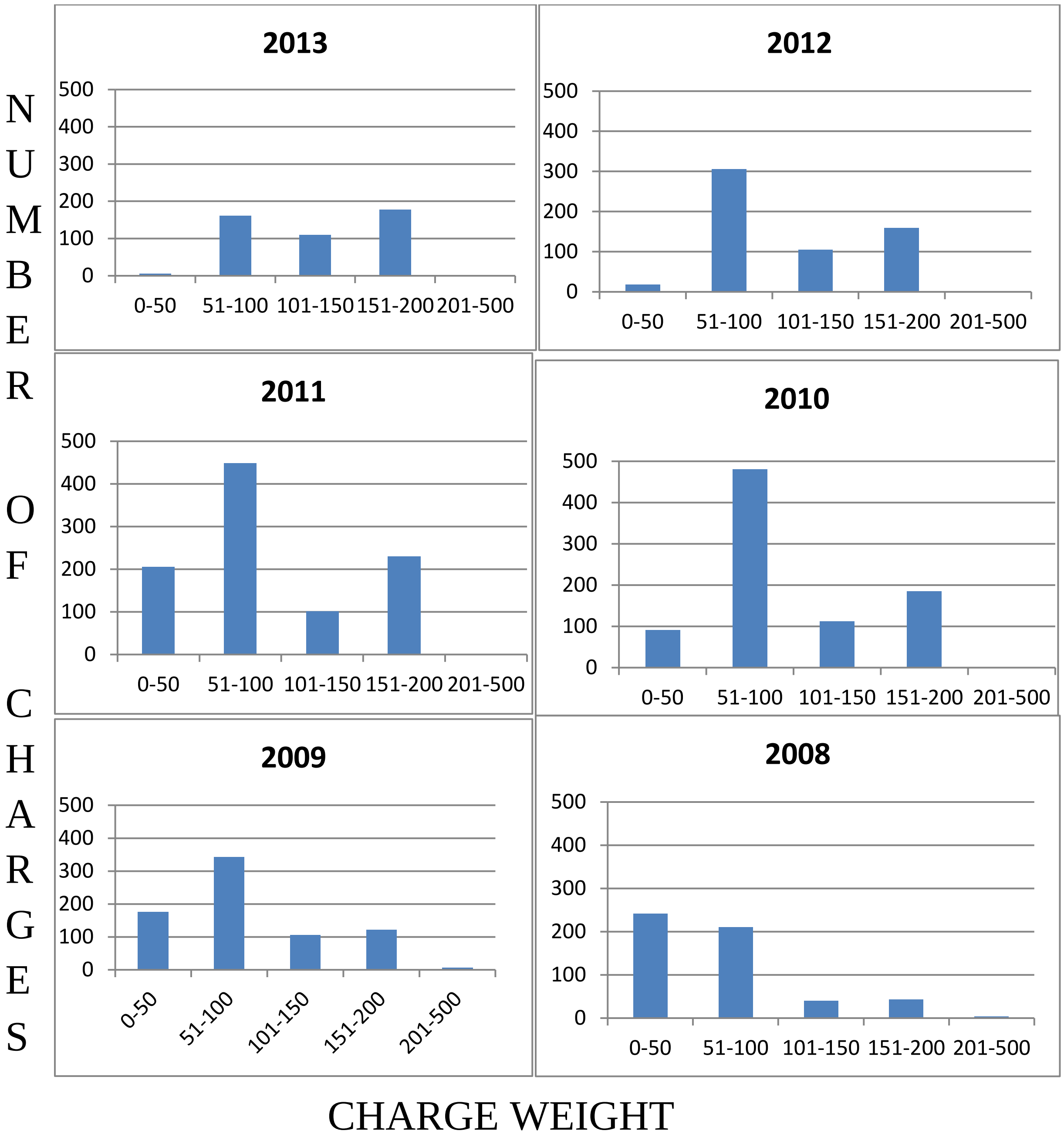
Table 79. Number of detonation events used to remove offshore structures in 2013.

	Number of Detonations Events/Structure				
	1	**2**	**3**	**4**	**5**
Number of Occurrences	50	34	3	5	1

Source: BOEM BA supplemental information.

Heavier charge weights result in explosions with larger impact zones. The decommissioning industry in the Gulf of Mexico can use charge weights ranging from 5 lb up to 500 lb, but they have only used up to 200-lb charge weights. Since 2008, there has been a trend to use increasingly larger charge weights because industry was permitted to use charge sizes above 50 lb. The most commonly used charge weight in 2008 was in the 5-100 lb range. In 2013, the use of 150-200-lb charges were the most commonly used charge weight (NMFS Platform Removal Observer Program, see Figure 79). Therefore, a 200-lb charge used in this analysis will conservatively estimate the largest zones of influence for all explosive removals.

BSEE has developed an “Under Water Calculator” (UWC) to estimate the distance of zones of influence from different charges sizes. The UWC can calculate a pressure distance for any charge placed 15 ft below the mudline inside a pile, leg, conduit, or other structure. The UWC is intended to be used as a tool to predict zones of influence from different charge weights placed inside or outside of a pile for various structure types and is considered the best available tool for its purpose. The UWC informs the development of appropriate mitigation measures to minimize impacts to sea turtles and marine mammals, and is used to identify the appropriate mitigation strategy for individual projects that propose different charge weights and their different uses to sever structures on the OCS. Example calculations presented show the impact associated with the commonly used 80-lb charges and 200-lb charges placed in open water and in a main pile of a structure to be removed (Table 80).



Source: BOEM BA supplemental information.

Figure 79. The size and number of charge weights used from 2008-2013.

The most recent version of the UWC underwent a peer review through the Center for Independent Experts (CIE) that was completed in early 2017. The CIE review results and recommendations were provided and can be found at https://www.st.nmfs.noaa.gov/science-quality-assurance/cie-peer-reviews/cie-review-2016. The three panelists that reviewed the UWC generally agreed that this tool was useful for informing mitigation, and had an adequate level of accuracy. The CIE panel made recommendations for improvements that BSEE has indicated it will be using to make adjustments to the tool. The UWC was used to calculate representative distances to impact zones relative to charge sizes for sea turtles and are shown in Table 80.

The mitigation plan in place since 2006 has been effective, as indicated by avoided animals detailed in PSO reports, and the current mitigation plan is proposed for continuation under the proposed action. BSEE will evaluate the effectiveness of these measures to minimize the take of adult and oceanic juvenile sea turtles and sperm whales in the following analysis of effects.

Table 80. Representative impact distances for sea turtles from two charge sizes within and outside structures.

Zone of Influence	UWC Radius (m) and Area (km^2) from Detonation			
	80-lb Charge in Open Water		200-lb Charge in Open Water	
	Radius	Area	Radius	Area
Mortality	155.2	0.076	210.7	0.140
Injury	358.8	0.404	478.9	0.721
Impairment	573.3	1.033	778.1	1.902
Disturbance	1,014	3.230	1376.8	5.955
	80-lb Charge in a Main Pile		200-lb Charge in Main Pile	
	Radius	Area	Radius	Area
Mortality	34.9	0.004	47.3	0.007
Injury	58	0.011	78.8	0.020
Impairment	78.5	0.019	106.5	0.036
Disturbance	111.8	0.039	151.8	0.072

Source: BSEE UWC supplemental information.

8.5.3.2 Sea Turtles

There are several accounts of sea turtles spending considerable time around some offshore oil and gas structures, presumably for shelter and feeding on animals living on or near the structure. Although turtles do not spend their entire lives around structures, they could spend days, or in some cases months, before moving on to other areas. Offshore oil and gas structures provide topographic relief and have been shown to attract sea turtles (Gitschlag and Herczeg 1994; Lohoefener et al. 1990; NMFS 1989; Rosman et al. 1987). Offshore structures support algae, barnacles, and other foods for sea turtles.

Several cases have reported the injury and death of sea turtles exposed to underwater explosions (Duronslet et al. 1991; Gitschlag and Herczeg 1994; Klima et al. 1988). NMFS studied the effects of offshore oil and gas structure removals using 23 kg (50 lb) of nitromethane (Klima et al. 1988). Loggerhead and Kemp's ridley sea turtles were located at distances of 213.4 m (700 ft), 365.8 m (1,200 ft), 548.6 m (1,800 ft), and 914.4 m (3,000 ft) from the platform removed with explosives. The charges were placed inside platform pilings at a depth of 5 m below the mudline. Four sea turtles within 365.8 m of the detonation were unconscious, as well as an individual at 914.4 m (3,000 ft). Sea turtles were expected to have drowned if not recovered from the water following the detonation. These turtles exposed to the blast exhibited everted cloacas, abnormal pink coloration of soft tissues around the eyes and external nares, and base of the throat and flippers, for a period of two to three weeks. Remaining Kemp's ridleys at more distant ranges were apparently unharmed. In an unintended exposure of sea turtles, two immature green turtles (100-150 ft away) were killed when 20 lb of plastic explosives (C-4) were detonated in open water by a U.S. Navy Ordnance Disposal Team. Necropsies revealed extensive internal damage, particularly to the lungs (Schroeder and Foley 1995). Three sea turtles were unintentionally exposed to underwater shock tests by the Naval Coastal Systems Center in 1981 off the coast of Panama City, Florida. Three detonations of 1,200 pounds of TNT at mid-depth (in about 120 feet of water) injured 1 turtle at a distance of 500-700 ft and another at 1,200 ft. A third turtle at 2,000 ft was apparently not injured (O'Keefe 1984).

Non-lethal effects of underwater explosions on marine turtles include impairment or displacement of oceanic juveniles from developmental *Sargassum* habitat. Observable behaviors of effects on adults include erratic swimming at the surface, stunned animals floating motionless or with little movement, and other indications of abnormal behavioral. Impacts resulting in these behaviors could include the detection of strong vibrations and pressure waves throughout the body that cause physical discomfort and temporary hearing loss. Physical discomfort or tactile detection can occur in the soft tissue areas around the nose, eyes, mouth, nares, and vent, or vibration through the shell and bones of a turtle. Marine turtle auditory perception occurs through a combination of bone and water conduction (Lenhardt et al. 1983b), and it is reasonable to assume that shock impulses produced by underwater explosions may be sufficient to elicit a strong disturbance response.

Exposure

Different sizes of impact zones result from the wide range of charge sizes that are authorized to be used under the proposed action. Response threshold levels are used to estimate the ranges certain effects can occur, determine the risk of those impacts to listed species, and develop any mitigation and monitoring that is needed to reduce those effects. Any exposure to levels resulting in impairment, injury, or mortality would adversely affect a sea turtle. Oceanic juvenile sea turtles could also be adversely affected throughout the disturbance zone since they could be displaced from important developmental habitat provided by the *Sargassum* community. The threshold levels for each type of effect considered in this exposure analysis are defined below (Table 81).

Table 81. Sea turtle exposure thresholds for five levels of severity from single detonation events.

Exposure Thresholds for Sea Turtles Exposed to Single Underwater Explosion Events				
Mortality	**Injury**	**Impairment**	**Disturbance**	**Onset of Behavioral Response**
> 237 dB (peak)[a] or 102 psi	> 229 dB (peak)[b] or 40 psi	> 224 dB (peak)[c] or 23 psi	> 218 dB (peak)[d] or 12 psi	> 180 dB (peak)[e] or 0.14 psi
Mortal injury, cracked carapace, lung,	Potentially lethal physical injuries, prolonged	Temporary hearing loss, stunning (disorientation,	Oceanic juvenile habitat displacement from	Brief response to a single explosive "bang," startle

intestinal, and organ damage	immobilization by stunning, auditory trauma	erratic flipper movements, or brief immobilization)	the area, increased swimming speed, increased heart rate	responses which include diving or swimming

[a] Richmond et al. 1973
[b] Popper et al. (2014)
[c] Impairment levels are approximated from the stunned sea turtles observed by NMFS PSOs following detonations.
[d] Disturbance levels are approximated as a sub-TTS, high level behavioral response.
[e] DeRuiter and Doukara 2012.

Next, we will consider the potential for adult sea turtle impairment, injury and mortality from underwater explosions. We took a representative removal scenario of a 200-lb charge detonated in a main pile and calculated the area over which it could cause adverse effects to sea turtles. To calculate the distance from a structure for each zone of influence, we used BSEE's UWC. We then analyzed PSO data from NMFS's Platform Removal Observer Program (PROP) to estimate how many animals may be expected to occur within these zones of influence during future removals under the proposed action. We believe using PSO data is the best approach for estimating exposures to explosive severance because PSO data from PROP is robust as many animals can be seen from a low flying helicopter prior to detonation and sea turtle exposures have been minimized since the start of the program in 1987. We acknowledge that there is still potential for unobserved turtles to be exposed, however, we believe that PROP is the best available mitigation and monitoring for explosive severance, and that the data provided by PROP are reliable.

We relied directly on PSO data to estimate exposure for adult sea turtles, as opposed to information on adult sea turtle densities in the action area, because PSO data were considered to better represent the actually density of turtles around platforms. As mentioned previously, platforms and other structures tend to create habitats that may in fact attract sea turtles, and therefore, the density of sea turtles around platforms may actually be higher than elsewhere in the action area. Given this, relying on PSO data to estimate exposure of adult sea turtles to explosives used in decommissioning is more appropriate and likely more conservative than using sea turtle density estimates, although we recognize that PSO's probably do not detect all exposed sea turtles.

First, we evaluated PSO sightings data and determined the average number of individuals sighted for each species per structure (Table 82).

Table 82. Total number of adult sea turtles[a] observed at structure removal sites during 2004-2013.

Species	YEAR									
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Avg. Number/ Structure
Kemp's ridley	7	15	5	18	17	50	53	56	76	60	0.3168
Loggerhead	90	67	168	44	53	108	83	93	124	71	0.7995
Green	2	4	0	1	4	4	3	0	16	7	0.0364

Species	YEAR										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Avg. Number/ Structure
Leatherback	1	0	2	2	2	3	3	7	9	8	0.0328
Hawksbill	0	0	0	0	0	1	1	2	0	0	0.0035
Unknown	36	14	16	20	20	32	24	24	68	31	0.2529
											Total
Total Turtles	136	100	191	85	96	198	167	182	293	177	1625
Number of Structures	90	93	69	86	96	126	144	188	130	105	1127

[a] Each sea turtle sighting was counted as a separate individual unless there was evidence indicating the same animal was observed on multiple occasions. Evidence might include distinguishing characteristics such as carapace size, barnacle pattern, etc., as well as dive frequency and location. When PSOs lacked a clear view of a turtle and it was impossible to determine if this was a repetitive sighting, the turtle was generally recorded as a new individual. Bias in the data include that these numbers over represent the actual number of individual sea turtles that occurred due to repeated sightings, and underreporting of individuals that went undetected by PSOs. Source data: NMFS' Platform Removal Observer Program.

Sightings of sea turtles from PSO data show that loggerheads are more commonly sighted around oil and gas platforms even though NMFS density estimates show that Kemp's ridleys are reportedly more abundant. Whether this is due to differences in habitat use (water depth of removals), a greater affiliation of loggerheads for oil and gas structures, or other reasons is currently unknown. From the total number of sea turtle sightings over the past 10 years, we corrected the number of sightings for unidentified sea turtles to obtain a more accurate number of sightings for our calculations. We corrected the sightings by applying the relative proportion of positive identifications for each species to unidentified turtle sightings, and then correcting the positive identified turtle numbers (Table 83).

Table 83. Adjusted number of adult sea turtle sightings around oil and gas structures to account for unidentified sea turtles.

Species	Adults/Structure	Percent of Sightings	Correction for Unknowns	Adjusted Adults/Structure
Kemp's ridley	0.3168	26.64	0.0673	0.3841
Loggerhead	0.7995	67.24	0.1700	0.9695
Green	0.0364	3.06	0.0077	0.0441
Leatherback	0.0328	2.76	0.0070	0.0398
Hawksbill	0.0035	0.30	0.0007	0.0043

We then used these sightings numbers (Table 83) to predict the number of adult sea turtles that may be exposed to future underwater explosions as a result of the 81 explosive removals predicted to occur annually. This was accomplished by converting the distances for each zone of influence we calculated with the UWC to an area (km^2). We then compared the areas for each zone of influence. For the representative scenarios for a 200-lb charge detonated in a main pile (Table 80), the comparison for each zone of influence shows the mortality zone is 5.19 percent of the total area, the injury zone is 14.81 percent of the total area, and the impairment zone is 26.67 percent of the total area monitored. The remaining 53.34 percent of the area encompasses the disturbance zone. Using these percentages, we have taken the average number of sea turtle sightings around platforms and calculated the percent number of sea turtles that could be present in each zone of influence (Table 84).

Table 84. Predicted annual number of adult sea turtles present in the zones of influence for 81 annual structure removals based on ten years of protected species observer sightings.

Effect	Total Predicted Sea Turtle Sightings from PSO Data				
	Kemp's ridley	Loggerhead	Green	Leatherback	Hawksbill
Mortality	2	4	0	0	0
Injury	5	12	1	0	0
Impairment	8	21	1	1	0

Note: Predicted sightings are calculated by multiplying the number of adjusted sightings per structure times 81 structures removed with explosives annually.

Although the data show that sightings are frequent, impacts are expected to be minimized due to the use of PSOs monitoring the area for sea turtles and detonations being delayed when sea turtles are sighted. Thirteen sea turtles have been observed to be injured or killed during explosive removals of platforms since 1987 when NMFS's Platform Removal Observer Program began observations of sea turtles during decommissioning activities (Table 85).

Table 85. Sea turtles that have been observed to be injured or killed during explosive removals of platforms between 1990 and 2016.

Date	Observed Injury	Species	Number of Charges	Charge Weight (lb)	Water Depth (ft)	Distance from structure/Time after Blast
10/4/90	Cracked carapace	Loggerhead	1	35	60	10 yd, 1-17 minutes after blast
11/20/97	Cracked carapace	Loggerhead	1	50	72	30 yd, 11 minutes after blast
7/16/98	Dead	Loggerhead	2	50	89	13 yd, 4 minutes after blast
8/20/01	Stunned/not recovered	Loggerhead	7	50	39	50 yd, 5 minutes after blast
8/8/10	Cracked carapace, died	Loggerhead	4 3	80 and 180	77	10 yd, 19 min after blast
8/20/10	Dead	Loggerhead	8 1	200 80	241	50 yd, 4 min after blast
8/15/11	Lethargic/not recovered/unknown injury	Kemp's ridley	1	60	52	500 yd, 2 min after blast
8/27/11	Belly up, flailing flippers/not recovered/injury unknown	unidentified	13	Six 160 and seven 80	136	Unknown, reported by barge captain
3/29/12	Stunned/not recovered/unknown injury	Green	4	160	98	66 yd, 30 min after blast

Date	Observed Injury	Species	Number of Charges	Charge Weight (lb)	Water Depth (ft)	Distance from structure/Time after Blast
10/23/12	Stunned/not recovered/unknown injury	Kemp's ridley	3	80	165	466 yd, less than 1 min after blast
7/18/13	Dead	Kemp's ridley	3	80	18	10 yd, 21 min after blast
03/03/15	Injured/bleeding/ cracked carapace	Loggerhead	4	200	130	25 yd, 50 minutes after blast [a]
11/09/15	Stunned	Kemp's ridley	4	80	130	648 yd, 10 minutes after blast

[a]Post-detonation survey had already ended.

To estimate the severity of effects from underwater detonations to adult sea turtles, we first evaluated injuries and mortalities, and then we evaluated impairments. We estimated takes over five-year periods using the most recent PSO data and BOEM's projected activity levels to predict the number of expected PSO sightings and observed injuries and deaths, because annual estimates would result in fractions of turtle takes. In our summary at the end of this section, weextrapolate our annual estimates to take levels over 50 years of the proposed action.

As displayed in Table 85 (above) from 2011-2016, two loggerheads, three Kemp's ridleys, one green, and one unidentified turtle were documented as having been injured or killed as a result of explosive removal of structures during decommissioning. There has never been a hawksbill or leatherback documented to be killed as a result of explosive removal of structures during decommissioning. For the mitigation effectiveness analysis, we use approximately four turtles mitigated per structure removed. Additionally, all unidentified sea turtles sighted around structures have been hardshell species that were likely loggerhead, green, or Kemp's ridley sea turtles. We calculate that injuries and deaths should correspond to one turtle for every 17 structures (24/405=0.05926 per structure) removed under the proposed action. Over each year, we expect 81 structures will be removed with explosives resulting in 24 sea turtle injuries and deaths for all species. Since injury can result in delayed mortality, to be conservative we have combined the injury and mortality takes into a single category (Table 86). Using the relative proportions of each species around structures calculated based on data from 2011-2016 PROP reports and the number of turtles reported taken by injury or mortality, we estimate the number of each species of adult sea turtles that will be injured or killed during any given year in Table 87. To conservatively account for some potential takes of leatherbacks and hawksbills in the future, we have assumed there is a potential for one individual take of each species. To estimate the number of unobserved turtles, we used the same PROP data for an average of the percentages of turtles that were observed within the pre-detonation zone, but were not observed during post-detonation surveys, or had unknown fate, which was approximately 91%.

Table 86. Numbers of predicted occurrences of adult sea turtles in the zone of influence for injury and mortality, and the number of takes expected from underwater explosives if the proposed mitigation and monitoring requirements are followed.

Injury and Mortality	Annual Number of Adult Sea Turtles				
	Kemp's ridley	Loggerhead	Green	Leatherback	Hawksbill
Number of predicted occurrences in ZOI	7	16	1	1	1
Number avoided[61] (observed turtles)	6.93	15.84	0.99	0.99	0.99
Total Takes Expected (including unobserved turtles[62])	6.44	14.72	0.92	0.92	0.92
50 year totals	322	736	46	46	46

Next, we evaluated potential impairment of adult sea turtles. Adult sea turtles that are impaired may remain mobile and rapidly swim away from the area following exposure to the sound, but a few may be stunned at higher exposures that temporarily immobilize the animal. Based on PSO reports few stunned turtles are expected and most of the temporarily impaired animals are not expected to be observed post-detonation since most turtles are expected to swim away from the area. Although we expect many of the potential impairments can be avoided with the proposed requirements to monitor for turtles pre-detonation, we can predict the number of turtles that will be impaired but may go unobserved.

Table 87. Numbers of predicted occurrences of adult sea turtles in the zone of influence for impairment and the number of takes expected from underwater explosives following the proposed effects minimization measures.

Impairment	Numbers of Adult Sea Turtles				
	Kemp's ridley	Loggerhead	Green	Leatherback	Hawksbill
Number of predicted occurrences in ZOI	8	21	1	1	0
Number avoided (observed turtles)	7.92	20.79	0.99	0.99	0
Total Takes Expected (unobserved turtles)	7.36	19.32	0.92	0.92	0
50 year totals	368	966	46	46	0

To estimate the number of oceanic juveniles that may occur in the zones of influence from explosions, we calculated the impact areas using BSEE's UWC for a 200-lb charge in a main pile (Table 88). Oceanic juveniles are expected to occur in greater numbers when *Sargassum* is

[61] Seven injury/mortality takes from 2011-2016 out of 1,042 PSO-reported turtle observations around platforms (PROP reports 2011-2016).
[62] Unobserved numbers were estimated by multiplying 91% (unknown fate) by the number expected in the ZOI.

present, such that the greatest risk to this age class would be present when removals are occurring within or near larger areas of *Sargassum*. Charges occurring in very deep pelagic waters probably have a minimal effect on oceanic juveniles at the surface, but data are not yet available for deepwater scenarios, and the UWC cannot yet predict the effect of charge depth on ZOIs at the surface. Despite the variable risks under different scenarios, we are applying the average oceanic juvenile density to all proposed removal operations to obtain the conservative estimates of overall numbers of exposures that can be expected from all of the proposed explosive removals of offshore structures.

Table 88. Zones of influence for a 200-pound charge detonated in a main pile.

Oceanic juvenile turtle Response Category	200-lb Charge in Main Pile	
	Radius (m)	Area (km^2)
Mortality	47.3	0.007
Injury	78.8	0.02
Impairment	106.5	0.036
Disturbance	151.8	0.072

We do not know the exact sound levels at which oceanic juveniles could be displaced; however, we estimate a high sound exposure that begins to approach TTS levels would cause alarm reactions that could result in oceanic juveniles leaving the area and abandoning *Sargassum* habitat it was using. A sub-TTS level of 218 dB re 1 µPa peak pressure that is 6 dB below TTS levels (TTS is 224 dB re 1µ Pa peak pressure) could cause oceanic juvenile sea turtles to abandon *Sargassum* and be displaced to open waters or to habitat that does not support food availability or provide protection. Oceanic juvenile sea turtles are at a higher risk of predation and need the food sources found within the *Sargassum* community to support their growth. Therefore, detonations occurring when *Sargassum* is present in the impact zone will adversely affect oceanic juvenile sea turtles by disturbance.

As we discussed earlier, industry typically uses charge sizes of 80-200 lb to remove offshore structures. A 200-lb charge is currently the largest size that has been used and provides a conservative estimate of the impacted area for all proposed explosive removals. Smaller charge weights are still used in a large number of removals completed. To estimate exposures, we calculated the oceanic juvenile density of each species within each impact zone for an individual event. We then multiplied that number times the number of structures to be removed annually to obtain an estimate of the number of oceanic juveniles of each species that may be taken (juvenile densities x area within each zone x 81 structures removed annually, Table 89).

Table 89. Estimated number of oceanic juvenile sea turtle exposures resulting from the use of underwater explosives.

	Oceanic Juvenile Animals Exposed				
	Kemp's Ridley	Loggerhead	Green	Leatherback	Hawksbill
Mortality/Injury	2.640365	2.191593	3.100291	0	0.09251

Impairment	3.520487	2.922124	4.133722	0	0.123347
Disturbance	7.040974	5.844247	8.267443	0	0.246694
50 year totals					
Mortality/Injury	132.0183	109.5796	155.0146	0	4.625505
Impairment	176.0243	146.1062	206.6861	0	6.16734
Disturbance	352.0487	292.2124	413.3722	0	12.33468

Response

The underwater use of explosives can kill, injure, impair, and cause animals to have behavioral responses to detonations. Lethal injuries result from massive trauma or combined trauma to internal organs as a result of close proximity to the point of detonation. Impacts to sea turtles from explosive removal operations may range from noninjurious effects (e.g. acoustic annoyance; mild tactile detection or physical discomfort) to varying levels of injury (i.e. non-lethal and lethal injuries) (Viada 2008). Very little information exists regarding the impacts of underwater explosions on sea turtles (Viada 2008). Effects of explosions on turtles often must be inferred from documented effects to other vertebrates with lungs or other gas-containing organs, such as mammals and most fishes. Types of lethal injuries reported for marine mammals include massive lung hemorrhage, gastrointestinal tract injuries (contusions, ulcerations, and ruptures), and concussive brain damage, cranial and skeletal (shell) fractures, hemorrhage, or massive inner ear trauma (Ketten 1995). Examples of nonlethal injuries include eardrum rupture, bruising, and immobilization of severely stunned animals. Stunned animals beneath the water may drown or become vulnerable to other impacts while they are immobilized. Minor organ injuries and contusions can occur as a result of underwater explosions; however, sea turtles would be expected to recover over time through normal healing processes. Still, delayed complications arising from nonlethal injuries may ultimately result in the death of the animal because of increased risks from secondary infection, predation, or disease. Rupture of the ear drum is not a life-threatening injury, but it does correlate to permanent hearing loss (Ketten 1995) and could have some adverse effects on animal hearing abilities.

Adult sea turtles exposed to underwater explosions may show startle responses and a turtle may be deterred from the area. Exposures at lower levels of 180 dB (peak) may briefly startle a turtle, but these lower sound levels are not expected to displace adult sea turtles from the area, and are not expected to disrupt normal behaviors. Exposure to louder sound > 180 dB (peak) may result in more pronounced behavioral responses that can include turtles leaving the area. Structure removals with explosives would result in some loss of available habitat for any adult sea turtles that were using the area. Adult sea turtles affected in this way would need to relocate to an adjacent area. Sea turtles use large oceanic areas relative to the area affected by explosive stressors and the displacement from the area while a removal is occurring is not likely to result in changes to a turtle's ability to survive or reproduce. Therefore, the displacement of adult sea turtles from areas due to sounds during underwater explosions is considered to be insignificant.

Based on sightings and observed impacts to sea turtles, the aerial and surface monitoring for sea turtles conducted by PSOs appear to be very effective at detecting animals and minimizing the number of injuries and deaths. Despite the effectiveness of monitoring to avoid impacts, some sea turtles are still injured or killed by the direct effects of underwater explosions and some sea turtles exposed to sublethal levels probably go unobserved because affected animals are likely to swim away before being sighted. Some injuries and deaths are probably underestimated because dead sea turtles are likely to sink to the ocean bottom (Klima et al. 1988), or they may not be sighted due to their small size. It is assumed that some additional turtle injuries and deaths may have occurred but were not observed due to the injured turtle's swimming away and possibly dying at a later time.

Like adults, oceanic juveniles are susceptible to injury and mortality from explosives. However, oceanic juvenile behaviors and habitat requirements may result in different responses to sound than adults. Oceanic juvenile turtles may be found when *Sargassum* habitat is present around a structure to be decommissioned. In the past, there have been anecdotal reports of detonations carried out in areas with high *Sargassum* coverage. Such events could place oceanic juvenile turtles at particular risk of injury or displacement from *Sargassum* habitat that they need for food and shelter. Currently, PSOs can call for the delay of a detonation if *Sargassum* or other conditions such as fog or high sea states pose conditions under which adult animals cannot be effectively monitored. There are currently no protective measures to delay detonations or take additional survey measures to avoid impacts to oceanic juvenile turtles when *Sargassum* habitat is present and no adult turtles are sighted. Oceanic juvenile sea turtles can be easily missed by PSOs because they are small and are well camouflaged in *Sargassum* patches. In one rare case, PSOs observed post-hatchling turtles taking cover beside a derrick barge. The turtles eventually moved away from the barge and were not sighted again. Oceanic juvenile presence around explosive removals is possible wherever *Sargassum* is present in quantities that can provide food and shelter for oceanic juvenile sea turtles. *Sargassum* coverage is widely variable from year-to-year and its presence in impact zones cannot be predicted with any certainty. However, we can use densities of oceanic juvenile sea turtles to calculate the number of exposed animals that are expected. Whereas adult sea turtle densities may be higher near structures, and thus using average sea turtle densities within the action area may be inappropriate, juvenile sea turtles are typically associated with *Sargassum*, not necessarily semi-permanent structures like platforms. For these reasons, as well as others outlined below, using density estimates for the action area was deemed appropriate for estimating juvenile sea turtle exposure to explosive sounds associated with decommissioning.

Despite the overall higher density of adult Kemp's ridley sea turtles than loggerheads in the Gulf of Mexico, PSO data show that loggerheads are most frequently sighted and may be more attracted to platforms than other species. We do not expect this trend to occur with oceanic juvenile loggerheads and would expect juvenile Kemp's ridleys to be more abundant. Using PSO sighting rates would over represent oceanic juvenile loggerheads, and under-represent oceanic juvenile Kemp's ridley sea turtles. Although oceanic juveniles may sometimes be found in other oceanic areas lacking *Sargassum* (e.g., hatchlings migrating offshore or larger oceanic juveniles traveling between habitats), Witherington et al. (2012) found that oceanic juveniles were most often found within or very near the occurrence of *Sargassum*. Based on their association with *Sargassum*, Witherington et al. (2012) calculated densities of oceanic juvenile sea turtles per square kilometer of *Sargassum* habitat. Therefore, oceanic juvenile densities for each species in the action area will be approximated by using the density estimates from Witherington et al. (2012) and applied to the maximum available *Sargassum* habitat in the northern Gulf of Mexico (Table 39).

Like adults, oceanic juveniles may show startle reactions resulting from lower levels of sound exposure. Brief dives or swimming responses are not expected to displace juveniles from *Sargassum* and these types of minor responses would have insignificant effects on individuals. However, exposure of oceanic juveniles to very high sound levels from explosives could result in their abandonment of the area. Temporary loss of shelter, decreased foraging success, or predation could result from habitat displacement. A displaced oceanic juvenile may return after a short period or may need to seek a new *Sargassum* habitat. In any event, some level of behavioral disturbance would be expected while the animal seeks new *Sargassum* habitat. Such disturbance could have fitness consequences for individual oceanic juvenile sea turtles.

8.5.4 Effects of Sound from Construction and Operations

This section of our sound analysis for construction and operation sound addresses pile driving associated with the installation of structures (i.e., platforms, caissons, wellheads, etc.). Other sources of sound from construction and operations associated with the action were considered in Section 9.2.2 and found to not likely adversely affect ESA-listed species. We will characterize the common sources of pile driving sound and analyze their potential to adversely affect sea turtles and sperm whales.

We do not expect pile driving to affect Bryde's whales because this species is not typically observed in areas where construction or main operational Oil and Gas Program activities would occur. Bryde's whales are typically found in the EPA, where there are no surface structures, and no plans for installation of structures. Although Bryde's whales may also transit through areas where there are piles being driven and could be exposed to sounds from pile driving, we believe that the chances of those exposures are extremely low because we expect that Bryde's whales would avoid loud sounds and because this species remains mostly in the EPA, where no structures are proposed for installation, hence discountable. Therefore, pile driving sounds from the proposed action are not likely to adversely affect Bryde's whales.

Our analysis will begin by comparing the sound produced by offshore activities with response thresholds to determine if any potential exists for adverse effects to occur. If adverse effects are possible, we will further consider these sound sources for their likelihood to expose listed species to sound levels above the thresholds and result in adverse effects.

To determine if adverse effects may occur to sperm whales, we are using the PTS and TTS thresholds we used for G&G surveys presented in Table 66 and found in the NOAA Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals. The threshold for the onset of behavioral disturbance are sound sources that are within the hearing range of sperm whales and were determined by the Wood et al. (2012a) step function where different proportions of animals will be disturbed at different levels of sound exposure. All underwater decibel (dB) levels are referenced as dB re μPa at 1 m.

For sea turtles, we are using the PTS/TTS criteria for pile driving (i.e., impulsive sound source) adopted from Navy Phase III modeling and behavioral criteria explained in Table 72. We will not include or analyze continuous sound source thresholds being that there is no direct evidence of injury to sea turtles from ship sound, however, there is a high chance of masking and behavioral reactions when close to vessels (Popper et al. 2014).

As Southall et al. (2007) stated, certain sound sources (e.g., seismic airguns and pile driving) may produce pulses at the source but, through various propagation effects, may meet the non-pulse definition at greater distances (e.g., Greene & Richardson, 1988). This means that a given sound source might be subject to different exposure criteria, depending on the distance to the receiver and intervening propagation variables. Changes in sound characteristics with distance generally result in exposures becoming less physiologically damaging with increasing distance because sharp transient peaks become less prominent. We believe that it is highly unlikely sperm whales would approach a construction site near enough to be exposed to the damaging high peak pressures and rapid rise time near a pile driving sources (e.g., this is a concern for smaller species such as fish that may be present and unseen at a pile driving site).

Because sperm whales are unlikely to be exposed to the pressure with rapid rise time, we are using the criteria for SEL that covers a larger area over which exposure to multiple pulses will be treated as a non-pulse (as discussed in NOAA's draft acoustic guidance for impulsive and non-impulsive acoustic thresholds).

8.5.4.1 Overview of the Effects of Pile Driving

Pile driving was the main source of concern for construction and operational sound. We compared the threshold levels for sea turtles and sperm whales to the sounds produced from pile driving activities to determine if there is any potential for adverse effects to occur (Table 90). The potential for any source of sound to adversely affect a listed species depends on its source level and frequency range.

Table 90. Pile driving sound sources associated with the construction of oil and gas.

Source of Sound	Source Level (dB)	Frequency (Hz)
Pile Driving	220-250 (peak), 209-225 (rms)	20-20,000 (strongest at 100-500)

Note: Data from BOEM's 2017-2022 Lease Sale EIS and A Review of Existing Data on Underwater Sound Levels Produced by the Oil and Gas Industry (2008).
Sources and sound levels were provided by BOEM's BA prepared for this opinion and from Genesis Oil and Gas Consultants (2011).

For our analysis of pile driving sound effects on sperm whales, the effects are divided into three response categories: (1) hearing injury, (2) hearing impairment, and (3) disturbance. We compared the sound levels to the exposure levels at which the potential for adverse effects may begin to occur for sea turtles and sperm whales (Table 91). Below, we analyze the significant effects of pile driving sound on sea turtles and sperm whales.

Table 91. Sound sources above the exposure thresholds for sea turtles and sperm whales.

Pile Driving	X	X	X	X	X
Diver Tools	–	–	–	–	X
Helicopters	–	–	–	–	X
Small vessels	–	–	–	–	X
Tug (4 engine)	–	–	–	–	X
Seismic Vessel (guns off)	–	–	–	–	X
Semi-submersible Pipeline Barge	–	–	–	–	X
Pipeline-laying Vessel	–	–	–	–	X
Positioning Thrusters	–	–	–	–	X
Drilling from platforms	–	–	–	–	X
Drilling from ships	–	–	–	–	X
Producing Platform	–	–	–	–	X

Note: There are no SEL measurements available, so we relied on the peak exposure criteria or estimated SEL values from peak values to determine if the effect potential is present.
An (X) indicates the sound is within the species' hearing range and exceeds the threshold level for exposure.
A (–) indicates the sound does not exceed the threshold for the exposure category and is not considered further in the analysis.
[a] Diver tools and thruster sound are only 1-5 dB above the disturbance threshold for sperm whales; however, we have excluded these sources from further analysis because sound from these sources will quickly drop below disturbance levels less than 2 m from the source due to attenuation. Sperm whales are highly unlikely to get close enough to these sources to be exposed to disturbing sound.

Pile driving is needed to install mooring buoys, install piles to serve as the support for oil and gas structures, or to install pile anchors to attach floating structures. Fixed structures can be installed in up to about 300 m water depths and are secured to the sea floor with steel piles. With newer technologies, pile driving capabilities are reaching deeper water depths up to 2,000 meters

(Scaggs 2010).Semi-submersible structures used in depths greater than 300 m are secured to anchor piles in the sea floor. Pile driving during construction activities is of special concern because it generates sound with a very high source level. During pile installation, sound is produced when the energy from construction equipment is transferred to the pile and released as pressure waves into the surrounding water and sediments. The expected type of injury to sea turtles and sperm whales is caused by pressure wave damage to hair cells, ear canals, or ear drums as these structures compress and expand with passage of the wave. Severe injuries are reported to occur to the internal organs in fish (Halvorsen et al. 2012a; Halvorsen et al. 2012b), but these types of injuries have not been reported in larger animals such as sea turtles and sperm whales.

Oil and gas pile driving sounds are typically produced from the installation of open-ended, steel piles that are commonly used in foundations for offshore platforms. These piles are usually driven into the sea floor with impact hammers which use steam, diesel fuel, or hydraulic power as the source of energy. Drilling may also be used to ensure a pile is driven to the needed depth if an impact hammer cannot penetrate hard substrate layers. The amount of sound produced by pile driving depends on a variety of factors, including the type and size of the impact hammer, size of the pile, the properties of the sea floor, and the depth of the water. Thus, the actual sound levels produced would vary from location to location. BOEM could not provide specific details on the installation methods, duration of installation, and sound levels produced from construction activities. Therefore, we relied on information available in the published literature to characterize pile sizes and sound levels produced to conduct a reasonable worst case analysis.

Our review of the literature indicates that platforms and caissons used to install offshore structures typically use steel piles between 36 and 96 inches in diameter, well conductors which require between 26- and 36-inch diameter steel piles, and subsea piles (anchoring piles) which are typically 48 inches in diameter. The size and number of piles appears to be project-specific and are dependent on the complexity of the structure and water depth. We used the best available information on pile-driving sound (CalTrans 2012; Genesis 2011) to determine sound levels for a range of pile sizes used in the construction of oil and gas structures (Table 92). Data are from bridge and port construction reported in CalTrans, Compendium of Pile Driving Data (Version October 1, 2012) and oil and gas pile driving sound reported in Genesis (2011). We also compared with field measurements from piles driven for the Block Island, RI wind turbine base structure installation, which is similar to Gulf of Mexico oil and gas structure installation in that it was installed in deeper water depths than those recorded from CalTrans. Block Island was a four-pile installation with a 42-54 inch single pile diameter range in about 80 m water depth. In some cases, we have back-calculated to the source so we can compare sound levels at the source.

Table 92. Sound source levels for different steel pile sizes used for offshore construction.

Pile Diameter (inches)	Source Level of Sound (dB)		
	Peak	RMS	SEL
24	213	209	198

Pile Diameter (inches)	Source Level of Sound (dB)		
	Peak	RMS	SEL
30	230	210	197
36	230	213	203
40	228	215	200
48	208	215	200
59	228	unreported (215 est.)	211
66	230	215	unreported (211 est.)
71	250	unreported (225 est.)	211
96	240	225	214

Block Island structure installation (from post-construction acoustic monitoring report):

Sound Level	Range (dB)
Apparent peak SL (dB re 1 μPa)	202–242
Apparent rms SL (dB re 1 μPa)	192–224
Apparent cSEL SL (dB re 1 $\mu Pa^2 \cdot s$)	218–249

BOEM does not collect specific data on the types of piles and numbers used for offshore structures in the Gulf of Mexico. We do not know if most of the pile diameters are mostly large or the numbers of piles installed each year for different sizes of piles. Based on the limited data available from BOEM, our analysis will assume a conservative source level of sound for all pile-driving values in Table 92, as indicated below:

- Peak pressure (0-peak) source level of 240 dB
- RMS source level of 225 dB
- SEL (single shot) source level of 215 dB

RMS sound levels are often used to characterize the behavioral response to a sound, although behavioral responses to peak pressure and SEL have also been reported in the literature. The auditory effects (temporary and permanent hearing loss) from a particular sound can be caused by exposure to either of two thresholds, the peak pressure level or the SEL. This is often referred to as “dual exposure criteria” in the literature. For comparison of the dual criteria differences, the peak pressure can be considered to be the “instantaneous” potential for injury to occur from single exposures to sound, and SEL can be considered to be the potential for injury to occur from exposure to sound over time. The predominant metric (peak pressure or SEL) that has the greater potential to cause injury is then chosen as the exposure level to be used in the analysis. For brief exposures, the peak pressure usually dominates as the sound level having the greatest potential to affect animals. For longer periods of exposure, the SEL can be the predominant exposure level of concern. In open-water environments, several assumptions must be made about the movement of animals around a sound source to determine the time period over which an animal may be exposed.

The construction of new offshore structures may take place over a period of a week (for smaller structures) to over a month (for large, complex structures). The time to complete the pile-driving portion of construction activities depends on the number of piles required for a structure, the complexity of the structure (e.g., connected platforms), mooring needs, and the depth to which piles will be driven into the substrate. Pile driving could be completed in one day for simple structures or over a week or more for large structures. From Table 93 we see that BOEM expects most structures to be installed in depths less than 200 meters that will only affect sea turtles (i.e., sperm whales occur in water depths greater than 200 meters). Approximately four of the 51 structures anticipated to be constructed each year will occur in deep water that may affect sperm whales. According to BOEM's BA, deep water structures will likely be larger and require five days of pile driving.

Table 93. Number of structures installed annually in the Gulf of Mexico.

	Water Depth (m)					
	0-60	**60-200**	**200-800**	**800-1,600**	**1,600-2,400**	**> 2,400**
Number of Structures	30-43	3-4	1	< 1	< 1	< 1
Number of Well Conductors	Very numerous (unknown; data not required to be reported to BOEM)					

Construction may occur over both daylight and nighttime hours in offshore environments. BOEM could not provide any detailed information on the installation time for piles for different structure types. In general, larger structures will probably be required in the future to meet the demands of deepwater drilling and to increase structure resilience to wind and wave damage from hurricanes. For this analysis, we will assume pile driving occurs every day of the year for the 51 structures and well conductors to be installed annually (seven days of pile driving for 51 structures and associated well conductors).

To determine the effects of cumulative sound exposure on sea turtles and sperm whales, we reviewed the literature to determine how much pile driving is possible over a 24-hr period. For the analysis, we are considering daily exposures may be possible because adult sea turtles and sperm whales may remain in an area for a short period feeding or resting, but are unlikely to remain within the area around a platform construction site longer than 24 hours. Therefore, the exposure analysis "resets" every day and the number of days of pile driving expected is assumed to have the potential to expose new animals on a daily basis.

To determine how many piles may be installed per day, we reviewed information compiled on platform piles (Dos Santos 2008). A typical pile installation requires 30 strikes per foot to install a pile to a typical depth below the mudline of 164 ft (50 m). The reported pile driver blow rates for offshore structures averages 40 per minute. Therefore, a typical platform pile would require approximately 4,920 strikes (30 strikes x 164 feet depth below mudline) over a period of about two hours (4,920 total strikes/40 strikes per minute=123 min). Based on this information, we believe that up to five piles can be driven per day for typical offshore construction. About ten total hours (five piles taking about two hours each to drive) of actual pile driving will occur each day with the remaining time dedicated to pile placement, welding and pile attachments, and movement of personnel, vessels, and equipment.

For our analysis of effects to sea turtles and sperm whales, we calculated ZOIs for SEL and peak pressure to determine the dominant metric of the dual criteria for PTS and for TTS in sea turtles and sperm whales. We analyzed the potential cumulative SEL area as the area impacted over a 24-hr period by the installation of five piles. As animals are exposed to sound over greater periods of time (measured as 40 pile strikes per minute), the distance over which sound levels can cause hearing-related effects of PTS and TTS is also greater. As discussed above, each pile is estimated to require 4,920 strikes to install, which is considered a conservative number of strikes being that there are many factors (sediment type, water depth, pile type/diameter, drive depth below mud line, etc.) that play into how many strikes to drive each pile. Sea turtles and sperm whales could potentially be exposed to 24,600 pile strikes from the installation of five piles each day (Table 94).

Table 94. Additional distance over which the daily cumulative exposure to pile-driving sound can affect the hearing of sea turtles and sperm whales.

Number of Piles Installed/Day	Number of Strikes to Install Each Pile	Accumulated dB from Multiple Exposures 10 LOG (strikes)	Additional distance over which hearing injury can occur (m)
5	4,920	33.91	157

We compared the cumulative SEL ZOIs to the peak pressure ZOI to determine which metric of the dual criteria has the greater ZOI (Table 95). When we consider that animals could be exposed to sound from the installation of five piles per day, our comparison shows the cumulative SEL areas affected dominate for both the potential for hearing injury and hearing loss. The cumulative SEL metric has a larger zone of influence that could affect sea turtles and sperm whales. The SEL metric and associated zone of influence will be used for the remainder of this analysis to assess the potential for the occurrence of auditory injury in sea turtles, and for potential of both hearing injury and temporary hearing loss in sperm whales.

Table 95. A comparison of the dual criteria of cumulative sound exposure level and peak pressure criteria to assess the potential for auditory effects under the proposed action.

	PTS cumulative SEL radial distance to threshold (m)	PTS cumulative SEL zone of influence (km2)	PTS peak radial distance to threshold (m)	PTS peak zone of influence (km2)	TTS cumulative SEL radial distance to threshold (m)	TTS cumulative SEL zone of influence (km2)	TTS peak radial distance to threshold (m)	TTS peak zone of influence (km2)
Sperm Whale	--	--	--	--	2,873	25,927	6.3	0.125
Sea Turtles	5,568	97,398	2.5	0.0196	31,295	3,076,804	5	0.079

The following exposure analysis for sea turtles and sperm whales will assess how many animals will be exposed to pile driving sound in each exposure category. For each effect analyzed, we calculated the size of the zone of influence (ZOI) for each effect and calculated how many individuals of each species could be exposed. The following information was used to estimate the ZOI and the number of sea turtle and sperm whale exposures:

1. 20 LOGR spreading of the sound in offshore lease areas.
2. Distance of 20 LOGR radial distance was converted to an area (km^2), also known as the ZOI.
3. Sound levels are from CalTrans (2012); Genesis (2011).
4. Densities for sea turtles are provided in 8.1.2.2 and sperm whale density used is 0.0033 whales per km^2 (2,128/644,992[63] km^2).
5. Up to five piles per day can be driven.
6. The number of sea turtles exposed will be determined by:
   ZOI x density x 365 days.
7. The number of sperm whales exposed will be determined by:
   ZOI x density x 20 days of pile driving in deep water.

Exposure

We calculated the ZOIs for disturbance from temporary hearing impairment and behavioral disturbances to analyze the potential effects on sperm whales. As described above, disturbance of sperm whales is evaluated by both the Wood et al. (2012a) behavioral step function and TTS ZOIs. We evaluated the ZOIs and the number of animals responding in each exposure category to determine which set of criteria best represent the risk of sperm whales exposed to pile-driving sound. When we consider disturbance by TTS, the sound exposure level for whales exposed to five piles per day results in the largest ZOI (Table 95), and consequently more disturbed whales. The radial distance to onset of TTS is greater than the radial distance to behavioral onset,

[63] Total acreage shown in Figure 1 was converted to square kilometers for calculating density.

therefore the TTS sets the entirety or limit of extent for potential effects for the area. Because of high source level and long periods of pile driving, the daily ZOI for disturbance from TTS levels of exposure occur over the greatest area (Figure 80). Within this entire area spanning from outside the injury zone to the TTS isopleth, an animal could experience temporary hearing impairment, or exhibit behavioral responses.

As discussed above, we will conduct a conservative analysis for exposure of sound from pile driving, assuming greater than 71 in-diameter steel piles will be completed because we do not have information on the numbers and diameters of piles that will be used for future structure installations. Cumulative sound exposure estimates (SELcum) assume the highest source levels and resulted in 1,711 annual exposures to sound that could cause TTS or other behavioral responses and 85,559 exposures over the 50-year proposed action. Effects would be greater based on accumulated sound levels.

Our analysis finds that it is likely sperm whales will be exposed to sound levels that disturb them over fairly large distances from daily sound exposure from five piles installed per day, for 20 days per year. The results of this analysis show that the cumulative exposure of sperm whales to pile-driving sound will have the greatest potential to disturb the largest number of sperm whales.

Response

For sperm whales, we anticipate exposure to sound from pile driving would result in TTS or other behavioral responses, including some local displacement from the area for as long as the pile driving is occurring. The potential duration of exposure for an animal to accumulate levels in the area is less likely, because sperm whales are expected to be moving and less likely to remain stationary during pile driving events.

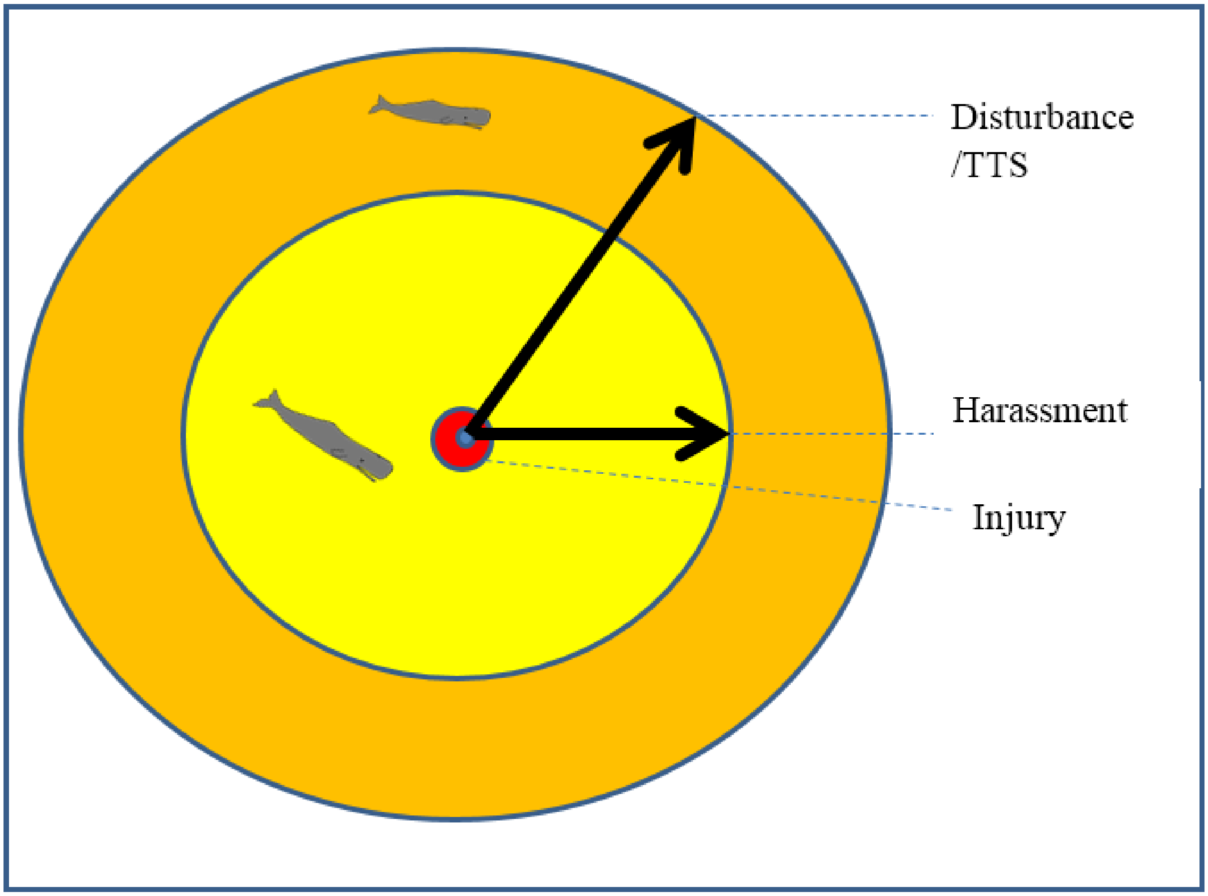


Figure 80. Diagram showing the relative distances of the response categories for sperm whales exposed to daily pile-driving sound.

Sea Turtles

Exposure

To calculate the number of animals that could be exposed in each of the two response categories of auditory injury or disturbance, we multiplied the area of each ZOI (km^2) times the density of each species (number/km^2 from Section 9.1.3.2 above) to determine a reasonable worst case estimate of the number of sea turtles that may be exposed annually (Table 96). The result of these calculations for each species and life stage are shown in Table 96.

Table 96. Annual take estimates for sea turtles exposed to pile-driving sound.

Species of Sea Turtle	Annual Takes of Sea Turtles from Pile Driving				
	PTS ZOI		Disturbance ZOI	Total	
	Adults	Oceanic Juveniles	Oceanic Juveniles	PTS	Disturbance
Kemp's ridley	116	86	28	202	28

Species of Sea Turtle	Annual Takes of Sea Turtles from Pile Driving				
	PTS ZOI		Disturbance ZOI	Total	
	Adults	Oceanic Juveniles	Oceanic Juveniles	PTS	Disturbance
Loggerhead	81	71	23	152	23
Green	1	101	32	102	32
Leatherback	1	0	0	1	0
Hawksbill	4	3	1	7	1

Response

High levels of sound exposure can adversely affect sea turtles by hearing injury, impairment, and disturbance responses of oceanic juvenile sea turtles. Pressure waves compress and decompress molecules of the surrounding medium as they pass which can injure ears and is detectable by other vibration-sensitive body parts such as the carapace of sea turtles. As in the analysis for sperm whales, we used the highest reported source levels for pile driving of 204 dB (SEL) and 232 dB (peak) to calculate cumulative exposure that could result in auditory injury in sea turtles.

At louder levels of greater than 200 dB (peak), behavioral responses to pile driving are expected to result in disturbance of sea turtles. We expect the consequences of exposure to pile driving sound to be different for adults and oceanic juveniles. Pile-driving could result in some temporary loss of available habitat for any adult sea turtles that use the area. The continuous "banging" of a pile should provide ample warning to an adult sea turtle to avoid the immediate pile-driving area. Adult sea turtles affected in this way would need to relocate to an adjacent area; however, adult sea turtles use large oceanic areas and the temporary displacement from the area during pile driving is not likely to result in changes to a turtle's ability to survive or reproduce. Therefore, the effects of displacement of adult sea turtles from pile-driving sound will be insignificant. However, adult sea turtles may still be within the cumulative sound exposure area which covers larger oceanic areas. Therefore, the risk of hearing injury to some turtles would still be present due to the large areas ensonified, and we calculated the number of turtles that may be found in the each ZOI.

Oceanic juvenile turtles may be motivated to remain in *Sargassum* habitat and may not leave the area which could cause hearing injury or impairment while others may leave at exposure levels of 200 dB (peak) or higher. Oceanic juveniles exposed to loud sound levels from pile driving that do leave the area would be adversely affected by being displaced from *Sargassum* habitat if it were in an area in which pile driving would occur. Although avoidance responses are advantageous at preventing direct injury, we must consider that the displacement from *Sargassum* on oceanic juveniles has a more severe consequence than deterred adults. Effects on oceanic juveniles may be important if they disrupt feeding and sheltering, or indirectly increase the risk to individuals (e.g., via predation). Some oceanic juveniles may be biologically motivated to remain in *Sargassum* habitat for protection, but as exposure levels increase beyond

200 dB (peak), they may abandon use of the habitat due to exposure to very loud sound levels. Abandonment of developmental habitat would decrease foraging success and may result in an increased risk of predation, particularly for younger oceanic juveniles which are more readily preyed upon by a number of predatory fish. The annual number of predicted disturbances of oceanic juveniles is relatively low (see Table 96). Because predation rates are naturally high and oceanic juveniles swim between patches in search of new food resources, the expected impact of the disturbance on predation risk will be insignificant. Although some predation risk is associated with increased movement between *Sargassum* patches, the risk would be undetectable from natural predation rates. The expected adverse effects on oceanic juvenile sea turtles of the disturbance is displacement from preferred sheltering and foraging areas, and the reduction in foraging resulting from that displacement. The duration of the disturbance will be widely variable (hours to days) and will depend on the time it would take a juvenile to locate a new *Sargassum* patch.

8.5.5 Effects of Sound from Vessels

Sounds caused by vessels (Table 97) in transit as part of the proposed action have the potential to disturb ESA-listed species. Acute effects of such exposure can range from none to minor depending on how close in proximity the sounds are to an individual animal. In addition, chronic exposure to vessel sound may result in stress and masking of biologically important sounds.

Table 97. Sources of vessel sound.

Source of Sound	Source Level (dB)	Frequency (Hz)
Service, crew, and support vessels	160-180 (rms) 187 (peak)	20-10,000
Tug (4 engine)	173-177 (rms) 188-191 (peak)	broadband
Seismic Survey Vessel	125-132 (rms) at 500 m (approx. 179-186 [rms] at source)	broadband
Semi-submersible Pipeline Barge	161 (rms) 171 (peak)	10,10,000
Pipe-laying Vessel	170-182 (rms) 179-191 (peak)	broadband
Drilling Ship (MODU) with positioning thrusters (Dynamic Positioning)	195 (rms) 195 (peak)	10-10,000

In addition to the risk of a vessel strike (addressed in Section 99.4 above), vessels associated with the proposed action may produce visual or acoustic diturbances that may affect sperm whales, Bryde's whales, sea turtles and Gulf sturgeon. Given the magnitude of vessel traffic associated with the proposed action (approximately 43 percent of all vessel traffic in the Gulf of Mexico; see SectionS 9.4.1) we anticipate that all individual sperm whales, Bryde's whales, sea turtles and Gulf sturgeon within the action area will be exposed to vessel sound, at least at some level. The operation of vessels may result in acute visual or auditory disturbances caused by a vessel passing by a sperm whale, Bryde's whale, sea turtle, or Gulf sturgeon, which may disrupt thier behavior (Parsons 2012). Sound from vessels also has the potential to accumulate from multiple vessels and increase the ambient sound level (Hildebrand 2009). Longterm, chronic exposure to such sound may result in stress and masking of important biological sounds (Clark et al. 2009b; Hatch et al. 2012; Rolland et al. 2012).

Whales

Vessels associated with the proposed action may cause visual or auditory disturbances to ESA-listed species that spend time near the surface, such as sea turtles and cetaceans, and more generally disrupt their behavior. Studies have shown that vessel operation can result in changes in the behavior of cetaceans and sea turtles (Arcangeli and Crosti 2009; Hazel et al. 2007; Holt et al. 2009; Luksenburg and Parsons 2009; Noren et al. 2009; Patenaude et al. 2002; Richter et al. 2003; Richter et al. 2006; Smultea et al. 2008). In many cases, particularly when responses are observed at great distances, it is thought that animals are likely responding to sound more than the visual presence of vessels (Blane and Jaakson 1994; Evans et al. 1992; Evans et al. 1994). Nonetheless, it is generally not possible to distinguish responses to the visual presence of vessels from those to the noise associated with vessels, which is further considered below. Moreover, at close distances, animals may not even differentiate between visual and acoustic disturbances created by vessels and simply respond to the combined disturbance.

Cetacean's behavioral responses to vessel disturbance range from little to no observable change in behavior to momentary changes in swimming speed and orientation, diving, surface and foraging behavior, and respiratory patterns, as well as changes in vocalizations (Au and Green. 2000; Baker et al. 1983; Baumgartner and Mate 2003; Hall 1982; Isojunno and Miller 2015; Jahoda et al. 2003; Koehler 2006; Lesage et al. 1999; Malme et al. 1983; Richardson et al. 1985a; Scheidat et al. 2006; Watkins et al. 1981). Watkins et al. (Watkins et al. 1981) found that both fin whales and humpback whales appeared to react when approached by small vessels by increasing swim speed, exhibiting a startle reaction and moving away from the vessel with strong fluke motions. In a study on North Atlantic right whales, 71 percent of 42 whales that were closely approached by a research vessel (within 10 m) showed no observable reaction; when reactions occurred, they included lifting of the head or flukes, arching the back, rolling to one side, rolling to one side and beating the flukes, or performing a head lunge (Baumgartner and Mate 2003). In another study on North Atlantic right whales, Nowacek et al. (2004) observed no noticeable behavioral responses to passing vessels nor to simulated vessel sounds. Studies of other baleen whales, specifically bowhead and gray whales, have documented short-term behavioral responses to a variety of actual and simulated vessel activity and sounds (Malme et al. 1983; Richardson et al. 1985b). Close approaches by small research vessels caused fin whales (n = 25) in the Ligurian Sea to stop feeding and swim away from the approaching vessel (Jahoda et al. 2003). A study on the effects of research vessel presence on sperm whale behavior found that sperm whales (n = 12) off the coast of Norway spent 34 percent less time at the surface and 60 percent more time in a non-foraging silent active state when in the presence of the vessel than in the post-vessel baseline period, indicating costs in terms of lost feeding opportunities and recovery time at the surface (Isojunno and Miller 2015). Regardless of the response, cetaceans appear to resume species' typical behavior within minutes of vessels leaving the area (Au and Green. 2000; Baker et al. 1983; Baumgartner and Mate 2003; Hall 1982; Isojunno and Miller 2015; Jahoda et al. 2003; Koehler 2006; Malme et al. 1983; Richardson et al. 1985a; Scheidat et al. 2006; Watkins et al. 1981).

The nature of the behavioral response cetaceans exhibit to vessels may depend on vessel speed, size, and distance from the animal, as well as the number and frequency of vessel encounters (Baker et al. 1988; Beale and Monaghan 2004). In addition, characteristics of the individual animal and/or the context of the vessel encounter, including the animal’s age and sex, the presence of offspring, whether or not habituation to vessels has occurred, individual differences in reactions to vessels, and the behavioral state of the whales (Baker et al. 1988; Gauthier and Sears 1999; Hooker et al. 2001; Koehler 2006; Lusseau 2004; Richter et al. 2006; Weilgart 2007b; Wursig et al. 1998). Observations of large whales indicate that cow-calf pairs, smaller groups, and groups with calves appear to be more responsive to vessels (Bauer 1986; Bauer and Herman 1986; Clapham and Mattila 1993; Hall 1982; Williamson et al. 2016). Reactions to vessel sound by bowhead and gray whales were observed when engines were started at distances of approximately 914 m (Malme et al. 1983; Richardson et al. 1985a), suggesting that some level of disturbance may result even if vessels do not come near the animals. It should be noted that human observations of a cetacean’s behavioral response may not reflect a whale’s actual experience; thus our use of behavioral observations as indicators of a whale’s response to vessels may not be correct (Clapham and Mattila 1993).

Much less is known about the physiological responses cetaceans exhibit to vessel disturbance, but based on their behavioral responses and studies of terrestrial species, it is often assumed that they may exhibit a stress related response (Parsons 2012; Wright et al. 2007). We are aware of only one study specifically aimed at examining the physiological responses of cetaceans to vessel disturbance (but see Ayres et al. 2012). Following a decrease in shipping traffic in the Bay of Fundy, Rolland et al. (2012) found that North Atlantic right whales had reduced fecal stress-related hormone metabolites (glucocorticoids), suggesting that despite no overt behavioral response to passing vessels (Nowacek et al. 2004), at least some North Atlantic right whales may exhibit a physiological hormonal response when exposed to chronic vessel disturbance. Based on these data, we assume that some individual sperm and Bryde’s whales may exhibit a short-term stress response to a passing vessel that may be associated with the previously discussed behavioral responses.

In addition to having acute effects such as a short-term behavioral and stress response, regular, ongoing vessel traffic has the potential to significantly add to ambient ocean sound levels (Hildebrand 2009). The dominant source of vessel sound from the proposed action is propeller cavitation, although other ancillary sounds may be produced. The intensity of sound from service vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more sound than unladen vessels.

Unlike sperm whales, Bryde's whales are expected to hear best and communicate at the same low frequencies that many large vessels produce the most sound. As such, the effects of chronic vessel sound are more likely to have adverse effects on Bryde's whales when compared to sperm whales. In fact, some low frequency sounds, such as those produced by large commercial vessels, are estimated to have reduced the communication space for North Atlantic right whales in the Northeastern United States by up to 67 percent compared to historically lower sound conditions (Hatch et al. 2012). While masking due to vessel sound may be more severe for North Atlantic right whales compared to fin whales (Clark et al. 2009a), masking of other baleen whale sounds still likely occurs. Furthermore, chronic exposure to vessel sound has been correlated with changes in stress hormones (Rolland et al. 2012) and long and short term changes in vocalizations (Parks et al. 2007; Parks et al. 2011; Parks et al. 2012).

Given that there is substantial frequency overlap between vessel sounds and the vocalizations of baleen whales such as Bryde's whales, vessels associated with the proposed action could mask these calls at some of the lower frequencies for this species. While the range of Bryde's whales is not within the bussiest vessel traffic regions of the action area, a variety of vessels are expected to transit through and around Bryde's whale habitat. The sound of these vessels, in combination with all other vessels elsewhere in the action area, is likely to lead to an increase in ambient low-frequency sound, to which all Bryde's whales are expected to be exposed. Such exposure is expected to result in chronic stress in some individuals (Rolland et al. 2012), which may lead to an overall reduction in health and could have negative effects on reproduction (Rolland et al. 2017; Rolland et al. 2012; Rolland et al. 2016). Chronic exposure to vessel sound is also expected to interfere with Bryde's whale communication and mask important biological cues (Clark et al. 2009c; Hatch et al. 2012; Richardson 1995), which is expected to negatively affect the fitness of individual Bryde's whales by interfering individuals abilities to find mates and disrupting mother-calf communication. While it is possible that Bryde's whales may adjust their communication to cope with changes in ambient sound, as has been suggested in North Atlantic right whales (Parks et al. 2007; Parks et al. 2011; Tennessen and Parks 2016), if such changes occur, we expect them to occur over many years and not without negative effects to individauls along the way.

In summary, sound sources associated with vessel movement as part of the proposed action are likely to adversely affect Gulf of Mexico Bryde's whales. Sperm whales are not likely to be adversely affected by vessel sound due to the low frequencies that many large vessels produce in comparison to the hearing range sperm whales primarily hear and vocalize within.

Sea Turtles

Potential responses of sea turtles to vessel disturbance, both behavioral and physiological, are likely similar to those of cetaceans and may include startle responses, avoidance, other behavioral reaction, and/or a physiological stress response. However, very little research exists on sea turtles responses to vessel disturbance. In fact, in our literature searches we could find no study specifically aimed at quantifying sea turtle response to vessel disturbance. However, a study examining vessel strike risk to green sea turtles suggested that sea turtles may habituate to vessel sound and may be more likely to respond to the sight of a vessel rather than the sound of a vessel, although both may play a role in prompting reactions (Hazel et al. 2007a). Regardless of what specific stressor associated with vessels turtles are responding, they only appear to show responses (avoidance behavior) at approximately 10 m or closer (Hazel et al. 2007a). Based on this study, and our a recent programmatic evaluation of NMFS' scientific research permitting program for ESA-listed turtles, vessels are expect to cause very minimal disturbance to sea turtles (NMFS 2017d). As a result, sound sources associated with vessel movement as part of the proposed action are insignificant and therefore are not likely to adversely affect sea turtles.

Gulf Sturgeon

Gulf sturgeon are not found in the areas of oil and gas development, but may be exposed to vessel sound from transiting work and crew boats. It is not likely that lease sales in the WPA will result in any trips east of the Mississippi River that would affect the habitat of the Gulf sturgeon. Some ports in the CPA and EPA may service oil and gas lease areas that involve transit across Gulf sturgeon habitat. Gulf sturgeon may be able to detect the sounds of passing vessels, but they are not expected to be affected by the sound, therefore effects are insignificant.

8.5.6 Summary of the Effects of Sound

The summary of estimated numbers of exposures related to sound associated with the Oil and Gas Program over the 50 years of the proposed action are presented in Table 98.

Our quantitative analysis of the effects of G&G sound on adult sea turtles predicted the number of exposures resulting in TTS and harassment for each of the five ESA-listed species. In addition to species specific exposures, our analysis also estimated exposures for the "hardshell turtle" group since data use for this analysis was not always at the species level (e.g. unidentified hardshell turtle). For purposes of evaluating the overall effects of the proposed action on each ESA-listed species (or DPS), we divided the "hardshell turtle" exposures among the four hardshell turtle species: Kemp's ridley, loggerhead, green, and hawksbill. Hardshell exposures were divided based on the relative proportion each species made up of the total exposures to G&G sound for the four species combined. These proportions were as follows: Kemp's ridley 43.6 percent, loggerhead 32.6 percent, green 8.9 percent, and hawksbill 15.0 percent. The additional hardshell exposures were added to the original (species specific) exposures to arrive at the annual total estimated exposures for each species.

Our exposure analysis for the effects of oil spills (Section 8.8, below) also estimated some exposures for the “hardshell turtle” group. We used the same approach as described above for dividing G&G exposures attributed to the “hardshell” category among the four species. The proportions used to divide the “hardshell” oil spill exposures were as follows: Kemp’s ridley 45.7 percent, loggerhead 31.6 percent, green 8.5 percent, and hawksbill 14.2 percent.

Table 98. Estimated exposures from sound related to the Oil and Gas Program expected over the 50 years of the proposed action. In this summary exposure table, the hardshell category was partitioned among the other species according to their relative percentages as described above. The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

	Sperm whale	Bryde's whale	Kemp's ridley turtle	Loggerhead turtle	Green turtle	Leatherback turtle	Hawksbill turtle
G&G PTS	-	600	-	-	-	-	-
G&G TTS	-	-	10,924,459	8,884,870	10,671,175	67,850	1,069,797
G&G harass (no restrictions)	1,610,105	22,550	78,648,277	63,964,817	76,824,780	488,350	7,701,625
Explosive structure removal injury and mortality	-	-	454	846	201	46	51
Explosive structure removal impairment	-	-	544	1,112	253	46	6
Explosive structure removal Disturbance (harass)	-	-	352	292	413	-	12
Pile driving PTS	-	-	10,100	7,600	5,100	50	350
Pile driving TTS/harass	85,559	-	1,400	1,150	1,600	-	50

Note: A dash indicates a source that did was considered to have no effect on this species in the specific category.

We conclude that G&G survey activity is likely to adversely affect sperm whales, Bryde's whales and sea turtles (Green [North and South Atlantic DPSs], Kemp's ridley, hawksbill, leatherback, and loggerhead [Northwest Atlantic Ocean DPS] sea turtles. Conservation measures implemented under the final MMPA rule are expected to minimize duration of exposure to sounds above threshold. The use of a ramp-up procedure should alert whales to the nearby acoustic source before the airgun array is at full power, giving them an opportunity to leave the area prior to receiving sound levels that would cause PTS (Stone et al. 2017, although see Dunlop et al. 2016). It is reasonable to assume that the same ramp-up and shutdown measures will also provide some benefit to sea turtles.

Sea turtles are not likely to be adversely affected by pre-severance activities, non-explosive severance techniques, or the removal and transport of the offshore structure to shore. Sea turtles will be adversely affected by the use of underwater explosions (Section 8.5.3) associated with decommissioning activities. The effects of exposure to detonation can range from injury and death, temporary impairment, or disturbance of oceanic juvenile sea turtles. In addition to injurious impacts associated with exposure to high pressure levels, oceanic juvenile sea turtles may be displaced from developmental habitat after exposure to very loud sound. The disturbance is expected to be insignificant for adults, but is likely to adversely affect oceanic juveniles due to their dependence on *Sargassum* for food, shelter, and protection from predators. Therefore, when quantities of *Sargassum* are present in a ZOI that could provide oceanic juvenile habitat, the *Sargassum* can serve as an indicator of the presence of oceanic juveniles.

Pile driving is the main sound source of concern from offshore construction and operational activities. Pile driving produces very loud levels of underwater sound that can affect large areas of ocean surrounding the activity and result in the taking of sea turtles and sperm whales. We have concluded that the other non-pile driving sources of construction and operational sound discussed in this section are extremely unlikely to cause hearing injury or disturbance. The effect of some of these sounds in the marine environment are ephemeral, while others ensonify too small of an area to have any potential for adverse effects to occur. Any responses that might occur are expected to be short term and minor responses that fall within the normal range of behaviors of these animals. We conclude that the potential effects of these non-pile driving sources of construction and operational sound on sea turtles and sperm whales will be insignificant.

Adult sea turtles will be adversely affected by PTS and oceanic juveniles in offshore developmental habitat will be adversely affected by PTS and through disturbance by pile-driving activities. Based on our analysis, an estimated 23,200 sea turtles (all species, adults and juveniles combined) could be adversely affected by PTS from pile-driving sound over the 50 years of the proposed action (Table 98).

Oceanic juveniles which are exposed to pile driving sound will be adversely affected by being displaced from *Sargassum* habitat or other surface-pelagic habitats occurring near pile activities.

Displacement from *Saragssum* could have an energetic cost associated with decreased foraging rate and increased swimming associated with finding a new patch of *Sargassum*.

We expect that the vessels associated with the proposed seismic surveys would actively avoid ESA-listed cetaceans and sea turtles due to the proposed vessel strike avoidance measures and the use of PSOs. In fact, an encounter with an ESA-listed cetacean or sea turtle during seismic surveys may necessitate a shutdown, pause, or delay airgun activation, which would ultimately impede the seismic survey operator from obtaining the desired data. As such, any encounters of ESA-listed cetaceans or sea turtle are expected to be brief, as the vessel transits pass the animal.

Considering the proposed conservation measures to minimize and avoid disturbance from vessels, and the level of disturbance that may result from the vessel activity associated with the proposed action, we find that the effects of vessel sound disturbance on sperm whales and sea turtles are insignificant or discountable. This is especially true during active seismic survey operations, since relative to the sound produced by the airgun array, vessel disturbance is expected to be inconsequential. Thus, any disturbance that may result from vessels associated with the proposed action is not likely to adversely affect these species.

Conversely, we find that exposure to chronic vessel sound produced by the proposed action is likely to adversely affect Bryde's whales due to it causing chronic stress and significant masking. These more severe responses are only expected for Bryde's whales since Bryde's whale hearing and communication has greater overlap with the low frequency sounds produced by vessels. The chronic stress and masking caused by the increase in vessel sound due to the proposed action is expected to reduce the fitness of at least some individual Bryde's whales. Being that the GOMESA area was removed from the proposed action, these effects should be minimized but not removed. We are unable to quantify the reduction without having the exposure scenarios remodeled.

The sound produced by passing vessels would be brief, and the sound levels received by sturgeon would not cause any harmful behavioral responses. Vessel sound will have insignificant effects on sturgeon. Because no other sound sources are expected in Gulf sturgeon habitat, they are excluded from any further analysis of sound effects.

8.6 Effects of Entanglement and Entrapment

Entanglement and entrapment can result in death or injury of marine mammals and sea turtles (Moore et al. 2009; Van Der Hoop et al. 2012). Entangled marine mammals may drown or starve due to being retricted by gear, suffer physical trauma and systemic infections, and/ or be hit by vessels due to an inability to avoid them. Entanglement can also cause injury that can lead to secondary infection, or cause death (Moore 2014). During consultation we identified entanglement as a stressor created by seismic survey equipment such as ocean bottom nodes, hydrophones, geophones and other cables; and other survey activities including sediment sampling and installation of mooring buoys; and marine debris generated from these activities.

We identified entrapment as a stressor created by moon pools, seismic survey gear, and trawl gear used for site clearance associated with decommissioning activities.

BOEM has implemented mitigation measures through their permits to reduce the possibility of entanglement in seismic survey equipment. The measures include the use of stiff non-buoyant lines, acoustic pingers to alert marine mammals of the presence of the line in the water co`lumn, and having protected species observers on node retrieval vessels to watch for signs of entanglement. Despite these measures, we determined that entanglement and entrapment may affect marine mammals and sea turtles. Our analysis of the effects to these species is summarized below.

8.6.1 Whales

Sperm whales could be exposed to hydrophone streamers, bottom cables, geophones, and ship-based receivers, buoy mooring lines, and other lines or cables. The hydrophones or geophones are encased in plastic tubing and either towed behind the survey vessel, laid on the sea floor, or in rare instances spaced at various depths in vertically positioned cables suspended from a vessel. Equipment locations are determined by GPS and acoustic pingers, and do not contain any buoy lines to mark the recovery location.

While it is possible that towed seismic equipment will come into contact with sperm whales, we are not aware of any reports of such interactions. If such interactions were to occur, we do not anticipate they would result in entanglement for several reasons. The towed equipment is rigid and as such would not encircle, wrap around, or in any other way entangle any a sperm whale. Furthermore, baleen whales, and possibly sperm whales, are expected to avoid areas where airguns are actively being used (see Section 8.5.2), meaning they would also inadvertently avoid towed seismic equipment.

With the implementation of BOEM NTL 2016-G02, BSEE NTL 2012-G01 (Section 3.1.6), permit conditions of approval, and other mitigation measures such as the protected species stipulation, sperm whale entanglement in hydrophone cables and streamers, geophones, bottom cables and other associated gear is extremely unlikely to occur. We find the risk of entanglement in Oil and Gas Program equipment so low as to be discountable. Moon pools are too small to allow a sperm whale to enter such that they will not be affected by moon pools. Therefore, sperm whales are not likely to be adversely affected by entanglement and entrapment.

Similar to the effects to sperm whales discussed above, Gulf of Mexico Bryde’s whale could be exposed to hydrophone streamers, bottom cables, geophones, and ship-based receivers, buoy mooring lines, and other lines or cables. For the same reasons as provided above, we find the likelihood of Gulf of Mexico Bryde’s whale entanglement to be extremely low. We find the likelihood of Gulf of Mexico Bryde’s whale to become entangled in Oil and Gas Program equipment to be discountable. No cases of marine mammals entering moon pools have ever been documented. Moon pools are too small to allow a Bryde’s whale to enter such that Bryde’s whales will not be affected by moon pools. Therefore, Gulf of Mexico Bryde's whale is not likely to be adversely affected by entanglement or entrapment.

8.6.2 Sea Turtles

Sea turtles could come into contact with any part of the towed seismic equipment, moored buoy lines, bottom cables or other lines and cables associated with the Oil and Gas Program. Below we summarize the exposure and response of sea turtles, which may come into contact with these items. Sea turtles have become entrapped in power plant intake structures and dredge equipment (NRC 1990a) and have the potential to become entrapped in any submerged structure that an individual is able to enter. Sea turtles appear to find their way into submerged structures, but some individuals cannot find their way out and the subsequent entrapment can lead to drowning. Since 2004, sea turtles have been reported to become entrapped in moon pools associated with oil and gas activities. A moon pool is a large wall-sided hole in the bottom of a ship or other offshore structure such as drilling platforms. Moon pools are used on many types of vessels: cable-laying vessels, exploration and drilling vessels, production barges, research and offshore support vessels. They are used to launch and retrieve equipment, divers, or diving bells, or lay cables or risers, in an environment protected from the waves. Fish and other animals can enter moon pools, and in the case of sea turtles, surface within moon pools. Prolonged entrapment within moon pools may have adverse consequences on animals.

8.6.2.1 Exposure

Entrapment or Entanglement from Site Clearance Post-Removal Trawling

Following severance, a structure is typically transported to a service base for salvage. Some "jacket-hopping," or reuse of a removed structure for another structure may occur but is rarely used. After all decommissioning work is completed, operators are required to perform site-clearance work on leases in depths less than or equal to 200 meters to ensure that the sea floor of their lease(s) have been restored to pre-lease conditions. Based upon requirements found in Subpart Q of the OCSLA implementing regulations (30 CFR §250.1740 to 250.1743), operators have the option of either trawling with commercial nets or conducting diver or high-resolution sonar surveys over the area. The high-resolution sonars are of high frequencies and are not able to be heard by sea turtles. The diver surveys would have no detectable impact on sea turtles. Site clearance activities using trawl nets may affect sea turtles, as demonstrated in fisheries that use trawl nets. The effects of site clearance using trawl nets are discussed below.

After OCS structures are removed, contractors are employed to trawl the salvage area with commercial nets (i.e., otter/shrimp trawls) to retrieve any objects or obstructions (e.g., tools, containers, batteries) that may have been lost or discarded during the operational life of the structure. Current guidelines in MMS's Notice to Lessees and Operators (NTL) No. 98-26, Minimum Interim Requirements for Site Clearance (and Verification) of Abandoned Oil and Gas Structures in the Gulf of Mexico, instruct trawling contractors to remove turtle-excluder devices (TED's) from their nets to allow for debris collection. However, without TED's, sea turtles near the sea floor in a trawl path could be captured and drawn into the nets with the salvaged debris. In addition to discomfort and/or possible injuries from contact with the netted debris, captured sea turtles could become exhausted as struggling from forced submergence leads to energy consumption, oxygen depletion, and other stress-related impacts (NRC 1990a).

Site clearance with trawls typically occurs over two to six days, depending on the clearance area required for the particular structure type (Table 99) and distance from shore. Trawling may occur with multiple nets and must be conducted in two directions (North-South and East-West) over a grid of the entire area. Trawlers drag the net along the bottom such that we would not expect oceanic juvenile sea turtles that use surface waters of the OCS to be affected by site clearance trawling.

Table 99. Site clearance distance requirements for different structure types.

Structure Type	Radius (ft)
Dry Hole Wells	300 ft
Single Wells/Platform (No Significant Facilities)	400 ft
Single Well Caissons and Protectors	600 ft
Platforms (Significant Facilities)	1,320 ft

We estimated the annual number of adult sea turtle interactions based on the nearshore and offshore shrimp fishery catches per unit effort (CPUE) rates for each species of sea turtle in the western Gulf of Mexico (Epperly et al. 2002) between March and November, the months in which most removals occur. CPUEs were calculated for nearshore waters (zero to 60 feet) and offshore waters (greater than 60 feet). From the total numbers of structures expected to be removed in each depth strata (see Table 2), approximately one-half will be removed in nearshore waters and one-half in offshore waters. Site-clearance trawlers work during daylight hours. Time is spent transiting back and forth from the site, checking nets every 30 minutes, and removing debris. We estimate net effort in the water is approximately four hours per day based on travel out to location, trawl time and travel back time before dark. Since site clearance occurs over two to six days, we estimate the following annual site clearance effort:

Annual Site Clearance Effort (Net Hours) = 275 removals per year x four days of work each removal x four net hours per day = 4,400 hours

Therefore, 2,200 hours of site clearance effort are expected in zero to 60 feet depths, and 2,200 hours of effort in greater than 60 feet depths each year.

Using the site clearance effort estimated to occur annually, we can calculate expected captures for each species of sea turtle (Table 100).

Table 100. Number of annual sea turtle captures (harassment) from site clearance activities with trawl nets.

Species	CPUE Nearshore	Captures	CPUE Offshore	Captures	Annual Total Captures
Kemp's ridley	0.0371	82	0.0003	1	83
Loggerhead	0.0124	27	0.0006	1	28
Green	0.0026	6	0.0023	5	11
Leatherback	0.00012	1	0.00019	1	2
Hawksbill	0.0	0	0.0	0	0

Note: Captures = CPUE $_{species,\ area,\ time}$ x Effort $_{area,\ time}$

Depending upon conditions at the time of capture, the turtle could drown if kept submerged, especially if tow times exceed 60 minutes (Henwood and Stuntz 1987). To minimize harm of sea turtles if they are caught in the trawl net, BOEM limits site clearance trawling to 30 minutes to avoid the likelihood of turtles drowning in the nets. Net tow times are often shorter if significant debris is gathered in the net. Thirty minute tow times would be effective in minimizing the stress of sea turtles caught in the net and prevent drowning. Therefore, we predict the captures in Table 100 will be non-lethal.

- 83 nonlethal captures of Kemp's ridley sea turtles annually (or 4,150 over 50 years of the proposed action)
- 28 nonlethal captures of loggerhead sea turtles annually (or 1,400 over 50 years of the proposed action)
- 11 nonlethal captures of a green sea turtle annually(or 550 over 50 years of the proposed action)
- Two nonlethal captures of leatherback sea turtles (or 100 over 50 years of the proposed action)

Site clearance activities can result in captures of sea turtles. Thirty minute limits on tow times and proper handling and release of sea turtles caught in trawl nets will minimize the likelihood of injury to any individuals. Based on our analysis above, we conclude that the numbers of sea turtles in Table 101 will be nonlethally taken over 50 years by site clearance trawling, as a result of the proposed action.

Table 101. Estimated number of takes by capture (harassment) in site-clearance trawls over 50 years.

SPECIES	SITE CLEARANCE TRAWLING TAKE BY LIFE STAGE OVER 50 YEARS						TOTAL
	LETHAL			SUBLETHAL			
	Oceanic Juvenile	Adult/Neritic Juvenile	Total	Oceanic Juvenile	Adult/neritic Juvenile	Total	
Kemp's Ridley	0	0	0	0	4,150	4,150	4,150
Loggerhead	0	0	0	0	1,400	1,400	1,400

SPECIES	SITE CLEARANCE TRAWLING TAKE BY LIFE STAGE OVER 50 YEARS						TOTAL
	LETHAL			SUBLETHAL			
	Oceanic Juvenile	Adult/Neritic Juvenile	Total	Oceanic Juvenile	Adult/neritic Juvenile	Total	
Green	0	0	0	0	550	550	550
Leatherback	0	0	0	0	100	100	100
Hawksbill	0	0	0	0	0	0	0
Sperm whale			0			0	0

Rigs to Reefs

BSEE's "Rigs-to-Reefs" policy allows some obsolete, nonproductive offshore oil and gas platforms to be converted to artificial reefs to support marine habitat instead of being transported to shore for salvage and disposal (see Section 3.1.4 for details). BSEE cooperates with stakeholders, coastal states, and the offshore industry to benefit marine life on and around oil and natural gas platforms. When approved by the appropriate states and the USACE, BSEE may approve a variance to the operator's contractual obligations for the decommissioning of some offshore platforms.

BSEE is responsible for insuring that when an operator is no longer producing oil or gas from a well, the well is correctly decommissioned, which entails permanently sealing the well to protect the environment and removing all structures which could affect the environment and impede navigation or other uses of the area. These obligations are part of the original lease term, but BSEE is not involved in any programs to create artificial reefs. Consultation under the ESA for such artificial reef creation is the responsibility of the USACE. Therefore, any variance granted by BSEE for alternative decommissioning requirements of a structure to be used as a reef does not have additional effects on listed species than those described above. Any effects from artificial reef creation from obsolete oil and gas platforms would be evaluated in consultations with the USACE and the applicant-proponent of the reef creation.

Entanglement in Ocean Bottom Node (OBN) Survey Lines

Ocean bottom nodes (OBN) are a method of receiving and recording seismic survey data. An airgun is towed over the survey area as in typical seismic surveys. However, instead of towing hydrophone streamers to receive the seismic signals, ocean bottom nodes are deployed on the sea floor that receive and record the data. The nodes are deployed along miles of line laid directly on the sea floor (Figure 81). Vertical lines are used to locate and recover the survey lines once a survey is complete.

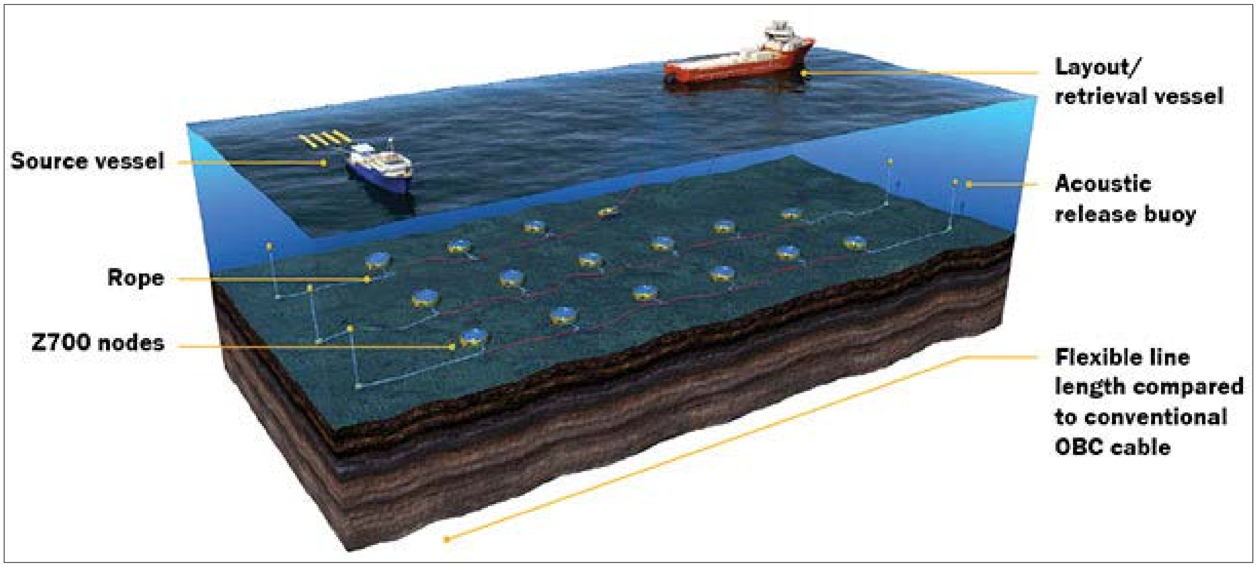


Figure 81. Diagram showing OBNs deployed on the sea floor.

Previous OBN surveys resulted in entanglement of several animals including a loggerhead sea turtle, manta ray, and Atlantic spotted dolphin. Line entanglements were associated with acoustic buoy release lines, acoustic pinger lanyards, nodal tether cables, and nodal lanyards. In 2013, a manta ray was documented to be entangled in a vertical buoy line. On February 13, 2014, a sea turtle became entangled in a pinger line associated with OBN seismic survey receiver equipment. The pinger line was attached near a node on the sea floor in depth of about 40 meters. The turtle was brought onboard, disentangled, and released by the crew. Photographs suggest the turtle was injured, near death, and should not have been released without further coordination with the stranding network or NMFS veterinarian. Other entanglements also included the drowning death of an Atlantic spotted dolphin in the bottom line connecting many miles of deployed nodes connected by bottom line.

As a result of past entanglements, a number of consultation and coordination calls between NMFS, BOEM, BSEE, and the operator occurred to understand the entanglement risks and recommend solutions to reduce those risks. Some updates to lines and equipment have occurred to reduce risk. However, some entanglement risk will continue in the future, therefore these effects are considered further in this opinion.

Recently, additional companies have requested seismic survey permits from BOEM to use the OBN seismic survey method of collecting data. We believe OBN surveys will continue to pose an entanglement risk to sea turtles. PSOs have not been previously required on OBN vessels and data is limited to a single report where a PSO on a nearby airgun vessel observed the entanglement. Entanglement of sea turtles in OBN lines has likely been under-reported. The surveys may occur over periods of several months or may be continually occurring with lines repeatedly deployed, data collected, the lines retrieved, and then deployed again in an adjacent area. Based on an estimated two to three OBN surveys occurring each year, we believe that three turtles (one per survey) may be entangled and succumb to injury or die in the lines associated with ocean-bottom-node surveys annually. We used densities in the seven zones presented in section 8.1.2.2 and applied them to zonal areas (square kilometers) for each of the species, to get totals for abundance. Based on the relative abundance of each species in the Gulf of Mexico, up to 20 Kemp's ridley, 19 loggerhead, five green, and seven hawksbill sea turtles may be lethally taken by entanglement over the 50 years of the proposed action.

Tail bouys

The most likely equipment to entangle sea turtles is the streamer tail buoy (Keatos Ecology 2009). Nelms et al. (2016) notes that while they could not find any peer-reviewed literature documenting sea turtle entanglement in seismic equipment, they did receive anecdotal reports of entanglement in tail buoys and airgun strings during seismic surveys off the west coast of Africa, which Weir (2007) also reports on and notes that these incidents were fatal. Keatos Ecology (2009) also notes that turtles have been entangled in seismic equipment off the coasts of India and Australia and in the Gulf of Mexico, with at least some of these resulting in mortality. For these incidents they did not specify what equipment caused the entanglements (tail buoys or other towed equipment), so it is unclear how they relate to the proposed seismic surveys. A 2011 seismic survey off the coast of Costa Rica recovered a dead olive ridley turtle (*Lepidochelys olivacea*) in the foil of towed seismic equipment, but it was unclear whether the sea turtle became entangled pre- or post mortem (Spring 2011).

There have been reports of sea turtles being entrapped by seismic tail buoys, however design improvements prevent this entrapment (Ecology 2009; Ketos Ecology 2007) and BOEM has indicated that the majority of industry in the Gulf of Mexico uses tail buoys with turtle guards.

In contrast to these accounts, there are several observations of sea turtles investigating streamers and not becoming entangled, along with seismic operations occurring in regions of high sea turtle density elsewhere in the world with no entanglements occurring (Hauser and Holst 2008; Holst et al. 2005a; Holst et al. 2005b; Holst and Smultea 2008). The likelihood of entanglement may in large part depend on the design of the equipment (e.g., the tail buoy, Keatos Ecology 2009), so it is possible that the contradictory cases mentioned above are the result of differences in equipment used. In particular, the use of properly designed 'turtle guards' that have both a deflector and an exclusion element likely reduce or may even eliminate entanglements in tail buoys (Keatos Ecology 2009).

Other Receiving Devices and Equipment, Including Moon Pools

Hydrophone streamers, bottom cables, geophones, and ship-based receivers act as receiving devices for acoustic sources. The hydrophones or geophones are encased in plastic tubing and either towed behind the survey vessel, laid on the sea floor, or in rare instances spaced at various depths in vertically positioned cables suspended from a vessel. Equipment locations are determined by GPS and acoustic pingers, and do not contain any buoy lines to mark the recovery location. ESA-listed species have been documented to interact directly with the towed hydrophone streamers. For example, during a 2011 survey in the eastern tropical Pacific, a dead olive ridley sea turtle was recovered from within the towed seismic gear. It could not be determined if the sea turtle became lodged in the gear pre- or post-mortem (Spring 2011). However, hydrophone cables and ocean bottom cables are rigid and generally pose no entanglement risk to ESA-listed species. Observations of sea turtles investigating streamers and not becoming entangled are also available (Hauser et al. 2008; Holst and Smultea 2008); (Holst et al. 2005c; Holst et al. 2005d). Although the towed hydrophone streamers could come in direct contact with an ESA-listed species, entanglements are highly unlikely.

Since 2004, sea turtles have been reported to become entrapped in moon pools associated with oil and gas activities. Prolonged entrapment within moon pools may have adverse consequences on animals.

On four occasions, sea turtles have been reported to have surfaced in moon pools and become trapped (Table 102). Three of the turtles required rescue and release after remaining in the moon pool for more than a day, while a single animal eventually swam out of the pool under its own volition. Although the bottom remained open, three sea turtles remained in the moon pool. We surmise the tall, narrow nature of the moon pools may confuse the turtles and they become entrapped in the vertical column of moon pools.

Table 102. Reported occurrences of sea turtles trapped in moon pools.

Date	Species	Lease Area, Block	Structure Type	Water Depth (ft)	Moon Pool Depth (ft)
December 4, 2004	loggerhead	Mississippi Canyon, Block 243	Matterhorn Fixed Spar (Platform A)	2,816	120
December 20, 2004	loggerhead	Mississippi Canyon, Block 243	Matterhorn Fixed Spar (Platform A)	2,816	120
October 24, 2011	leatherback	Ship Shoal, South Addition	Drill Ship ENSCO DS-3	184	100
September 25, 2014	leatherback	Grand Isle, Block 70	Drill Ship	120	39

Note: Measurements and tags put on the released animals show that the loggerhead was not the same individual surfacing in the platform.

There are no existing requirements or protocols for operators to follow in the event of a sea turtle entrapment in a moon pool. NMFS has been contacted in instances when an animal remains in a moon pool and the operator becomes concerned for the animal's welfare (Figure 82). In these cases, NMFS has rescued, assessed, measured, tagged, and released the animals under their authorities (see 50 CFR §222.206, 222.310). The number of sea turtles entering moon pools is probably underreported. Many sea turtles may exit moon pools under their own volition and the occurrences go unreported.

The number of sea turtles reported to be entrapped in moon pools has been sporadic (two in a single year, three in seven years, and four in ten years). Based on the cases of sea turtles reported to be entrapped in moon pools, and successful rescues and releases that have occurred, we approximate about one on average will be sublethally entrapped in moon pools every year, or 50 sea turtles (25 loggerheads and 25 leatherbacks) every 50 years.

Figure 82. NMFS rescue of an entrapped leatherback sea turtle from a moon pool on the drillship West Vela on September 25, 2014.

8.6.2.2 Response

Sea turtles are prone to entanglement in a variety of submerged lines, including monofilament fishing lines and surface buoy lines. Entangling gear can interfere with an animal's ability to swim or surface. This could result in impacts to the animal's ability to breathe, feed, breed, or migrate. Sea turtles are particularly prone to entanglement as a result of their anatomy and behavior. Records of stranded or entangled sea turtles reveal lines can wrap around the neck, flipper, or body of a sea turtle and severely restrict swimming or feeding. If the sea turtle is entangled when young, the line may become tighter and more constricting as the sea turtle grows, cutting off blood flow and causing deep gashes, some severe enough to remove an appendage. Sea turtles that survive an initial entanglement may later succumb to injuries sustained at the time of capture or from exacerbated trauma from entangling lines or lines otherwise still attached.

While there could be minor injury from entanglement and entrapment, mortality is less likely. Once an entanglement occurs, the turtle would be expected to die if it was prevented from surfacing for 30 or more minutes or its ability to swim or feed was restricted. We are aware of only one report of turtle entanglement under BOEM's previous permits to other seismic operators in the Gulf of Mexico based on 15 years of PSO data. Furthermore, during consultation BOEM informed us that the vast majority of seismic companies in the Gulf of Mexico use turtle guards on their streamer tail buoys, and some even use some form of a turtle guard on the airgun array itself. This is perhaps not surprising since if a turtle were to become entangled, it would cost the seismic operator time and money to untangle the turtle and re-survey tracklines where the data have been compromised. Since these turtle guards have been in place, there have been no reports of entangled sea turtles in the Gulf of Mexico. Based on the above, we find it is extremely unlikely that sea turtles would become entangled in Oil and Gas Program equipment.

The deployment and recovery of equipment could result in direct contact from sea turtles investigating the equipment or result in temporary avoidance reactions of animals in the immediate area; however, the vessel strike NTL requires all vessels to maintain a distance of 100 yards from sperm whales and 50 yards from sea turtles at all times. With the implementation of the NTL, entanglement from hydrophone cables and streamers, geophones, bottom cables and other associated gear is extremely unlikely to occur.

Sea turtle entrapped in moon pools could starve to death, become injured as a drilling vessel moved to a new location, become injured from unauthorized rescue attempts by offshore personnel or exit moon pools under their own volition. During previous oil and gas development in the Gulf of Mexico, instances of sea turtle entrapment in moon pools has resulted in NMFS being contacted and the turtles successfully rescued, assessed, measured tagged and released under NMFS authorities. While we expect turtles to be entrapped in moon pools, we expect sublethal effects because operators would take steps, including contacting NMFS or other authorized turtle stranding network personnel if a turtle is entrapped in a moon pool.

8.6.3 Gulf Sturgeon

There have been no reported incidences of Gulf sturgeon entanglement as a result of Oil and Gas Program activities. While it is possible a Gulf sturgeon could get entangled, the likelihood of entanglement from Oil and Gas Program equipment or lines is extremely unlikely due to the distribution of the species being so far from there area where the majority of Oil and Gas Program activity occurs, hence effects from entanglement to Gulf sturgeon are discountable.

8.6.4 Giant Manta Ray and Oceanic Whitetip Shark

As described above in the "*Entanglement in Ocean Bottom Node Survey Lines*" section, there have been several documented entanglement events including a sea turtle, manta ray and a dolphin. Cetaceans (e.g., dolphins) and turtles may be more likely than giant manta rays or oceanic whitetip sharks to “play” with a coiled line (dolphins) or mistake a line for a prey item (turtles) and get entangled. Because of the prior occurences of entanglement BOEM, under in consultation with NMFS, implemented measures, such as removing use of certain types of lines or requiring the use of a heavy coated fiber line to prevent coiling or slack lines, to reduce the chance of such entanglements occurring. Therefore, the probability of entanglement in lines or cables from G&G equipment is extremely low for oceanic whitetip sharks and giant manta rays. Because data on giant manta ray and oceanic whitetip shark abundance are uncertain, that these two species are expected to be sparsely encountered in the Gulf of Mexico, and that these are rare, isolated events that BOEM has since implemented measures to reduce potential for gear interactions, we believe the risk for giant manta rays and oceanic whitetip sharks to be entangled in OBN lines has been removed. Therefore, we consider the effects of entanglement from the proposed action on giant manta rays and oceanic whitetip sharks to be discountable.

8.6.5 Summary of the Effects of Entanglement and Entrapment

We conclude that capture in site clearance equipment, entanglement in seismic gear and/or entrapment in moon pools are likely to adversely affect the following listed sea turtles: green [North and South Atlantic DPSs], Kemp’s ridley, hawksbill, leatherback, and loggerhead [Northwest Atlantic Ocean DPS]. Conservation measures that BOEM has indicated are being implemented by industry to mitigate effects of entanglement include the use of taut lines/cables/chains, turtle guards on tail buoys, and the exclusion of vertical lines, such as acoustic pinger lines used in OBN surveys. These measures may reduce, but not eliminate the risk of entanglement and entrapment. The summary of estimated take associated with 50 years of the Oil and Gas Program are displayed in Table 103.

Table 103. Estimated number of sea turtle takes from entanglement or entrapment expected over 50 years of the proposed action.

	Loggerhead	Leatherback	Kemp’s ridley	Green	Hawksbill
Capture from site clearance activities (non-lethal)	1,400	100	4,150	550	0
Entanglement in lines (lethal)	19	0	20	5	7
Entrapment in moon pools (non-lethal)	25	25	0	0	0

8.7 Effects of Marine Debris

The Oil and Gas Program may result in marine debris such as trash - paper, plastic, wood, glass, and metal associated with offshore operations being discharged to the marine environment.

While disturbance or strike from marine debris as it falls through the water column is possible, it is not likely because the objects will slow in velocity as they sink toward the bottom and can be avoided by highly mobile organisms. Release of trash and debris is prohibited in the ocean unless it is broken up by a comminutor to less than 25 millimeters in diameter (33 CFR 151.51-77). Microplastic accumulation on Northern Gulf of Mexico beaches is similar to other places in the world with nearly 60 percent of content on beaches found in the dunes, which likely exposes sea turtle nesting sites (Beckwith and Fuentes 2018). While inadvertent polluting of trash and debris is possible as a result of the Oil and Gas Program, including lost equipment such as hard hats, gloves, etc., USCG and the U.S. Environmental Protection Agency regulations require proactive avoidance of accidental loss of trash and debris (BSEE NTL 2015-G03, Appendix D). Furthermore, all permits from BOEM would include guidance for handling and disposing of marine trash and debris, similar to BSEE NTL 2015-G03. Additionally, site clearance trawls are required for cleaning up after a site is decommissioned. The amount of trash and debris that would enter the marine environment as the result of the Oil and Gas Program is expected to be minimal.

Intentional discharge of marine debris is prohibited by law (30 CFR §250.40 and MARPOL, Annex V, P.L. 100-220 [101 St. 1458]), yet accidental losses of debris into the marine environment do occur. Marine debris may originate from a variety of sources, though specific origins of debris are difficult to identify. Reports indicate that up to 80 percent of marine debris results from land-based sources in some parts of the world (Allsopp et al. 2006; GESAMP 2010), and a worldwide review of marine debris identifies plastic as the primary form (Derraik 2002). Another published study regarding shoreline trash at Padre Island National Seashore, reported that approximately ten percent of marine trash that washed ashore originated from offshore structures and/or vessels associated with the oil and gas industry (Miller and Jones 2003). There are many types of materials used in offshore energy production including a variety of plastics, pallets, hard hats, gloves, tools, ropes, and storage drums that could accidentally be lost overboard. The Miller and Jones (2003) study indicated that the majority (76 percent) of items originating from the oil and gas industry consisted of wood (e.g., lumber, wooden pallets, and wood spools). While wood is less concerning in regards to protected species, many of the plastics used by industry can withstand years of saltwater exposure without disintegrating or dissolving. Further, floating materials have been shown to concentrate in ocean gyres and convergence zones where *Sargassum*, and consequently juvenile sea turtles, are known to occur (Carr 1987).

Marine debris has the potential to impact protected species through ingestion or entanglement(GESAMP 1990; Gregory 2009). These effects could result in reduced feeding, reduced reproductive success, and potential injury, infection, or death of protected marine organisms (Laist et al. 1999).

Accidental release of debris from OCS activities is known to occur offshore, and ingestion of or entanglement in discarded material could affect ESA-listed species. However, BOEM and BSEE have taken steps to raise awareness of this potential hazard. BOEM requires an annual training and certification for marine debris education and elimination for all offshore personnel, including the potential for adverse effects to listed species (NTL-2015-G03, "Marine Trash and Debris Awareness and Elimination"). Additionally, the debris awareness training, instruction, and placards required by the Protected Species Lease Stipulation should minimize the amount of debris that is accidentally lost overboard by offshore personnel. Despite these efforts to raise awareness and reduce accidental pollution, NMFS believes marine debris still poses a risk to sperm whale, Bryde's whale, and sea turtles. The risk of ingestion remains as even small pieces of debris can be consumed by sperm whales, Bryde's whales, and sea turtles. Entanglement in floating debris is most likely to affect sperm whales, Bryde's whales and sea turtles.

Quantifying potential take associated with industry-generated marine debris is difficult for several reasons. First, only a small proportion of harmful interactions of any kind with listed species in offshore environments result in strandings, as most carcasses of animals that die offshore are unlikely to reach shore (Baulch and Perry 2014; TEWG 1998). Secondly, it is difficult to determine if sea turtles or whales have consumed marine debris, as gut content analyses can only be conducted on captured or stranded animals. Lastly, there can be varying rates of ingestion or entanglement based on species distribution, species density, and sample location (Baulch and Perry 2014; Schuyler et al. 2013).

8.7.1 Whales

Exposure

Marine debris can affect sperm whales through entanglement and ingestion. While most entanglements of protected species involve fishing line or net fragments (Balazs 1985), strapping bands and ropes from a variety of vessels are also a concern. A 2014 literature review (Baulch and Perry 2014) evaluated the impacts of marine debris on cetaceans from around the world. Like ingestion rates for sea turtles, rates vary by species and geographic location. Ingestion rates for sperm whales varied from zero percent in southern Australia to 100 percent along the Adriatic coast of Belgium. We calculated a global average ingestion rate and mortality rate for sperm whales using the data provided in (Baulch and Perry 2014). To get the ingestion rate, we used the total number of animals that were recorded with ingested debris and divided that by the total number of animals necropsied (15/91=16.5 percent). For mortality rate, we took the number where cause of death was determined to be from marine debris and divided that by the total number sperm whales necropsied (4/65= 6.2 percent). These values were then applied to density estimates of sperm whales within the Gulf of Mexico to determine the effect of marine debris on sperm whales within the action area. We only considered the portion of the action area beyond the continental shelf as these deeper waters are the areas of known habitat use by sperm whales. To refine the exposure of sperm whales to account for marine debris generated only by offshore oil and gas operations, we considered the percent of non-wood marine debris identified as originating from the oil and gas industry (2.4 percent) as reported by (Miller and Jones 2003). The results (Table 104) indicate that few sperm whales will be impacted by the ingestion of marine debris within the action area at any given point in time. Though we do not have annual rates of impact, we believe that because sperm whales are long-lived (life expectancy up to 60 years) and the rate of population growth is small (four percent), there will not be a lot of turnover in the number of individual sperm whales entering or exiting the population. Therefore, we similarly do not expect there to be increases in the number of individuals affected by marine debris over the course of the 50-year action. According to our analysis above and the 4.96 percent mortality rate for sperm whales (Baulch and Perry 2014), we believe no more than three sperm whales will be nonlethally taken, with one sperm whale lethally taken through the ingestion of marine debris over the course of the action.

Table 104. Estimated interactions between sperm whales and marine debris over 50 years.

Planning Area	Off-shelf Area (km^2)	Sperm Whale Density (Number/km^2)	Impact Ingestion Rate from Oil and Gas Industry (16.5 percent x2.4 percent)	Mortality Rate from Oil and Gas Industry (6.2 percent x2.4 percent)	Estimated Sublethal Take	Estimated Lethal Take
Western	60,044	0.002	0.00396	0.001488	0.48	0.18
Central	196,506	0.002	0.00396	0.001488	1.56	0.58
Eastern	121,883	0.002	0.00396	0.001488	0.97	0.36
Totals	378,433				3.01	1.12

The likelihood of Oil and Gas Program-related marine debris affecting Bryde's whales is low, in general, because there are not many leases or production activities in the EPA. However, since oil and gas associated vessel traffic transits through the EPA, the effects are not discountable. At least one death of a stranded Bryde's whale has been attributed to marine debris. The animal was found at Everglades National Park in January 2019. A plastic shard was lodged in the gut of the animal, which succumbed to emaciation, stranding and drowning from the injuries sustained from the shard (FMMSN1908 necropsy report). Origin of the plastic shard has not yet been identified.

Global averages were used for this analysis based on marine debris having similar effects on any baleen whale species; and the study used had a higher number of data points, especially for baleen whales, for which there are few data at any one location. For 30 baleen whales that were necropsied from Canary Islands, United Kingdom, Croatia and Belgium, one in ten died as a result of marine debris (Baulch and Perry 2014). Hence, we considered a ten percent mortality rate for Bryde's whales based on Baulch and Perry (2014) data for baleen whales. The primary area where Gulf of Mexico Bryde's whale is found is a distance from areas that have oil and gas structures and therefore the oil and gas-related marine debris may not be as concentrated in the area that they live. Based on this and extrapolating the sperm whale analysis results, that we expect similar adverse effects to both whale species and given a much smaller population size for

Bryde's whale, we estimate one sublethal take and no lethal takes of Bryde's whales from marine debris over 50 years of the proposed action.

Response

Sperm whales are susceptible to threats from marine debris given their habitat use and feeding habits. An entangled whale may suffer from acute impaired mobility that quickly compromises its health, or it may decline slowly from diminished feeding and reduced reproductive capability (BOEM 2013; Smith et al. 2011). Further, the increased energy required to overcome the handicap of entanglement may require more food than the entangled whale can capture. Sperm whale ingestion of marine debris is a concern, particularly because their feeding behavior may include cruising along the bottom with their mouths open (Walker and Coe 1990). Further, a review by Baulch and Perry (2014) noted nine baleen and 39 toothed whale species (including sperm whale) with debris ingestion. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby reducing the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist 1987; Laist 1997). Weakened animals are then more susceptible to disease and are also less fit to breed or reproduce (Laist et al. 1999).

Bryde's whales are more susceptible to threats from marine debris given their habitat use and feeding habits. Bryde's whales, like all baleen whales are filter feeders, therefore are susceptible to microplastic ingestion. Several polymer types (polyethylene, polypropylene, polyvinylchloride, polyethylene terephthalate, nylon) have been documented in baleen whales, which can bioaccumulate toxic chemicals (Besseling et al. 2015; Fossi et al. 2016). Individual Bryde's whales are likely to be adversely affected from exposure to marine debris (through entanglement or ingestion) as a result of the proposed action. Exposure to marine debris may have sublethal effects on individual whales, including reduced fitness, and mortality is not expected.

8.7.2 Sea Turtles

Exposure

Stanley et al. (1988) reported that marine debris ingestion was evident in 32.9 percent of stranded turtle carcasses (loggerheads, greens, and Kemp's ridleys) from off the coast of Texas between 1986 and 1987. Subsequent necropsy studies of stranded turtles indicate varying rates of debris ingestion by species and location. A recent worldwide review of marine debris ingestion by sea turtles determined that approximately 47 percent of hawksbill, 42 percent of green, 34 percent of leatherback, 23 percent of loggerhead, and 15 percent of Kemp's ridley sea turtles sampled had ingested debris (Schuyler et al. 2013). We expect that sublethal and lethal effects to sea turtles from marine debris will be similar regardless of the species. While these are global estimates based on a literature review, we consider them the most comprehensive, current and best estimates available.

We consider the global percentages from Schuyler et al. (2013) relevant to this analysis based on the larger data set for global averages, which will provide a better estimate than a smaller data set, covering a shorter time period, in a more localized area. Turtle stranding data are mostly going to be collected from nearshore waters where vessel traffic and adult turtle density is generally higher and where data (and carcasses) are easier to collect. Therefore, assuming that marine debris ingestion in the Gulf of Mexico is similar to the worldwide values identified previously, we can estimate the number of sea turtles affected by marine debris within the Gulf of Mexico at any given point in time by multiplying these global percentages by density estimates in section 8.1.2 and spatial coverages for each sea turtle species within the Gulf of Mexico. To further refine the exposure of sea turtles to account for marine debris generated only by offshore oil and gas operations, we considered the percent of non-wood marine debris identified as originating from the oil and gas industry (2.4 percent) as reported by (Miller and Jones 2003) and calculated the number of sea turtles affected by marine debris in the Gulf of Mexico (Table 105).

Sea turtles affected by oil and gas related marine debris in Gulf of Mexico = Global percentage of marine debris ingestion x sea turtle densities x spatial coverage x 2.4 percent

Table 105. Estimated number of sea turtles affected by marine debris from oil and gas operations in the Gulf of Mexico at any given point in time.

Species	Adults and Neritic Juveniles		
	WPA	CPA/EPA	Total
Kemp's ridley	44	708	752
Loggerhead	291	767	1,058
Green	33	410	444
Leatherback	11	30	41
Hawksbill	0	779	779

We assume that once a turtle has ingested debris that it is considered affected and remains affected as long as it survives; therefore, it should only be counted once for the year in which the ingestion occurred. Increases in adult population numbers due to recruitment from younger age classes, and decreases in mortality in population numbers can be used to discern the number of new injuries occurring annually. In order to estimate the number of those newly impacted sea turtles that occur annually, we applied survivorship probabilities in the population to estimate the number and percentage of each sea turtle species that (1) leaves this age class each year, and (2) newly recruits to this age/size class. In order to take this approach, we have made the assumption that the individual species' populations are stable and the number of mortalities will be replaced with an equal amount of individuals that are at risk of ingestion. According to the recovery plans for loggerhead and Kemp's ridley sea turtles, annual survival probabilities average 0.853 and 0.935 respectively, corresponding to annual mortality rates of 14.7 percent for loggerheads and 6.5 percent for Kemp's of neritic juveniles and adults combined. We do not have species-specific survivorship probabilities for the age classes of other species of sea turtles occurring in the Gulf of Mexico, but we expect them to be similar to other sea turtles based on similar biological characteristics, such as life history.

We have conservatively applied the higher mortality rate of 14.7 percent for loggerheads to the neritic and adult age classes of green, leatherback, and hawksbill sea turtles as a surrogate value for this analysis (similar to the approach used for the vessel strike analysis in Section 8.4, above). Multiplying the mortality rates by the estimated number of sea turtles affected by marine debris at any given point in time provides an annual rate of impact (Table 106).

Table 106. Estimated number of adult and neritic juvenile sea turtles that may be affected by marine debris from the oil and gas industry per year.

Species	Adults and Neritic Juveniles			
	Correction factor	WPA	CPA/EPA	Total
Kemp's ridley	0.065	3	46	49
Loggerhead	0.147	43	113	156
Green	0.147	5	60	65
Leatherback	0.147	2	4	6
Hawksbill	0.147	0	115	115

Mortality as a result of marine debris is also variable. In a review of 37 studies, 15 of which included cause of mortality from marine debris, Schuyler et al. (2013) reported that mortality rates varied among 11 of the 15 studies from 2-17 percent of total mortality and 5-35 percent of mortality due to ingestion. To err on the conservative side of protection of the species, we consider that 17 percent of all sea turtles affected by marine debris will die as a result of this stressor (Table 107).

Table 107. Annual mortality rate of adult and neritic juvenile sea turtles associated with marine debris from the oil and gas industry.

Species	Annual Lethal Rates of Interactions with Marine Debris		
	WPA	CPA/EPA	Rounded Total
Kemp's ridley	0.4862	7.8234	8
Loggerhead	7.27209	19.16733	26
Green	0.82467	10.2459	11
Leatherback	0.27489	0.7497	1
Hawksbill	0.59976	19.46721	19

NMFS is aware of only a single study that addressed juvenile sea turtle density, and sampling was limited to the continental shelf off Florida (Witherington et al. 2012b). Therefore, we calculated densities of juvenile sea turtles in the Gulf of Mexico from this study. We corrected the density estimates reported by (Witherington et al. 2012b) based on the proportion of *Sargassum* habitat within the planning areas of the Gulf in relation to the total area of the three planning areas. The amount of *Sargassum* habitat was conservatively estimated from the work of Gower and King (2008). The number of pelagic stage juveniles that could be affected by marine debris originating from the oil and gas industry was then determined by the following equation:

Adjusted density x total area of the planning areas x rate of interaction (from above) x 2.4 percent

The number of lethal takes was further calculated applying the mortality rate of 17 percent (Table 108).

Table 108. Estimated number of pelagic stage juvenile sea turtles affected by marine debris associated with the oil and gas industry.

Species	Adjusted Density/km^2	Number of Juveniles within the Planning Areas	Number of Interactions at Any Point in Time	Number of Lethal Interactions at Any Point in Time
Kemp's ridley	1.207	570,219	13,685	233
Loggerhead	1.002	473,372	11,361	193
Green	1.418	669,901	16,078	273
Leatherback	0	0	0	0
Hawksbill	0.042	19,842	476	8

To account for the number of pelagic juveniles that could be impacted annually by marine debris we multiplied the total number of interactions from Table 108 by a correction factor that considers the number of years juveniles spend in the pelagic/oceanic stage. Although a proportion of the juvenile population interacts with marine debris, not all those interactions occur in a single year. Instead of applying survivorship probabilities to obtain a correction factor to estimate annual numbers of interactions as we did with adults and neritic juveniles, for juveniles we determine annual interactions by dividing the total number of juvenile sea turtles interacting with marine debris at any given time by the number of years a juvenile remains in the oceanic stage (similar to the approach used for the vessel strike analysis in Section 8.4, above). Juvenile Kemp's ridleys spend up to four years in the oceanic stage, green turtles up to 4.6 years (rounded up to five) (Reich et al. 2007), and loggerheads about 8.2 years (rounded down to eight) (Bjorndal and Bolten 2000). Although we do not have specific information related to the duration of time hawksbill sea turtles spend in the pelagic environment, we assume that since they are slow growing, they will spend longer durations in oceanic environments, similar to loggerheads. We expect the number of marine debris interactions in each juvenile sea turtle population in any given year to represent the total number of years turtles spend in the oceanic stage. For example, if a Kemp's ridley juvenile is injured through the ingestion of marine debris in Year one of the oceanic stage and survives to Year four; only one of the four years represents the annual rate for the oceanic age class (or 0.25). To determine the annual number of marine debris interactions resulting from the oil and gas industry for each species, we can divide by the total number of interactions by the total number of years juveniles spend in this age class. Annual interaction rates would be represented in 25 percent of the total Kemp's ridley interactions, 20 percent of green sea turtle interactions, and 12.5 percent of the total interactions in loggerheads and hawksbills (Table 109). Again here, we apply the 17 percent mortality rate to get the annual number of lethal interactions.

Table 109. Estimated number of annual interactions between pelagic-stage juvenile sea turtles and oil- and gas-generated marine debris.

Species	Correction for the Number of Individuals Ingesting Marine Debris Annually (1/years of life stage)	Annual Occurrence of Nonlethal Interactions with Marine Debris	Annual Occurrence of Lethal Interactions with Marine Debris
Kemp's ridley	0.250	3,421	582
Loggerhead	0.125	1,420	241
Green	0.200	3,216	547
Leatherback	0.250	0	0
Hawksbill	0.125	60	10

Because the actions under this opinion may extend 50 years into the future, we have extrapolated the above calculations over 50 years (Table 110).

Table 110. Estimated interactions between sea turtles and marine debris over 50 years.

Species	Sublethal Interactions			Lethal Interactions		
	Oceanic Juveniles	Adults	Total	Oceanic Juveniles	Adults	Total
Kemp's ridley	171,066	2,450	173,516	29,081	415	29,496
Loggerhead	71,006	7,800	78,806	12,071	1,322	13,393
Green	160,776	3,250	164,026	27,332	554	27,886
Leatherback	0	300	300	0	51	51
Hawksbill	2,976	5,750	8,726	506	973	1,479

Response

Entangled sea turtles may drown, become unable to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threatens their survival (Balazs 1985; Laist 1997). All sea turtles are susceptible to ingesting marine debris, though leatherbacks show a marked tendency to ingest plastic that they misidentify as jellyfish – a primary food source (Balazs 1985). Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby reducing the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist 1987; Laist 1997). Weakened animals are then more susceptible to predators and disease and are also less fit to migrate, breed, or, in the case of turtles, nest successfully (Katsanevakis 2008; McCauley and Bjorndal 1999).

Individual sea turtles are likely to be adversely affected from exposure to marine debris (through entanglement or ingestion) as a result of the proposed action. Exposure to marine debris may have sublethal effects on individuals, including reduced fitness, or could lead to death. We anticipate this stressor will result in a small proportion of individuals being adversely affected.

8.7.3 Gulf Sturgeon

Gulf sturgeon are a coastal species that selectively feed on a variety of benthic invertebrates. Debris from the Oil and Gas Program would generally be lost in offshore areas and it is unlikely that these items would be transported to coastal areas and settle in benthic areas where Gulf sturgeon reside. We believe that the likelihood of Gulf sturgeon encountering or ingesting marine debris from the Oil and Gas Program is extremely unlikely and thus, discountable. Therefore, we determined marine debris from oil and gas operations are not likely to adversely affect Gulf sturgeon.

8.7.4 Giant Manta Ray and Oceanic Whitetip Shark

There is little available information on the effects of marine debris on giant manta rays or oceanic whitetip sharks. As planktivorous filter feeders, manta rays may be susceptible to the ingestion of microplastics and other small debris resulting from oil and gas activities. There are no abundance estimates for oceanic whitetip sharks or giant manta rays for the entire northern Gulf of Mexico, so we are not able to quantify exposures. Since oceanic whitetip sharks and giant manta rays are expected to be very uncommon within the action area, the number of individuals exposed to marine debris from oil and gas activities is expected to be extremely small. Oceanic whitetip sharks, which are normally associated with surface waters, may be susceptible to entanglement in large, floating objects of marine debris including plastic straps, lines, and wood. The effects of marine debris from oil and gas activities should be smaller on highly mobile and widely dispersed species populations, such as manta rays and oceanic whitetip sharks, due to the temporary, localized and patchy distribution of marine debris within the action area. While it is possible that individual giant manta rays and oceanic whitetip sharks could be adversely affected from exposure to marine debris (through entanglement) as a result of the proposed action, we believe that the rare occurrences of oceanic whitetip sharks and giant manta rays coupled with the localized, patchy distribution of oil and gas related marine debris make the chances of interaction extremely unlikely (i.e., discountable). Hence, we conclude that oceanic whitetip sharks and giant manta rays are not likely to be adversely affected by marine debris resulting from the proposed action.

8.7.5 Summary of the Effects of Marine Debris

We conclude that marine debris is likely to adversely affect sperm whales, Bryde’s whales, and sea turtles (green [North and South Atlantic DPSs], Kemp’s ridley, hawksbill, leatherback, and loggerhead [Northwest Atlantic Ocean DPS] sea turtles). Conservation measures that BSEE implements to mitigate the effects of marine debris include the posting of placards, required marine debris awareness training for industry personnel, and reporting of training or lost debris. This is in addition to MARPOL requirements under the USCG. These measures may reduce, but not eliminate the risk of marine debris.

Table 111. Estimated number of takes from marine debris expected over 50 years of the proposed action.

	Lethal	Non-lethal
Sperm whale	1	3
Bryde's whale	0	1
Kemp's ridley	29,496	173,516
Loggerhead	13,393	78,806
Green	27,886	164,026
Leatherback	51	300
Hawksbill	1,479	8,726

8.8 Effects of Oil Spills

Oil spills are well known to damage the environment and kill animals that are directly and indirectly exposed to oil. Oil spills, and especially when mixed with dispersants used to control larger spills, are toxic to marine life. From Trustees (2016):

Crude oil contains different compounds of toxic aromatic chemicals that have at least one benzene ring. When crude oil is released, it immediately begins the degredation process, called weathering. Some oil compounds will weather, by evaporation, dispersion into water, or bacterial degredation, while others will not, such as polycyclic aromatic hydrocarbons or PAHs. Different crude oils have different chemical compositions that are governed primarily by the geologic conditions under which they were formed, migrated, and accumulated. These conditions can result in oil from a given location or geologic formation having a unique chemical composition, including specific compounds that help experts distinguish one crude oil from another. The fate and transport of oil and gas after a spill differs. Oils may sink, become entrained in the water column, or surface. The moment oil reaches the surface, it begins to evaporate the aromatic compounds and the remaining heavier compounds react to other environmental conditions (i.e., sun, wind, waves, currents). Natural gas may remain submerged and be degraded by bacteria prior to reaching the surface, depending on the depth of the spill. The same bacteria produce mucus that may form with oil droplets and cause marine oil snow that then settles to the seafloor.

Dispersants are chemicals that reduce surface tension between oil and water, leading to oil droplet formation, so that the oil will more readily disperse into the water column. They typically contain surfactants and solvents and are used to entrain oil in the water column so as to protect shorelines from floating oil, but in turn, increases exposure to underwater organisms.

Oil spills directly affect ESA-listed species through various pathways and often animals may be exposed in all pathways at the same time. Exposure pathways include external contact (through the skin and eyes), inhalation, aspiration, and oil ingestion (through oiled prey or accidental oil ingestion). Disruption of other essential behaviors, such as breeding, communication, and feeding may also occur. External contact with oil can cause irritation of the eyes, skin, and mucus membranes. In addition, oil present around a blowhole or in the mouth could lead to aspiration of oil. External contact can potentially transfer into the bloodstream; however, uptake through the skin has been considered unlikely in healthy cetacean skin in high salinity waters due to the tight intercellular bridges and thick epidermis (O'Hara and O'Shea 2001). The effects of long-term skin exposure that could occur during long duration spills have not been determined, however, oil was applied to the skin of a live, stranded sperm whale and skin lesions formed (Trustees 2016).

Hydrocarbon spills have varying levels of negative impacts on listed species and the marine environment depending on the size and location of a spill. Oil spills associated with the proposed action can occur for a number of reasons including equipment failure, human error, natural forces such as hurricanes, or a combination of causal factors. Sources of spills include drilling platforms, well-heads, vessels, pipelines, and oil barges. The volume of oil released can range from “droplet” leaks to millions of barrels. When spills do occur, the size of the spill depends on the volume (in a container or within the earth), the flow rate (a low-pressure/low-flow leak up to a high-pressure/high-flow event), and the capability of the responsible party or response agencies to contain and control the source of the spill and clean up the oil. An oil release will continue until either the reservoir is depleted or until the release is brought under control. Oil spills are accidental and unpredictable events, but are a direct consequence of oil and gas development and production from federally regulated oil and gas activities in the Gulf of Mexico. Oil releases can occur at any number of points during the exploration, development, production, and transport of oil. Any discharge of hydrocarbons into the environment is prohibited under U.S. law. Consequently, there are stringent regulatory mechanisms, industry best practices, and BOEM/BSEE-required spill response plans in place to reduce the risks associated with oil spills. Despite the mechanisms in place, there are still many spills each year in the Gulf of Mexico due to this region’s very large number of subsea wells, offshore production structures, pipelines, vessels, and other infrastructure supporting oil and gas activities. The following analysis will consider the risk of oil spill events and the consequences they could have on ESA-listed species and designated critical habitat.

Causes and Predicted Occurrence of Future Oil Spills

Table 112 and Table 113 summarize BOEM’s estimated probability of spills over 1,000 barrels (bbl) and over 10,000 bbl resulting from pipeline, platform, and tanker accidents. The spills from all sources will be grouped together by spill size (volume) based on the expected volumes of oil that could be spilled in the future. The highest likelihood of occurrence of spills is from pipelines, followed by platforms, and a lower occurrence from tankers. The high risk from pipelines is due to the fact that most all of the oil produced in the Gulf of Mexico is transported to shore via the vast pipeline infrastructure found offshore. Accidental pipeline breaks from underwater landslides, anchoring, storms, and an aging pipeline infrastructure are the causes of most pipeline spills. Several small and a few large pipeline spills are certain to occur in the future.

Table 112. Likelihood of Occurrence for Oil Spills over 1,000 bbl from Platforms, Pipelines, and Tankers in the Gulf of Mexico (2012-2051).

Planning Area	Probability of One or More Spills (Percent Chance)			Total Chance
	Platforms	Pipelines	Tankers	
WPA	47-60 percent	89-94 percent	0-17 percent	94-98 percent
CPA	98-100 percent	100 percent	0-35 percent	100 percent
EPA	5 percent	17 percent	0 percent	21 percent

Source: BOEM BA supplemental information citing Ji et al. 2014.

Table 113. Likelihood of Occurrence for Oil Spills over 10,000 bbl from Platforms, Pipelines, and Tankers in the Gulf of Mexico (2012-2051).

Planning Area	Probability of One or More Spills (Percent Chance)			Total Chance
	Platforms	Pipelines	Tankers	
WPA	28-38 percent	36-43 percent	0.0-6.0 percent	54-67 percent
CPA	87-94 percent	94-97 percent	0.0-13 percent	99-100 percent
EPA	3 percent	4 percent	0 percent	6 percent

Source: BOEM BA supplemental information citing Ji et al. 2014.

Transporting crude oil from wells within the Gulf of Mexico by tankers is uncommon due to the fact that, as mentioned above, most crude oil is transported from wells to shore via pipelines. However, there is limited use of tankers to transport produced oil from deepwater developments in the Gulf of Mexico where pipeline infrastructure is not feasible and there is additional tanker traffic associated with the export of oil produced in the Gulf of Mexico as well as the transportation of oil produed in the Gulf of Mexico to other locations in the United States. Nonetheless, the amount of oil produced in the Gulf of Mexico that is expected to be transported by tanker is relatively small compared to that transported by pipeline, as reflected in the low risk of oil spills reported by BOEM for tankers compared to pipelines. Overall, the highest likelihood for spills to occur is in the CPA, followed by the WPA, and EPA. The differences directly correspond to the amount of activity in each planning area (measured by volume of oil produced).

To conduct our analysis, it is helpful to characterize spills from all sources collectively into spill size categories for each planning area. The primary assessment method to estimate oil impacts on marine life is to evaluate the likelihood of direct oil exposure, which is related to the size of a spill. Other pathways of exposure will be discussed later in this analysis. We used the spill size categories BOEM used in the BA and labeled then for purposes of our analysis as very small, small, medium, large, and very large based on the volume of oil spilled. The number of spills estimated is derived by BOEM's application of the historical rate of spills per volume crude oil handled (1996-2010) (Anderson et al. 2012), and applied to the projected production from the proposed action. Table 114 shows that numerous small spills are common and will likely continue to occur in the future. Based on BOEM's historical spill data, numerous small spills are expected to occur, but spill frequency decreases as the size of the spill increases. BOEM notes that the only spill greater than 10,000 bbl to occur in the last 20 years was the DWH, and estimates up to two spills greater than 10,000 bbl may occur over the next 50 years of the proposed action. Based on information provided by BOEM, NMFS estimated an extremely large spill size (as detailed further in **Appendix G**), which was conservatively considered by assessing how long a spill might last and how much oil could flow over that time and considered as the largest possible spill volume to possibly occur based on a 30-day release. We are particularly interested in determining the risks associated with another rare, but high-impact event (such as DWH) occurring within the time frame of this opinion.

Table 114. Average Number and Size of Spills projected by BOEM to Occur on the Gulf of Mexico OCS Resulting from Permitted Lease Actions on Leases Awarded through 2027.

Spill Size Category (bbl)	Median Spill Size (bbl)	Range of theTotal Number of Spills	Average Spills over 50 Years
Short-term, Minor Spills			
0-1.0	0.024	6,060-12,120	9,090
Very Small			
1.1-9.9	3.0	172-344	258
Small			
10.0-49.9	30	52-104	78
Medium			
50-499.9	130	34-68	51
Moderately Large			
500.0-999.9	750	5-10	7.5

Spill Size Category (bbl)	Median Spill Size (bbl)	Range of theTotal Number of Spills	Average Spills over 50 Years
Large			
1,000-9,999	2,200	3-7	5
Very Large			
≥ 10,000	100,000	2	2

Source: BOEM BA supplemental information.

In summary, BOEM has provided NMFS with information that two oil spills greater than or equal to 10,000 bbl may occur over the duration of the proposed action. BOEM does not specify the maximum size expected for these events. However, BOEM's analysis and estimates of future exposures and effects from oil spills is not based on modeling or estimating the effects of discrete, particular extreme spill event scenarios. Instead BOEM used an oil spill risk analysis modeling described below in the *Approach to the Oil Spill Analysis* section 8.8.

As for the potential for an extremely large event due to a well-control incident in the Gulf of Mexico, the recent analysis provided by BOEM (Ji et al. (2014)) evaluated the risk of extremely large spill events on the U.S. OCS. This study predicted the return period for a worst-case spill (defined as a spill over 1 Mbbl) as 165 years with a 95 percent confidence interval between 41-500 years. This still results in a wide range of years over which an extremely large uncontrolled blowout might occur. This wide range of years is due, in part, to the high uncertainty involved in predicting rare events. BOEM has concluded that an extremely large blowout and uncontrolled release of oil should not be considered an effect of the action because the probability is so low that it is not reasonably certain to occur within the time period covered by this opinion and so is not an anticipated result of the proposed action. NMFS will defer to the BOEM and BSEE analysis on oil spills and oil spill control for this conclusion based on their expertise in this subject, and accordingly will not carry it into its analysis of the effects of the action the hypothetical occurrence of this low-probability extremely large (greater than 1 Mbbl) event. Further discussion of this hypothetical extremely large spill event, including its size are discussed further in **Appendix G**.

In our analysis, we will further consider the effects of different spill volumes by assessing these size categories on listed species and designated critical habitats. However, short-term, minor spills of no more than one barrel and an extremely large spill (discussed in **Appendix G**) will not be carried forward in our effects analysis. The less than one barrel spills are very small and limited in duration. They do not persist for long periods and quickly evaporate, dissipate, or dilute into the water column due to their limited volume. In these spill scenarios, there is such a low likelihood of exposure to listed species and designated critical habitats that the effects are expected to be discountable. As noted above, we discuss a low probability extremely large spill in **Appendix G**. We did not carry this forward because we relied on data provided by BOEM to conduct the spill analysis, and defer to BOEM's analysis and conclusion that an extremely large spill is a low probability event, meaning there is too much uncertainty about occurrence, location, magnitude, or other factors to estimate such an event.

Exposure to larger amounts of oil has the potential to adversely affect any listed species and designated critical habitats that will be considered further in this analysis. To conduct our effects analysis, we used data provided by BOEM, developed a hazard assessment for each spill size category and a consequence scale for oil exposure. This scale was used to determine the area that each spill size could cover and the associated exposure of listed species and designated critical habitats. We took into account the number of spills predicted for each size category, the duration of the spills associated with each size category, and the distribution and abundance of each species and location of critical habitats. Larger spills are more difficult to predict, but have the greatest potential to adversely affect listed species and designated critical habitats.

Approach to the Oil Spill Analysis

First, we will consider the response of individual ESA-listed species and habitats to oil spills. Effects analysis includes response, exposure and risk but you cannot evaluate exposure and risk without discussing the likelihood of different oil spill scenarios. Oil spills and spill response in the Gulf of Mexico can have effects on marine species including listed whales, sea turtles, Gulf sturgeon, oceanic whitetip shark, and giant manta ray. Second, we consider the causes of future oil spills that are expected and assess the risk of different sizes of these expected spills on listed species. Then, we assess the effects of the different oil spill size categories on ESA-listed species and habitats and estimate future oil impacts of the 40-year lease lives of the proposed action from leases awarded up to 2029 (lease activities through the year 2069). Last, we consider the capability of approved Oil Spill Response Plans to avoid or minimize the effects of oil spills on ESA-listed species.

Overview of Oil Spill information Used for Analysis

Predicting the future exposure of listed species to oil is challenging due to the uncertainty of where a spill may occur, differences in oil type, surface thickness, dispersion factors, and the areas that may be affected by spills. Estimating the generalized areal coverage for specific volumes of oil is useful to evaluate what impacts future oil spills may have on listed species. Similar to the analysis done for DWH, this oil spill exposure analysis includes consideration of effects to other potential contaminants associated with oil spills such as dispersants and drilling muds. To assess the exposure of listed species to oil spills, we will follow the following steps:

- First, for any size spill, we characterize oil thickness by the visible characteristics of the oil and volume of oil needed to produce those visible characteristics.
- Second, we conduct an exposure analysis using spatial data for oil spill risk and species densities.

- Finally, we apply consequence levels from each category to identify the severity of exposure to the different types of oil in each spill size category.

In general, oil spills may pose a variety of oiling conditions ranging from very thin silver sheens to fresh, dark, and thick oil. Using the range of values found in NOAA's Open Water Oil Identification Job Aid,[64] we calculated the water area that would be covered from different thicknesses of oil from different spill sizes, according to the following definitions based on the characteristics of the visible oil:

Sheen: Sheen is a very thin layer of oil (less than 0.0002 in or 0.005 mm) floating on the water surface and is the most common form of oil seen in the later stages of a spill. According to their thickness, sheens vary in color from *rainbows*, for the thicker layers, to *silver/gray* for thinner layers, to almost transparent for the thinnest layers. This oil is represented by an average of 10^{-3} mm thickness or equivalent to 0.026 bbl/acre.

Metallic: The oil color that tends to reflect the color of the sky, but with some element of oil color, often between a light gray and a dull brown. *Metallic* oil is described as "mirror to the sky." This oil is represented by an average of 10^{-2} mm thickness or 0.260 bbl/acre.

Transitional Dark (or True) color: This is the next distinct oil on water layer thickness after metallic that tends to reflect a *transitional dark* or *true* oil color. At the "transitional" stage most of the oil will be just thick enough to look like its natural color (typically a few thousandths of an inch, or few hundredths of a millimeter), and yet thin enough in places to appear somewhat patchy. This oil is represented by an average of 10^{-1} mm thickness or equivalent to 2.6 bbl/acre.

Dark (or True) Color: This color represents a continuous true oil color (i.e., its natural color), commonly occurring at thicknesses of at least a hundredth of an inch (or, a little over a tenth of a millimeter). Dark oil (especially in a calm and/or contained state) could range in thickness with heavy oil near the source and thinner oil at the margins of the spill area as it spreads. However, when the oil reaches an equilibrium condition, most oils would not achieve an average thickness beyond a few millimeters. Heavy fuel oils and highly weathered or emulsified oils (especially on very cold water) could, of course, reach equilibrium states considerably greater than a few millimeters. This oil is represented by an average of 1 mm thickness, equivalent to 26 bbl/acre.

We will calculate spill area (square kilometers) based on the volume of oil spilled per incident that results in different oil thicknesses defined by each category of visible oil described above. We believe this method provides a good estimate of the potential for exposure for short-duration spills, but this conversion becomes inaccurate for estimating spill sizes for volumes of oil

[64] http://response.restoration.noaa.gov/jobaid/aerialobs

released over longer periods that are dependent on the flow rate from a pipeline, container, well, or other source. Long spill releases are subject to many factors over the time of the spill that affect the availability of oil to continue spreading at the surface. Evaporation, dilution, weathering, emulsification, shore contact, and degradation limit the fate of oil such that it will no longer continue spreading on the surface of the water. In other words, oil spilled over a one-month period does not cumulatively spread, but rather spreads to some limit until other forces predominate that limit, evaporate, breakdown, or redistribute oil.

To estimate area impacted by oil from longer release spills, our very large spill release is evaluated as periods of "release windows." To ensure our very large spill estimates are not gross underestimates of spill areas, we verified the calculated areas by comparing them to spill areas modeled for a hypothetical extremely large spill. To check the accuracy of this method, we looked at BOEM's Extremely Large Spill Analysis for areas covered by an extremely large release of oil (30,000 bbl-60,000 bbl/day). Although BOEM's analysis does not model the surface oil of different thicknesses of oil, it does model the total area covered during different seasons and location so we can compare that average to our estimate of total spill area. BOEM used five hypothetical locations on the OCS to model a 60,000 bbl/day release of oil and calculated an average area of 200,000 km^2 (Table 115). For the sake of this analysis, we assumed spherical spreading of oil during a hypothetical spill with the highest consequence category types (i.e., thickest oil) being at the spill source center and radiating concentrically out from there in subsequent consequence categories. This gives us percentages of each category type that can then be applied to exposure numbers to give us consequence severity for estimated exposures (Table 116). Table 116 estimates account for the larger spill size category within the smaller spill size category (so the rainbow sheen extent is the outer most spread of the oil across that area, and does not incorporate the areas for the metallic, transitional and dark categories).

Table 115. Modeled areas impacted for a 30-day spill from five different launch points in the Gulf of Mexico (source BOEM BA supplemental information).

Launch Point	Spill Area (km^2)			
	Winter	Spring	Summer	Fall
LP1 - Central Gulf of Mexico shelf area west of the Mississippi River	198,000	82,100	185,700	296,000
LP2 - Central Gulf of Mexico shelf area east of the Mississippi River	220,600	128,300	128,000	178,600
LP3 - Central Gulf of Mexico slope area	442,900	325,000	557,100	525,000
LP4 - Western Gulf of Mexico shelf area	75,000	17,900	25,000	71,000
LP5 - Western Gulf of Mexico slope area	28,600	35,700	264,300	260,000
Average	193,020	117,800	227,020	266,120
Total Average	200,990			

Table 116. Estimated percentages of areas impacted in each consequence category assuming spherical surface spreading.

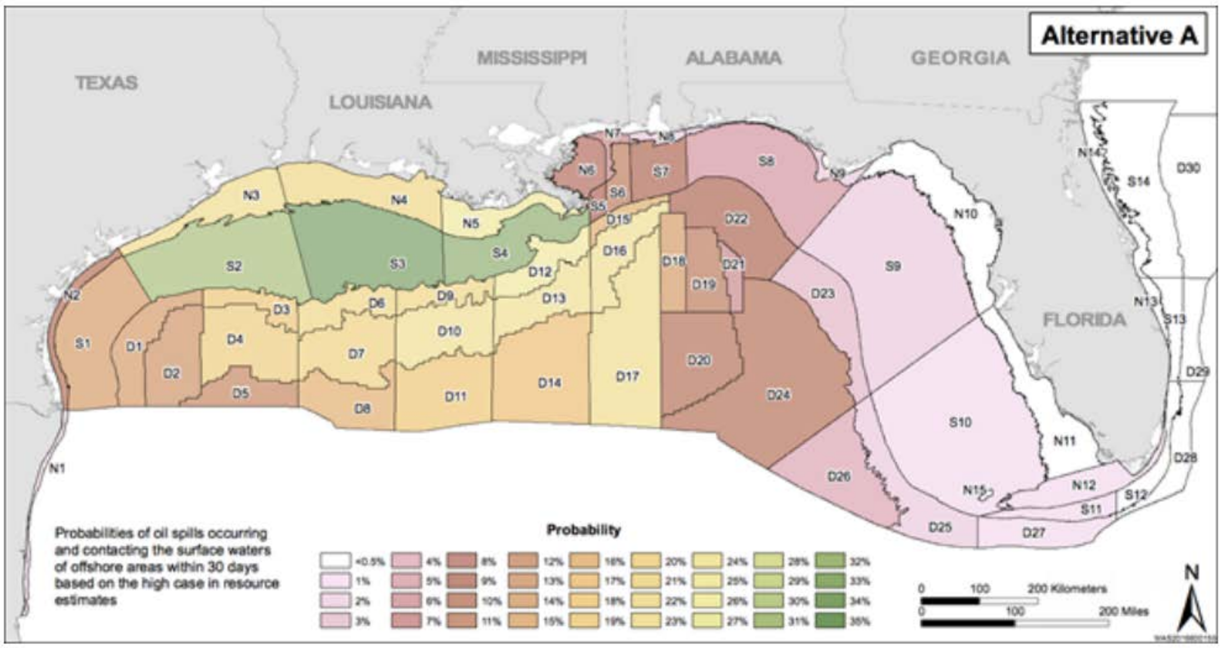
	Area Covered by Each Surface Oil Thickness (km^2)			
	10^{-3} mm rainbow sheen	10^{-2} mm metallic sheen	10^{-1} mm transitional dark	1 mm dark oil
Bbl/km^2	*6.42*	*64.3*	*642.5*	*6424.5*
km^2/Bbl	0.155654	0.015565	0.001557	0.000156
Total exposure percentage	**89**	**10**	**1**	**0 to <1**

Note: 0.001 mm of oil = 0.026 bbl/acre; 1 acre = 0.004047 km^2

To further consider the transport of oil with time, we considered the potential for oil transport via the Loop Current, a large gyre in the middle of the Gulf of Mexico that circulates and eventually feeds into the Gulf Stream up the U.S. Atlantic Coast. Oil could be transported by the Loop Current to wider areas. BOEM considered the potential for oil to contact south Florida and areas outside the Gulf of Mexico. BOEM's analysis considered many factors including multiple spill locations, water currents, seasonality, and a release rate of 30,000-60,000 bbl/day. Based on their robust analysis, on average, less than 0.5 percent of the simulated spills made it across the Florida Straits boundary within 30 days, and none contact south Florida (BOEM Extremely Large OSRA). Considering the possibility of a single 1.1 MM bbl spill occurring in an area near the Loop Current, if some oil became entrained in the water currents, it would disperse while inside the Gulf of Mexico water system. Based on the size of the largest spill expected and

BOEM's modeling, we anticipate that the amount of oil that would reach the Straits of Florida within 30 days would be so low as to not be measurable. Figure 83 below shows the upper bounds for BOEM's modeling of all oil spills greater than 1,000 bbl occurring and contacting surface waters within 30 days. We used this model to represent relative probabilities and the species densities (presented in section 8.1.2) in each of the areas to estimate oil exposures.

Figure 83. Probabilities of Oil Spills Greater than 1,000 bbl Occurring and Contacting Surface Waters within 30 Days [Nearshore ("N", 0-20m), Shelf ("S", 20-300m), and Deepwater ("D", 300m to outer jurisdiction)]. Polygons as a Result of the High Case in Resource Estimates. Alternative A is the preferred alternative in BOEM's Gulf of Mexico 2017-2022 Lease Sales EIS, Figure E-11 (BOEM 2017c).



The severity of exposure that can result in the adverse effects discussed depends on a number of factors. How severely species are exposed to spilled oil depends on several factors:

- size of a spill (the flow rate and duration)
- volume of oil available to be released (reservoir size)
- type of oil
- location
- time of year
- species, life history, or migratory stage
- manner of exposure (external only or ingestion, inhalation, or aspiration)
- oceanographic/environmental characteristics

For species discussed, especially sperm whales, Bryde's whales and sea turtles, the number of animals that may suffer oil-induced effects is proportional to the water-surface area covered by oil. In addition, depending on the location of a spill, spills in highly populated areas would be more likely to result in adverse effects than spills in sparsely populated areas. Additionally, animals can be affected outside of a main spill area through oil transported by currents and oiled prey. The exposure to oil needs to be in sufficient quantity to produce adverse effects from external oiling, internal absorption from ingestion of oil and prey, aspiration of oil, inhalation of volatile vapors in the air, and/or a combination of the above. Later in this analysis, we will use surface area estimates associated with different sizes and duration of spills to determine how many animals may be exposed to oil from the proposed activities that will occur in the future.

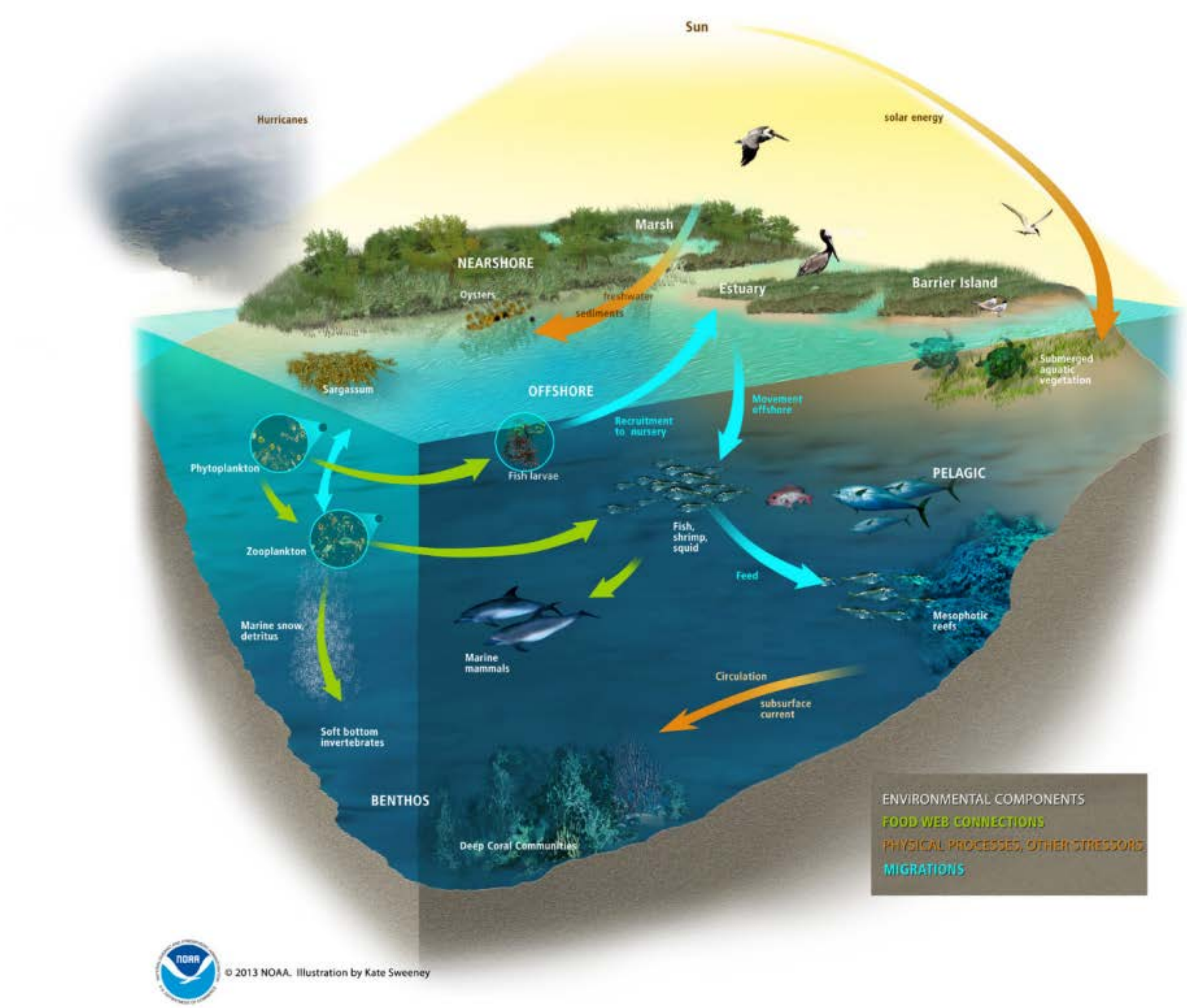


Figure 84. Key biological ecosystem processes, such as food web connections (green arrows), movement of animals from one place to another (blue arrows), and physical processes that influence biological communities (orange arrows). Figure courtesty of Kate Sweeney as published in (Trustees 2016).

Acute exposure could have chronic effects over the long-term, affecting several body systems, such as the immune system, endocrine system, respiratory system, nervous system, sensory systems, and circulatory system. A study of bottlenose dolphin unusual mortality in the area acutely affected by the DWH event showed that clusters of dead dolphins were consistent with the timing and spatial distribution of the DWH oil spill (Venn-Watson et al. 2015).

Reproductive impacts in pregnant whales exposed to oil are of particular concern. The effects of *in utero* exposure to and transfer of PAHs through mothers' milk in marine mammals is largely unknown. In addition, effects on the overall health of pregnant females will influence reproductive outcome. There is the potential for PAHS to be associated with reproductive failure and low birth weight. High levels of bile PAH metabolites were recorded in aborted and premature California sea lion (*Zalophus californianus*) pups opportunistically sampled on rookeries (Goldstein et al. 2009). A study using mink as a model for reproductive success of sea otters showed that oil exposed female mink had reduced reproductive success and kits had poor survival to weaning (Mazet et al. 2001). In addition, once mature, kits born to oil exposed females had significantly reduced reproductive success even though their only exposure was in utero or during nursing (Mazet et al. 2001).

The results of the NRDA process to assess the injuries to sperm whales has been completed, based on dolphin health assessments conducted in contaminated areas (Barataria Bay in 2011 and 2013 and Mississippi Sound in 2013) and an area not exposed to the oil (Sarasota Bay in 2011 and 2013). Findings from the 2011 assessments indicate that bottlenose dolphins in Barataria Bay, which received heavy and prolonged exposure to oil, are showing signs of severe ill health including low body weight, anemia, low serum glucose and/or symptoms of liver and lung disease (Schwacke et al. 2013). Nearly half of the 32 dolphins examined also had abnormally low levels of the hormones that regulate the stress response, metabolism and immune function. Additionally, there was an unusually high number of bottlenose dolphin strandings in the northern Gulf of Mexico during and after the DWH spill with the highest number of strandings coinciding with areas that received the heaviest oiling (Venn-Watson et al. 2015). These effects are also expected to have occurred to other whales exposed to oil, such as sperm whales and Bryde's whales.

There is a large amount of oil and gas development that overlaps with the range and habitats of sea turtles in the Gulf of Mexico. For example, turtle sightings of the two most common species in the Gulf of Mexico, and for which we have the best information (Kemp's ridley's and loggerheads), substantially overlap with active oil and gas leases and pipelines (Figure 85). Thus, there is a high chance that oil spills could affect any species or age class of sea turtle. Spills that occur in offshore waters would be expected to have less chance of affecting adult hardshell sea turtles due to their lower densities in deep water; however, oceanic juveniles, especially those living in *Sargassum,* may have a greater risk of adverse effects in offshore environments than nearshore environments. In any environment, hatchlings and juveniles of hardshell species that occur in the Gulf of Mexico are expected to be more vulnerable to lethal effects of oiling due to their increased time at the surface, feeding habitats near the surface, and smaller size. Direct exposure to heavy crude would likely be lethal when heavy oiling covers the entire body surface. The risk of exposure to heavy crude is relatively lower than lighter oil densities, as the densest, heaviest oil would be restricted to a smaller area near the spill source, due to the small surface area, but the risk could be considerable from larger oil spills. Risk of exposure to lower- density sheens is much greater due to the greater surface area of oil spreading across the surface of the water. Weathered oil may persist in the environment over a much longer period than the spill lasts, and an additional number of turtles could potentially be exposed to oil over the long term in the form of ingestion of tarballs and oiled prey, which could reduce fitness of individuals (Shigenaka and Milton 2003).

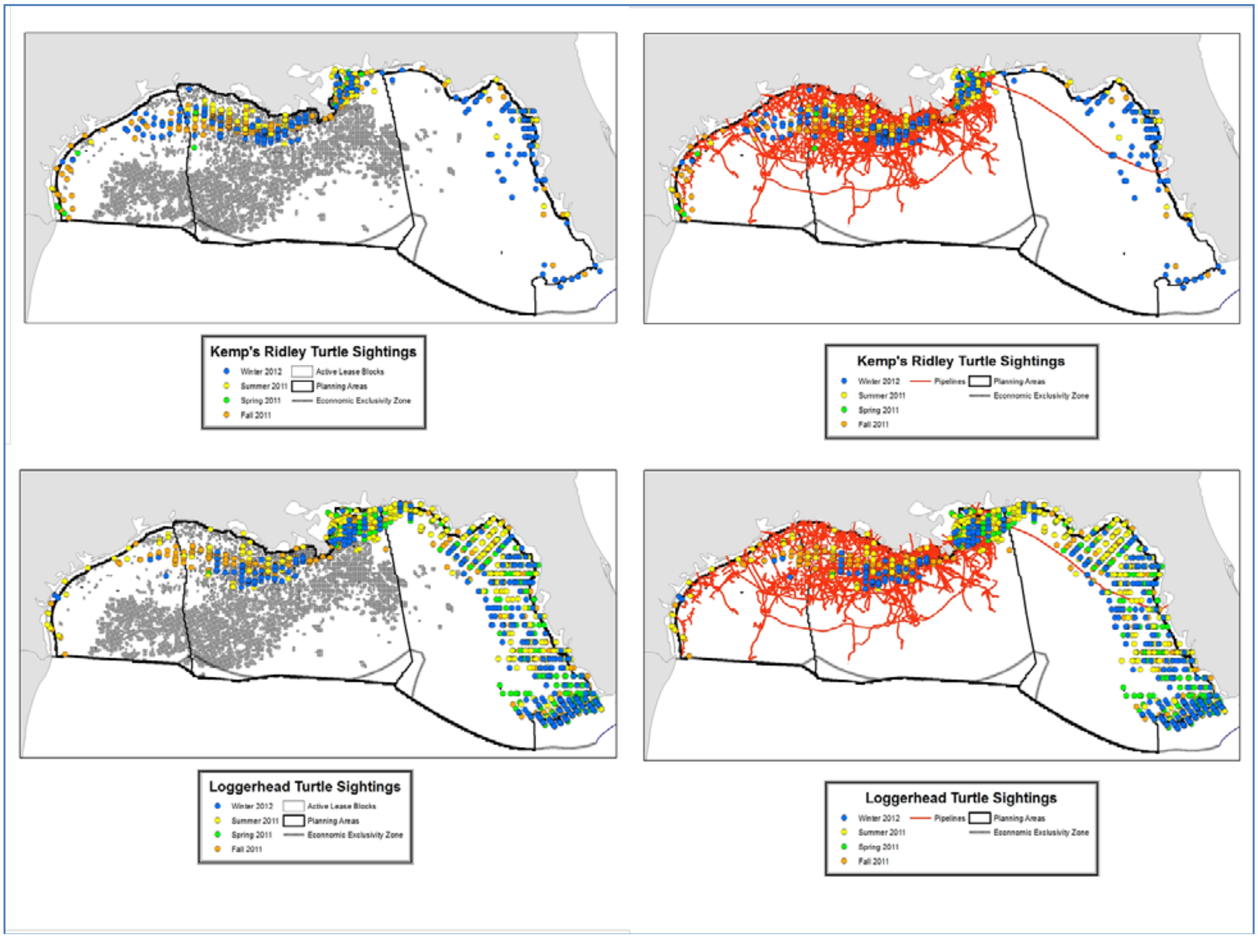


Figure 85. Aerial survey sightings of Kemp's ridley and loggerhead sea turtles in relation to active leases and pipelines in the Gulf of Mexico (Southeast Fisheries Science Center data).

Numerous short-term, minor spills of less than one barrel occur frequently due to the high level of oil and gas development in this region. Spills up to one barrel in size have a very short window of exposure. Such spills usually have an extremely thin sheen and do not last very long due to evaporation, weathering, and dispersion in the water. For small spills, oil typically spreads when it reaches the surface and results in a thin sheen that persists for a short period until it dilutes itself, usually lasting less than a day for most spills. Very small quantities of spilled oil would rapidly spread out, evaporate, and weather, quickly becoming dispersed into the water column where it is biodegraded. Although these small volume spills are expected to be numerous, impacts are only expected for small animals (e.g., zooplankton) over very small areas. The small size and limited duration of very small spills has a relatively low risk of exposing listed species compared to large, longer duration spills. The number of very small spills is large, but it is the size and duration of a spill which have the greatest potential of exposing listed species to oil. The limited exposure periods of listed species to the thin oil layer from minor spills are expected to be insignificant; therefore we will not discuss the effects of minor oil spills further in this document.

It is important to note that the risk of exposure differs between each species based on their distribution, life history, and behavior. Generally, surface-active animals are more susceptible to oiling than benthic animals. We are applying the same risk of oil exposure to sea turtles and whales, and can consider exposure to oil and consequences of those exposures together similarly. Compared to sea turtles and whales, Gulf sturgeon have a much more restricted marine range in nearshore and inshore waters. The distance of sturgeon habitat from federal waters, their seasonal presence between October and April, and their benthic habits make sturgeon less likely to be exposed to oil than either sea turtles or whales. Only spills in larger categories are believed to persist long enough to reach coastal waters where sturgeon are found. Giant manta rays and oceanic whitetip sharks have wider open water ranges, but are expected to be sparse and less common in the action area. Therefore, we will consider Gulf sturgeon, giant manta ray and oceanic whitetip shark separately from sea turtles and whales.

In the following sections, we calculate the exposure of listed species individuals to oil spills that may result from the proposed action. Not all spills have the same potential to expose animals to oil, and the severity of that exposure can depend on the size, location and duration of a spill. As spill volumes increase, the surface area impacted increases, more adverse consequences are expected, and likelihood of exposure proportionately increases as well.

8.8.1.1 Whales

Exposure

Oil development occurs in known areas inhabited by sperm whales and not far from where Bryde's whales are normally observed. Large spills pose an increased likelihood of exposing these whales to oil, dispersants, and dispersed oil. We looked at predicted densities of Bryde's and sperm whales in the Gulf of Mexico overlaid with active oil and gas leases and pipelines (Figure 86) and believe there is a high chance that oil spills could affect these whales.

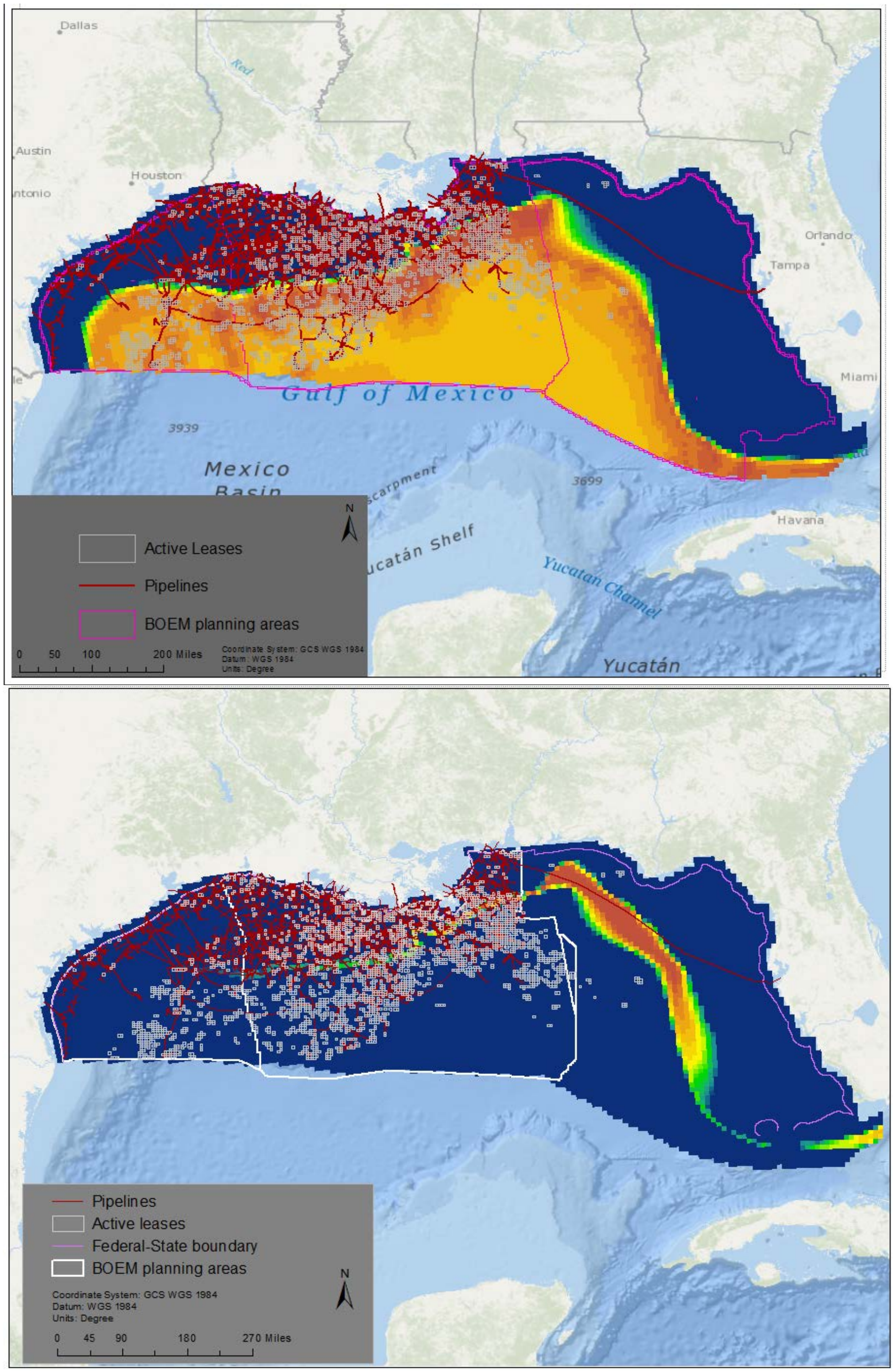


Figure 86. Sperm whale (upper) and Bryde's whale (lower) habitat areas based on habitat modeling using sightings data per Roberts et al. (2016b) in relation to active oil and gas leases and pipelines in the Gulf of Mexico.

A spatial analysis was conducted to estimate oil exposures to ESA-listed whales. We used this analysis to demonstrate, first, using relative probabilities, the possible extent of oil spilled as a result of the proposed action, and second, the consequence levels as determined by total volume, thickness and spread of potential spills as a result of the proposed action. We decided that the spatial analysis was worthwhile because it provides the locational aspect of where spills are most likely to occur according to BOEM's oil spill risk modelling, hence which species would overlap those areas or be most likely to be affected.

For the analysis, we relied on BOEM's projected oil spill risk probabilities shown in Figure 83 to determine the probabilities of exposures to each of the species density layers presented in section 8.1.2. BOEM's oil spill risk probabilities were created as part of an oil spill risk analysis process used during the creation of BOEM's programmatic EIS, which was included as supplemental information to BOEM's BA. BOEM's oil spill risk analysis is similar to the BOEM modeling described above in the introduction of this section where they make predictions of oil making contact with the water surface and/or landfall by modeling scenarios using different launch points and spill size areas.

In our analysis, we conducted a spatial intersection of BOEM's oil spill risk layer with each of the spatial layers on species density to estimate the overall exposure to oil spills in a manner that accounts for the estimated heterogeneity in the spatial distribution of both ESA-listed species and oil spills.

To quantitatively estimate the number of exposures from this spatially explicit approach, for each species we multiplied the number of animals per oil spill risk polygon by the associated spill risk in that polygon (probabilities shown in Figure 83), and summed these across the action area. This spatial analysis provided the estimated number of exposures to oil over the course of the proposed action in a way that accounts for the estimated distribution of oil spills and species (Table 117). We are making an assumption that higher risk areas would be more likely to have the larger sized spills. However, the oil spill probabilities that BOEM provided do not include information on the volume or thickness of the oil encountered, so the severity of those effects is not well characterized. That said, we applied a value of thickness/severity based on the categories described in Trustees (2016).

Table 117. Spatial analysis-estimated number of exposures to oil over the course of the proposed action.

Species	Estimated exposures to oil
Sperm whale	712
Bryde's whale	3.68

Sperm whales and Bryde's whales would be more likely affected by larger spills in higher risk areas although some lower-level exposures are expected for sperm whales. Similarly, we anticipate that sea turtles will also be affected more from larger spills in the areas or polygons where there is higher relative risk.

Similar to impacts as observed and noted by Trustees (2016), we define the following consequence levels related to each spill size category:

- Minor (rainbow sheen)- Minimal oiling expected to result in temporary exposure, with minimal impacts.
- Moderate (metallic sheen)- Light to moderate oiling expected to result in moderate irritation to eyes, skin, respiratory organs, incidental ingestion and contamination of *Sargassum* habitat and benthic habitats.
- High (transitional dark)- Moderate to high amount of oiling leading to sublethal exposures; impacts are expected to reduce the health of exposed animals, but chronic mortality is not expected within five years of exposure. Also could lead to impairment of adult sea turtles, mortality and life-threatening impacts to oceanic juveniles; mortality in exposed vulnerable adults; impairment of feeding, swimming, and mating behaviors in vulnerable animals; high degree of irritation to eyes, ears, and external parts from direct contact and to respiratory structures from inhalation; ingestion of oil likely; areas of *Sargassum* killed; live and dead strandings of sea turtles.
- Severe (dark oil)- Heavy oiling leading to high-exposure impacts resulting in mortality or delayed mortality in majority of exposed animals; large areas of *Sargassum* killed.

The consequence levels we apply here are simplified relative to the multitude of oil types and toxicity levels, but it is a reasonable representation in that we would generally expect larger volumes of spilled oil to represent darker categories and more severe consequence levels (i.e., larger spills result in severe consequences).

Using the identified consequence levels for severity of effects. We would expect that the range of severity would lead to mortalities (at least one for sperm whales), sublethal exposures, and calf losses from the number of exposures in each consequence level, with lesser impacts on the minor end of the consequence spectrum. In addition to a reduction in population numbers due to mortality, we expect sublethal exposures of females to result in an increase in the number of lost calves from high-consequence exposures to oil, and a lower increase in the number of lost calves from moderate-consequence level exposures to oil. Persistent exposure to oil during larger spills is expected to have reproductive consequences on some animals. Since all females do not reproduce in the same year having an inter-calving interval of four to seven years for sperm whales and possibly longer for Bryde's whales, we are assuming reproductive effects may continue for several years and will be most pronounced in the first-born calf following oil exposure. Female sperm whales make up about 72 percent of the Gulf of Mexico population (Engelhaupt et al. 2009); therefore given the severity analysis above, 72 percent of exposed animals in moderate to high exposure levels (about four or five sperm whales) will be subject to reproductive failure (all severe exposure will be lethal).

We expect the responses of Bryde's whales will be similar to sperm whales, but the numbers of exposures of Bryde's whales are fewer. We can expect that it would be an extremely rare event for a spill to occur in a location close enough, and be of great enough magnitude (i.e., not capped quickly enough), with all the necessary environmental conditions (wind, waves, etc.) to cause mortality of Bryde's whales. The spatial analysis resulted in 3.68 Bryde's whale exposures to spilled oil, but we do not know what severity those exposures would be. Based on the spill size category results where the majority of exposures are in the lesser consequence categories, we can reasonably expect that exposures would likely be minor to moderate and the chances of fitness reduction to Bryde's whales are minimal.

The spatial analysis provides a 'snapshot' view of exposures depending on the areas at higher risk for oil contacting the surface waters. The assumptions made in the spatial analysis may not be wholly realistic because of the one time snapshot analysis using a set density per species across the area with an undefined time period, but the assumptions were necessary given the available data. The analysis did account for spatial aspect of a spill occurring in a particular location, and could serve as a worst case scenario for some species depending on the location of an oil spill. The expected mortalities and reproductive effects of each of the populations will result from exposure to the five large spills or two very large spills over the 50 years of the proposed action, with very large spills having the greatest effect on ESA-listed whales and sea turtles. Larger spills depend on many factors including location, timing, volume, and other environmental conditions. The largest spills could cause reduced fitness and mortality for hundreds to thousands of each species of sea turtles, and reduced fitness and one death of a sperm whale.

Response

Oil spills could directly affect ESA-listed whales through various pathways and often animals may be exposed in all pathways at the same time. Exposure pathways include external contact (through the skin and eyes), inhalation, aspiration, and oil ingestion (through oiled prey or accidental oil ingestion). Disruption of other essential behaviors, such as breeding, communication, and feeding may also occur. External contact with oil can cause irritation of the eyes, skin, and mucus membranes. In addition, oil present around a blowhole or in the mouth could lead to aspiration of oil. External contact can potentially transfer into the bloodstream; however, uptake through the skin has been considered unlikely in healthy cetacean skin in high salinity waters due to the tight intercellular bridges and thick epidermis (O'Hara and O'Shea 2001). The effects of long-term skin exposure that could occur during long duration spills have not been determined, however, oil was applied to the skin of a live, stranded sperm whale and skin lesions formed (Trustees 2016). The effects of oil on cetacean eyes have not been determined; however, ringed seals (*Pusa hispida*) showed eye infections and breaking down of the cornea tissue after one day of exposure (Geraci and Smith 1976). Nevalainen et al. (2018) modeled oil spill exposures based on expert elicitation in the Arctic and found medium and heavy oiling to be the most dangerous oil types to seals and seabirds, and the type of oil has a greater effect on impact than does season that the spill occurred.

Crude oil can release volatile vapors, such as benzene, butane, N-hexane, isopentane, and pentane, when it comes into contact with the air. Whales may be at particular risk for inhalation exposure to polycyclic aromatic hydrocarbons (PAHs) within or downwind of a spill due to unique physiological and behavioral characteristics. Whales breathe at the air/water interface, exchange significantly more air and deeper inhalations than humans, and sperm whales have deep inhalations followed by a long breath hold on deep dives. Sperm whales also float at the surface while recovering from deep dives. Because deep breaths increase chemical inhalation injury to tissues deeper within the lungs, whales may be particularly susceptible when they are at the surface to breathe after a dive to exhale “bad” gasses and replenish “good” gasses to prepare for the next dive. Nursing calves spend a significant amount of time at the surface because they do not conduct feeding dives and wait at the surface for their mothers and, thus, may also be particularly susceptible to inhaled PAHs. Benzene is a known carcinogen in many animals and would likely have similar adverse effects on sperm whales. Inhalation of crude oil vapors or smoke from *in situ* burning of oil could irritate or burn the respiratory system, and even small levels of benzene could cause cancers. A recent study found that in Barataria Bay, Louisiana, which experienced heavy and prolonged oiling during the DWH spill in 2010, bottlenose dolphins were five times more likely to have moderate to severe lung disease, which authors suggest may be related to inhalation exposure to PAHs (Schwacke et al. 2013). Lung injuries due to inhalation of PAHs in Bryde’s and sperm whales would severely impact their survivorship since they must hold their breath to feed. The rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh oil and disturbance from response related sound and activity could limit the potential exposure of whales to prolonged inhalation of toxic fumes.

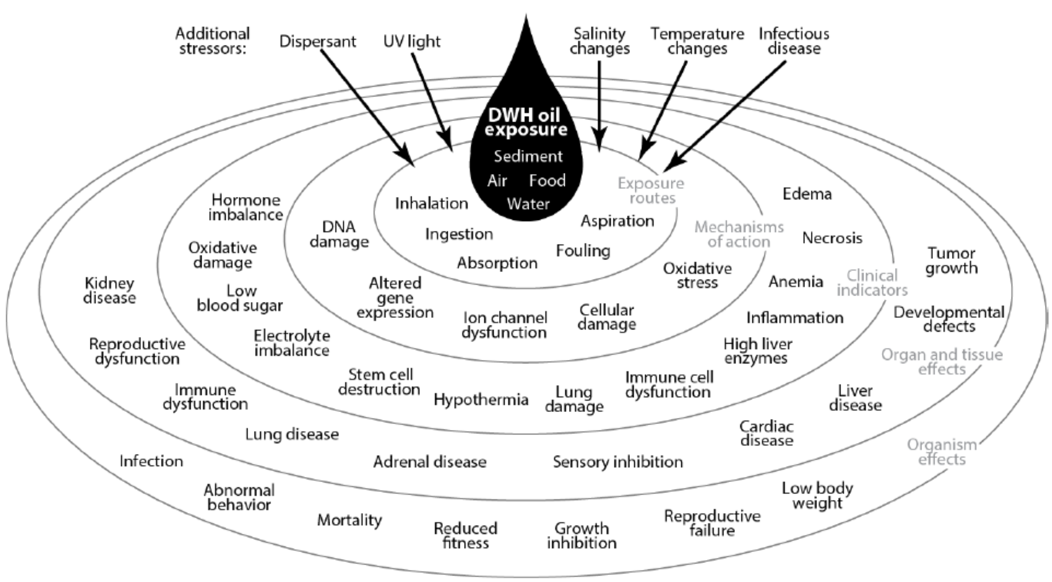


Figure 87. This conceptual model shows the interactions among oil exposure, exposure routes, mechanisms of action, clinical indicators, organ and tissue effects, and organism effects in marine organisms.

Marine mammals are at a risk of oil ingestion due to the spreading of oil in the water and the potential for contact with prey (Figure 87). Bryde's whales may feed and groom at the surface making them much more susceptible to oil ingestion for surface spills than sperm whales that feed at depth and spend a significant amount of time below the surface. A few experimental studies have fed dolphins relatively low doses of oil for three to four months and showed no clinical, hematological, or biochemical alterations (Engelhardt 1983). Whales are unlikely to ingest oil for the majority of the numerous small spills in the Gulf of Mexico, unless the oil is dispersed or spilled at depth in high amounts or is accumulated in ingested prey. Deep sea blowouts or subsurface spills could contaminate prey and the subsurface habitat as oil rises through water column or becomes entrained where prey items are found. Because sperm whales are suction feeders, they are more likely to suck in small oil droplets if oil is dispersed in the water column. Bryde's whales gulp water and then filter out prey from the water with a push through their baleen plates, so ingestion of oil would be dependent on where the oil is relative to prey sources. A concern from these subsurface spills are tarballs or mats of oil that become entrained in the deep scattering layer where whales feed, that could be mistaken as prey items and accidentally ingested. Ulcers, internal bleeding, and other gastrointestinal disorders could result from ingested oil and oiled prey. Systemic PAH exposure could also result from PAH ingestion. Ingestion of oil may result in temporary and permanent damage to whale endocrine function and reproductive system function; and if sufficient amounts of oil are ingested mortality of individuals may also occur.

Applying the expected effects from bottlenose dolphins to sperm whales, Trustees (2016) determined that 16 percent of the Gulf of Mexico population or about 262 whales were exposed to DWH oil. Thirty-five percent of those whales (or approximately 92 whales) were likely killed. In total, six percent of the Gulf of Mexico sperm whale population was killed. The initial exposure likely resulted in whale deaths later in time due to adrenal and lung disease as was observed in bottlenose dolphins. In addition to the sperm whale deaths, an estimated percent of exposed females that survived suffered reproductive failure through aborted fetuses or early calf death. Thirty-seven percent of all exposed sperm whales, including pregnant females, likely suffered adverse health consequences as a result of DWH oil exposure (Trustees 2016). A multi-year passive acoustic data project studied the impact of DWH on sperm whale presence in the DWH spill area (Ackleh et al. 2012). Prior to the spill (in 2007) the Littoral Acoustic Demonstration Center (LADC) collected baseline acoustic recordings near the spill site in 2007. These baseline data provide a unique opportunity to compare sperm whale activity in the area before and after the DWH spill event. In September 2010, LADC redeployed recording buoys at locations nine, 25, and 50 miles away from the incident site. A comparison of the 2007 and the 2010 recordings show a decrease in acoustic activity and abundance of sperm whales at the nine-mile site by a factor of two, whereas acoustic activity and abundance at the 25-mile site had clearly increased. This study showed that sperm whales were displaced away from the spill site.

The area of oil and gas development directly overlaps high-use habitats for sperm whales associated with concentration of prey resources. Sperm whales are deep divers and generally forage over large areas so that the magnitude of oil exposure would depend, in part, on the location of the spill, the composition of the spilled material, and the movement and fate of the spilled hydrocarbons/wastes in the offshore environment. The primary prey of sperm whales and other deep-diving marine mammals is deepwater squids that occupy water depths between 400-600 m. High levels of subsurface oil would have direct impacts on the prey community that could either lower the foraging success of whales, or cause the whales to move out of an area to a lesser quality foraging patch. A distribution shift may have impacts on survival and productivity of the populations. A worst case spill in deepwater can result in prolonged and/or repeated exposures of sperm whales to oil and dispersed oil, as well as to response activities. It is conceivable that similar effects could result to sperm whales that have been observed in other odontocetes that were more heavily studied (e.g., Barataria Bay dolphins). Disastrous blowouts and subsequent high pressure spills in deepwater areas with high concentrations of sperm whales could have adverse consequences on exposed animals. Because of the matriarchal social structure of sperm whales (Whitehead and Mesnick 2003) in the Gulf of Mexico, an oil spill could have adverse consequences on entire matriarchal groups of whales, including related females, calves, and juvenile whales. In addition, research has shown that female sperm whales and their calves are resident, while males leave the area, so females may be even more susceptible to negative effects from oil spills in their home range.

The effects of exposure generally described above and detailed for sperm whales would be the same for Bryde's whales with the exception of foraging ecology differences. Whereas sperm whales dive deep and their prey could be directly affected by deepwater blowouts, Bryde's whale may feed on the surface or dive into deeper water to feed on their preferred prey source. Gulf of Mexico Bryde's whales may feed on fish or small crustaceans, either of which can be exposed to oil or dispersants in the water column (Trustees 2016). Oil dispersed in the water column or oil at the surface could affect Bryde's whale prey, depending on the timing, location, magnitude, and duration of the spill. Surface feeding whales could ingest surface and near surface oil fractions with their prey, which may also be contaminated with oil components. Incidental ingestion of oil factions that may be incorporated into benthic sediments can also occur during near-bottom feeding. To the extent that ingestion of crude oil affects the weight or condition of the mother, the dependent young could also be affected. Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to accumulate high levels of fat to survive their environment.

The DWH spill exposed an estimated 48 percent (95 percent CI 23-100) and killed an estimated 17 percent (95 percent CI 7-24) of the existing Bryde's whale population (Trustees 2016). "The Trustees have determined that the majority of cetacean stocks within the DWH oil spill footprint were injured by some combination of increased mortality, increased reproductive failure, and/or adverse health effects, leading to reduced populations that will take decades to recover naturally." Studies have shown that while marine mammals may show irritation, annoyance, or distress from oil, for the most part, an animal's need to remain in an area for food, shelter, or other biological requirements overrides any avoidance behaviors to oil (McCay et al. 2004; Varoujean et al. 1983). DWH was located in a heavily active area of oil and gas activity in the CPA, therefore oil from another large spill in that area or on an active lease farther east could reach into the area where Bryde's whales are known to live and so the risk to Bryde's whales effects from oil spills is not discountable. However, we expect the consequences of those effects to be less than those that occurred after DWH because BOEM indicated the expectation that response to and capping of spilled oil will more efficiently occur in the future due to improved infrastructure and regulation in the Gulf of Mexico following DWH.

8.8.1.2 Sea Turtles

Exposure

For our exposure analysis for sea turtles we conducted the same spatial analysis as described for whales. Each of the five species, and the hardshell category, were estimated in Table 118.

Table 118. Spatial analysis-estimated number of sea turtles exposed to oil from the proposed action.

Species	Estimated exposures to oil
Kemp's ridley sea turtle*	484,562
Loggerhead sea turtle	334,841
Green sea turtle*	90,297
Leatherback sea turtle	9,015
Hawksbill sea turtle*	150,649
Hardshell sea turtle	5,665

**May be underestimated due to some areas with unavailable information, however inclusion of the hardshell category likely makes up for majority of this underestimation (see section 8.1.2.2).*

We expect the majority of these exposures to have minor to moderate effects and fewer animals to be more severely affected. With Kemp's ridley being the most vulnerable species due to their restricted range and the highest chance of exposures, and per the spill size analysis, we expect that few exposures will be of high or severe consequence that would result in eventual mortaility. The lesser consequential exposures may have some sublethal or fitness effects on individuals depending on the frequency, duration and individual body condition. Some individuals may be affected more than once and multiple exposures would be more detrimental to an individual. Same as whales, we would expect larger spills to have more severe consequences to individual sea turtles.

Response

Based on the exposure analysis, over the period of the proposed action, a large number of sea turtles could be exposed to various levels of oil. Most of the exposures would have minor or moderate effects from numerous small spills, but several thousand turtles could experience severe effects from the larger oil spills that are predicted. Kemp's ridleys, loggerheads, and greens would make up the majority of exposed species since they are more prevalent and occur in higher numbers in the Gulf of Mexico, compared to hawksbills and leatherbacks.

Spills originating in or spreading through coastal waters may impact any of the five sea turtle species inhabiting the Gulf of Mexico. Spilled oil could affect any life history stage or age class of sea turtles (Vargo et al. 1986). Sea turtle populations are most vulnerable when aggregating, which peaks around nesting and hatching or foraging in convergence zones (Shigenaka and Milton 2003). Effects from oil spills on sea turtles may be lethal or nonlethal, ranging from changes in biologically important behaviors to physiological injury and mortality. During DWH, approximately 1,800 turtles were directly observed within the footprint of the spill, 574 were documented by direct capture and it is estimated that 402,000 oceanic juveniles and 58,000 benthic juveniles and adults were likely exposed (Trustees 2016). Of the large numbers of animals that were exposed to oil, it is estimated that 35,000 hatchlings, 56,000 to 159,000 small oceanic turtles, and 4,900 to 7,600 benthic juveniles and adults were killed as a result of DWH (Trustees 2016). Excluding the DWH spill, it was previously estimated that approximately one percent of annual sea turtle strandings are associated with oil, with higher percentages from South Florida (three percent) and Texas (three to six percent) (Lutcavage et al. 1997a). Some potential pathways of oil effects on sea turtle life stages are shown in Figure 88. Studies using weathered oil and tests indicative of relative health have shown juvenile loggerhead sea turtles being highly sensitive to short exposure periods with oil (Lutcavage et al. 1997a).

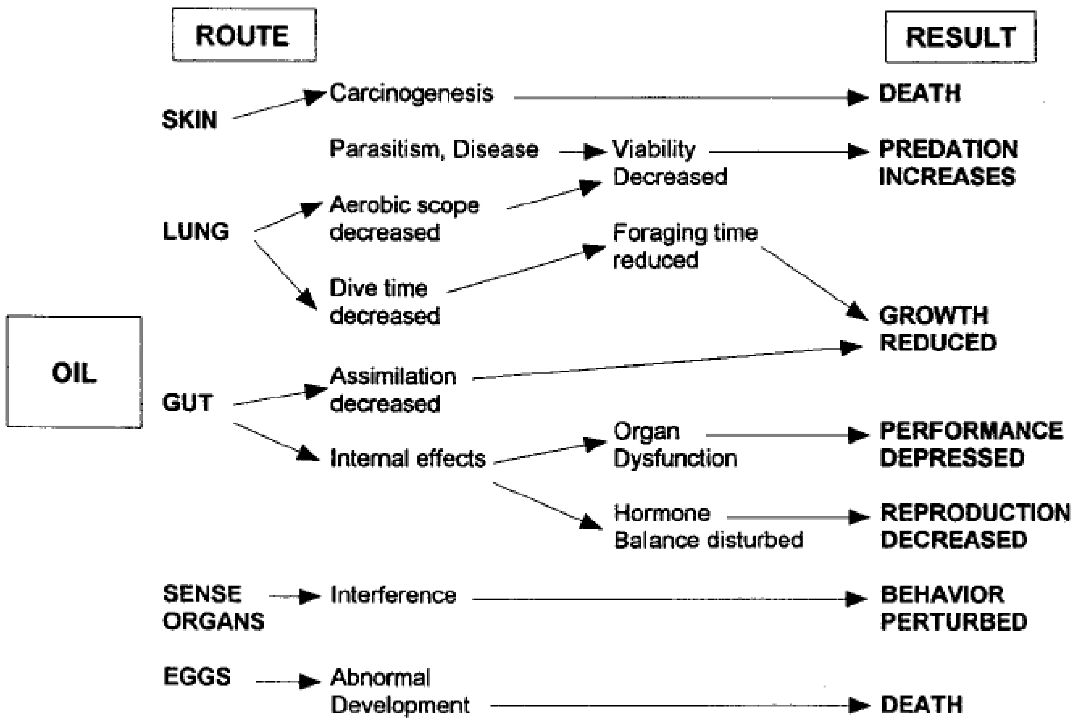


Figure 88. Different ways sea turtles may be affected by prolonged exposure to oil. Figure from Lutcavage et al. (1997a).

Direct contact of oil with sea turtles would continue to occur as long as the slick persists, and physiological effects could continue for long periods once the slick dissipates. Direct oiling could impair swimming and block breathing passages. Oiling can cause thermal stress by acting as an insulator that interferes with thermoregulation. Basking turtles would heat much faster and to a higher temperature in oil and could rapidly overheat. Sea turtles rapidly inhale a large volume of air, immediately at the air-water interface where hydrocarbon vapors and aerosolized oil concentrations would be the highest, before submerging. Repeated surfacing would result in repeated exposure to volatile hydrocarbon vapors and oil compounding the risk of lung injury and other adverse physiological effects (Shigenaka and Milton 2003). Any of these mechanisms – impaired swimming, blocked airways, overheating, or physical or chemical damage to lung tissues— could, if severe enough, result in mortality. Sublethal, physiological injury is more likely with larger turtles and lower degrees of oil exposure and could impair a turtle's overall fitness so that it is less able to withstand other stressors; however, the long-term effects of oil exposure on reproduction and health are relatively unknown. Lutcavage et al. (1997) provided qualitative evidence that oil exposure disrupted lachrymal gland (salt gland) function, in which the glands physiologically did not function for several days. Their experiments on physiological and clinicopathological effects of oil on loggerhead sea turtles showed that the turtles' major physiological systems are adversely affected by both chronic exposure (96-hour exposure to a

0.05 centimeter layer of South Louisiana crude oil) and acute exposures (0.5 centimter of oil for 48 hours). The skin of the exposed turtles, particularly the soft pliable areas of the neck and flippers, sloughed off in layers for up to two weeks, with recovery taking up to three weeks. Oil was also detected in the nares, eyes, upper esophagus, and feces, indicating that turtles were ingesting oil, though apparently not enough to cause intestinal bleeding and anemia. Internal effects of oil exposure also include significant changes in blood and blood chemistry. Hematocrits (red blood cell volume) decreased nearly 50 percent in oiled turtles and did not increase again during the recovery period. Immune responses were indicated by significant increases in white blood cells lasting more than a week in sea turtles exposed to oil. Although these effects may be sublethal in the near term, they could compromise a turtle sufficiently in the long-term to contribute to its ultimate death through predation, disease, or inability to forage. In addition, there are also certain volatile hydrocarbons called volatile organic compounds (VOCs) which can cause cancer and neurologic and reproductive harm in aquatic organisms (USGS 1997). Oil could impact both surface and benthic foraging habitats, oiling both the prey and habitats where prey could be located. Surface oil could aggregate along convergence areas where turtles spend prolonged periods feeding. Dispersed oil would contaminate benthic areas, and weathered oil that has consolidated with sediments and vegetation would sink and contaminate benthic environments where older turtles forage. Sea turtles could become oiled in these affected habitats and ingest contaminated prey. Larger volume spills could impact the entire foraging range of an individual.

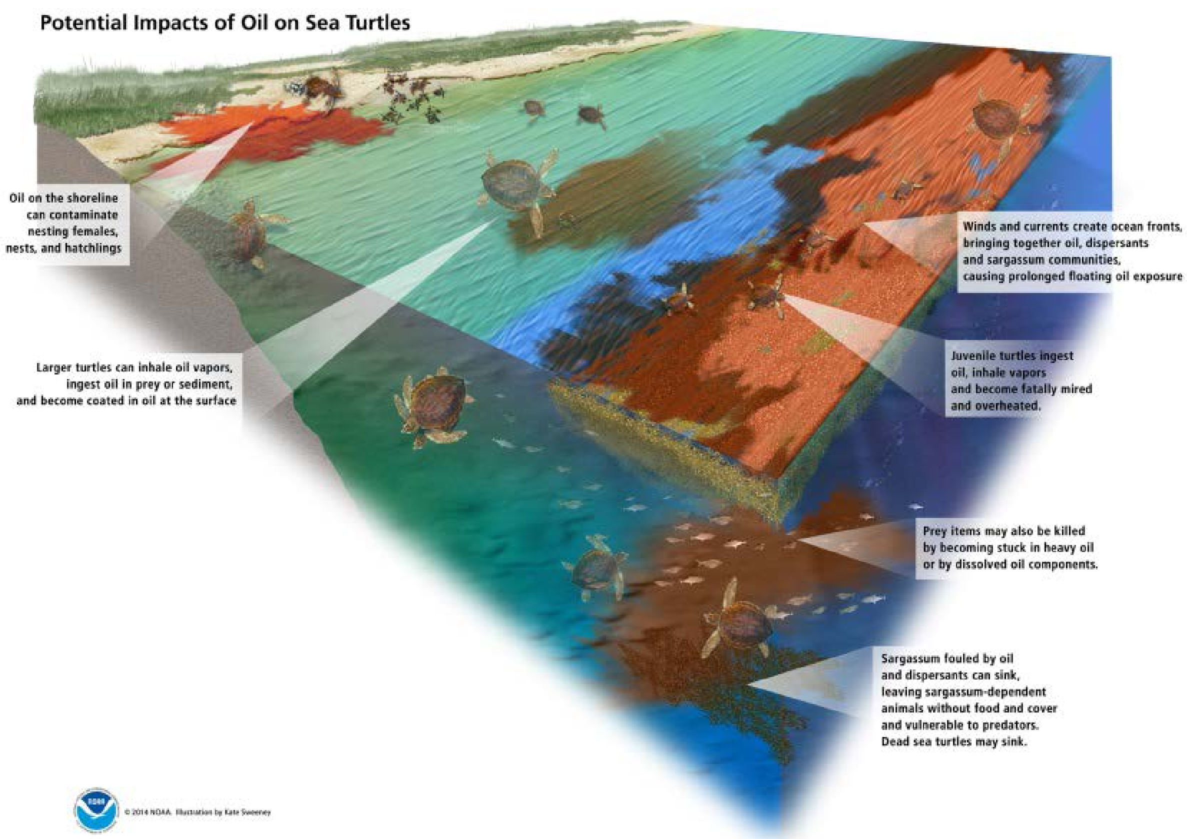


Figure 89. Potential impacts of Deep Water Horizon oil on sea turtles in the northern Gulf of Mexico. Text boxes highlight specific details about potential exposure pathways and adverse effects to turtles in their different critical marine and terrestrial habitats (Image Kate Sweeney for NOAA and included in Trustees (2016).

Even if a sea turtle were not directly exposed to a slick, hydrocarbons can persist in marine environments for decades or longer. Tarballs are a byproduct of accidentally spilled oil, normal and accepted ship operations (e.g., bilge tank flushing), illegal discharges from tank washings, and natural oil seeps on the sea floor. They are found in every ocean and on every beach; oceanographic features such as convergence zones and Langmuir cells can aggregate even widely dispersed tarballs into an area where sea turtles concentrate. Turtles indiscriminately eat anything that registers as being an appropriate size for food (Lutz and Lutcavage 1989), including tarballs and other materials. Non-food items ingested by sea turtles do not pass rapidly through its digestive tract and may be retained there for at least several days as they are being absorbed, metabolized, stored, or excreted (Valente et al. 2008). Protracted retention increases internal contact and the likelihood that toxic compounds will be absorbed. The risk of gut impaction also increases for turtles that have ingested oil. Tarballs ingested by any age class of sea turtle are likely to have a variety of effects, including starvation from gut blockage, decreased absorption efficiency, absorption of toxins, effects of general intestinal blockage (such as local necrosis or ulceration), interference with fat metabolism, and buoyancy problems caused by the buildup of fermentation gases (floating prevents turtles from feeding and increases their vulnerability to predators and boats), among others.

Sargassum, seagrass, and other oceanic juvenile habitats impacted by oil can impair or kill subadult sea turtles that depend on those habitats for shelter and food. *Sargassum* is the principal feature that defines habitat for hatchlings and oceanic juvenile sea turtles in the Gulf of Mexico. Oceanic juveniles aggregate in these *Sargassum* habitats both over the continental shelf and in deeper oceanic waters. Oceanic juveniles of four out of five sea turtles species found in the Gulf of Mexico have been found in floating *Sargassum*. *Sargassum* habitat supports abundant prey and provides cover that otherwise would not be available to oceanic stage sea turtles. The diet, high-affinity, and shallow dive behaviors reported for oceanic juveniles associated with *Sargassum* habitat show that *Sargassum* is extremely important for young sea turtles (Witherington et al. 2012b). Because oceanic juveniles have a high affinity for that habitat, *Sargassum* oiled during spills is likely to continue exposing sea turtles to many routes of exposure including external oiling, inhalation of harmful vapors, and ingestion of oiled prey. In addition to hydrocarbons, oil also contains traces of heavy metals such as mercury, arsenic, and lead that could be ingested. Removal of large numbers of individual clumps, patches, or lines of *Sargassum* would force animals to seek another habitat area to feed and shelter. Turtles having to seek alternative refuge could be susceptible to increased predation and energetic cost of searching for a new habitat. Hatchlings sticky with oil residue may have a more difficult time swimming and diving, rendering them more vulnerable to predation and interfering with successful feeding.

Oceanic juveniles that contact oil may exhibit a range of effects, from acute toxicity to impaired movement and normal bodily functions. There may be a large energetic cost since turtles may be unable to find adequate prey while seeking new habitat, as well as the increased cost of energy of moving through oiled waters or with oiled body surfaces. Oil spills that reach nearshore waters could impact benthic-stage juveniles and adults that spend considerably more time on the bottom foraging and resting. Oil remaining on the surface can oil sea turtles, but probably to a lesser extent than oil found near the source of a spill since the oil has dispersed and/or become weathered by the time it reaches nearshore areas. Weathered or dispersed oil may be present in the water column or sink to the bottom where it can interact with sea turtles or contaminate their prey.

There may also be indirect effects of oil on sea turtles, such as those from reduced prey availability or damage to nostrils and olfactory sensory organs. For a reduced prey example, a 1986 oil spill off Panama resulted in the destruction of seagrass and other invertebrates that sea turtles eat (Shigenaka and Milton 2003). The sense of smell plays an important role in navigation and orientation. Olfactory masking may not harm a turtle, but impairment of orientation for individuals could be as severe or worse to a population as direct effects (Shigenaka and Milton 2003).

Oil spill response activities are another consideration for effects. Dispersants are made with chemical surfactants that can interfere with lung, digestive, respiratory or salt-gland function (Shigenaka and Milton 2003). Shigenaka and Milton (2003) also noted that for in-situ burning, sea turtles could have impaired lung function from inhalation of smoke, gases and particulates in the air near the burning site or could ingest tar residues (unburned oil) left behind, if not removed properly.

8.8.1.3 Gulf Sturgeon

Exposure

To estimate the number and severity of exposure of Gulf sturgeon, we took a more qualitative approach. The routes of exposure for sturgeon primarily come from contact with dissolved oil in the water column, sunken oil, and oil that could remain in the sediments. Sturgeon are not expected to be exposed to surface oil, but could be exposed to dispersed oil, weathered oil, or oil mixed in to the water column by wave action. Very small and moderately-sized spills are not expected to have a long duration and would have minimum exposure periods for sturgeon. The risk of sturgeon exposure is dependent on the size, location and season that a spill occurs in the CPA or EPA.

The Gulf sturgeon is an anadromous fish; adults spawn in freshwater then migrate to feed and grow in estuarine/marine habitats, so exposure to fresher oil[65] is highly dependent on the time of year oil is present. Persistent oil may remain in Gulf sturgeon habitat after a spill that sturgeon may contact upon returning to their winter marine habitat. Based on the life history of this species, adult sturgeon would be most vulnerable to an oil spill, and would only be vulnerable during winter months (between October and April) when adults of this species are foraging in estuarine and marine habitats. We would not expect any eggs or young fish to be exposed to oil from the proposed action because we do not expect oil to reach upper freshwater inhabited areas. For this estimate, based on BOEM's probabilities shown in Figure 83, we will assume that that the largest predicted spill will impact nearshore marine habitat of adult sturgeon within 30 days.

BOEM estimates about zero to eight percent chance (depending on location) of an oil spill's contacting Gulf sturgeon marine habitat within 10 and 30 days based on a spill size of greater than 1,000 bbl (Figure 83, above). The chances of contact will be greater for a much larger spill. Assuming a larger spill occuring east of the Mississippi could contact Gulf sturgeon marine habitat (Figure 90), we used the approach described below to estimate exposure numbers.

[65] Fresher oil here means not yet weathered of its most toxic chemicals.

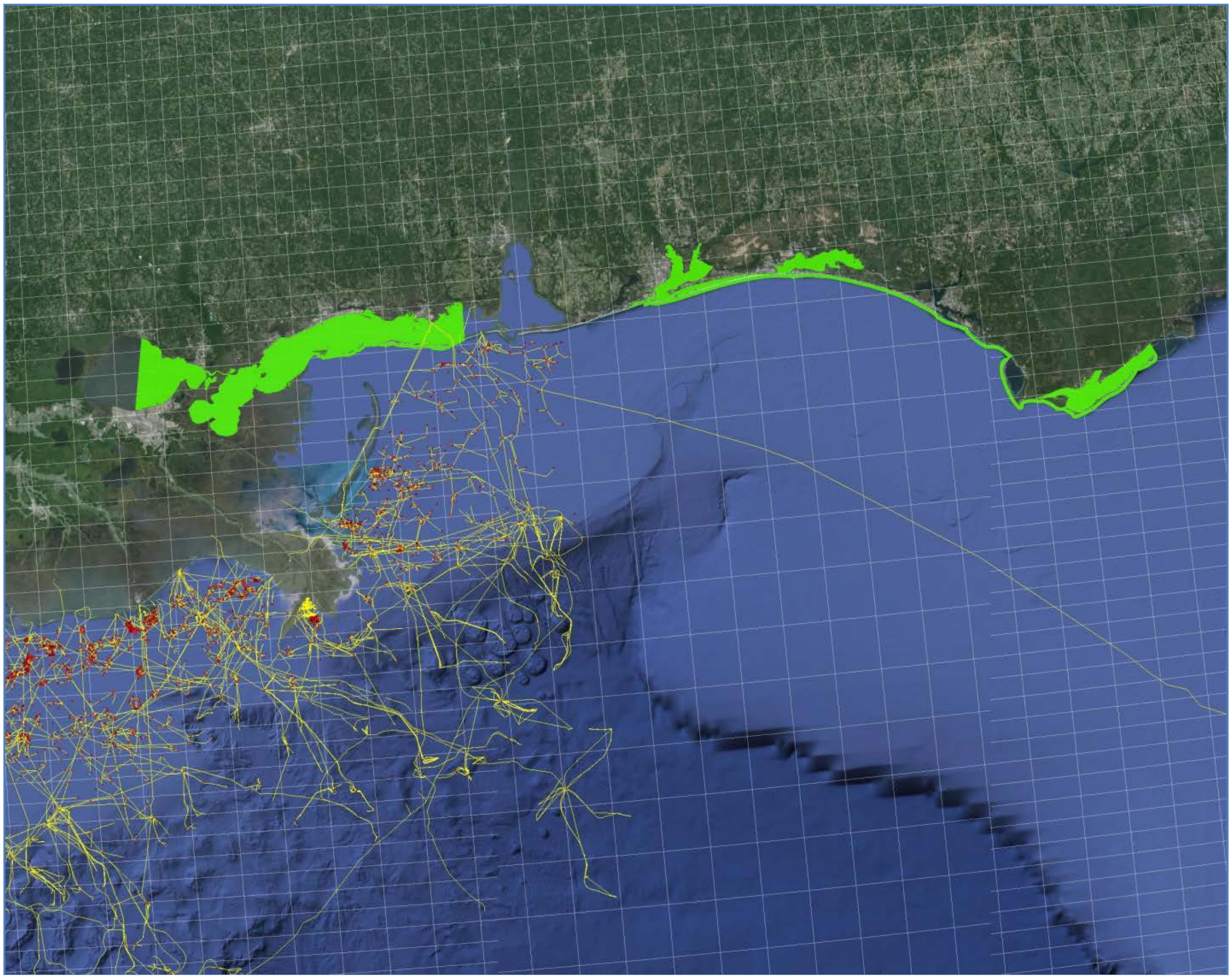


Figure 90. Location of Gulf sturgeon critical habitat (green) in relation to oil and gas platforms (red) and pipelines (yellow). Google Earth© (2013, 2014).

Based on the extent of the oiling area of shallow unvegetated habitats during DWH (Trustees 2016), many animals from river populations in Louisiana, Mississippi, and Alabama were exposed to DWH oil. The DWH damage assessment concluded that approximately 63 percent or between 1,100-3,600 of Gulf sturgeon from the Pearl, Pascagoula, Escambia, Blackwater, Yellow, and Choctawhatchee river populations were exposed to oil from the DWH spill (FWS 2015; Trustees 2016). The Mississippi Canyon area where DWH occurred is a highly active oil and gas producing region, therefore we could assume another spill could happen in a similar location east of the Mississippi River outlet. A shorter duration spill is anticipated under the proposed action that is approximately one third the duration of DWH (30 days compared to 87 days) with one third of the volume of oil that could be spilled. A commensurately smaller area is expected to be affected than occurred during the DWH spill. Therefore, using the DWH exposure estimate of 1,100-3,600 individuals, we estimate that one third of that number or up to 1,200 individuals (367-1,200 fish) will be exposed by spilled oil under the proposed action. Note that these individuals could also be exposed by other multiple moderately sized accidental spills under the proposed action in similar locations with shorter duration. However, we are using a very large oil spill scenario to analyze for Gulf sturgeon impacts as a worst-case scenario.

We are not expecting severe oiling and direct mortality of Gulf sturgeon since sturgeon do not occur directly within oil and gas leasing areas. Still, we expect that up to 1,200 Gulf sturgeon will be adversely affected primarily through ingestion of contaminated prey or incidental ingestion of oil, resulting in genotoxicity and immunosuppression, and that such effects would result in a reduction in fitness of exposed individuals.

Response

The effects of oil on Gulf sturgeon include genotoxicity (fractured DNA) and imunosuppression which can lead to malignancies, cell death, susceptibility to disease, infections, and a decreased ability to heal (FWS 2015).

Fish can be exposed to dispersants and oil droplets through a variety of pathways, including direct dermal contact and inhalation, as well as indirectly, through ingestion of contaminated prey (Cohen et al. 2014; Fingas 2008). The risk of exposure of Gulf sturgeon to oil spills would be dependent upon the species' presence in the affected area, as well as the size and persistence of an oil spill. There are no BOEM-permitted oil and gas structures in Gulf sturgeon critical habitat because critical habitat is found exclusively in state waters (Figure 38); however, oil spills transported by wind and currents could contact other marine areas where Gulf sturgeon are present and foraging.

Routes of exposure include ingestion of oil or oiled prey, uptake through the gills, and direct exposure through weathered oil, mats, or tarballs settling back to the sea floor in nearshore waters. Although sturgeon were not directly present in the DWH spill area when oil was actively being released, the effects of post-release oil exposure on Gulf sturgeon included genotoxicity (fractured DNA) and imunosuppression which can lead to malignancies, cell death, susceptibility to disease, infections, and a decreased ability to heal (USFWS 2015). Direct oiling of the body surface could occur if a spill takes place during winter months when adults are present in the marine waters of the Gulf of Mexico. Crude oil from the DWH spill has been shown to have caused developmental abnormalities and defective hearts in young bluefin and yellowfin tunas that resulted in early mortality of young **(Incardona et al. 2014b)** that were present during the active release of oil from DWH. Gulf killifish exposed to different sediment concentrations of PAHs in concentrations of about 38 ppm were sufficient to cause DNA damage, decreased heart rates, and decreased hatching success of developing eggs (Pilcher et al. 2014). These studies show that young fish are more sensitive to oil exposure than adults; widespread impacts on younger life stages can have population effects. Exposure to hydrocarbons has been linked to malformations, genetic damage, mortality, decreased size, inhibited swimming, skin and fin lesions in numerous species of fish (Carls et al. 1999; Collier et al. 2013; Hargis et al. 1984; Murawski et al. 2014). Adult fish can also be adversely affected by stress associated with the detoxification of PAHs in the body (Crowe et al. 2014).

Dispersant exposure can directly affect sturgeon and other fish by damaging their gills during respiration. Corexit exposure caused hemorrhaging of the gills ("separation and rupture of the secondary branchial lamellae") and direct mortality in capelin (Mallotus villosus) (Khan and Payne 2005). While this study emphasized the impact of dispersants on pelagic species that were directly exposed to dispersant applications in the water column, it also confirmed that the dispersant-oil mix may be more toxic to aquatic species than either crude oil or dispersants alone as it increased the amount of oil in the water column, and thus the availability of polycyclic aromatic hydrocarbon (PAH) toxins to fish (George-Ares and Clark 2000; Ramachandran 2005; Schein A. et al. 2009).

About 2,800 mature Gulf sturgeon are estimated in the Choctawhatchee River population (Alabama-Florida), and about 224-376 are estimated in each of the Pearl, Pascagoula and Escambia Rivers; and Yellow, and Apalachicola river populations are estimated at about 1,036 and 1,288 individuals, respectively (Table 31). Depending on the locations of the affected areas one or more of these populations could come into contact with mixed or submerged oil. Based on variable environmental conditions, sunken oil would generally be expected to scatter in deeper passes and offshore of beaches where sturgeon are found foraging in marine habitats. Diluted oil would be available for the duration of the spill, and sunken oil would persist for longer periods of time. It is likely some sturgeon would come into nonlethal contact with oil, and a few would be exposed to or ingest oil in amounts that could impair the future reproductive success of the animals. The amount of exposure would be dependent on the amount of Gulf sturgeon winter habitat affected by oil.

The most likely route of exposure for all the populations would be ingestion of contaminated prey and incidental oil ingestion, followed by physical contact while foraging or resting, and uptake of dissolved oil through the gills. Because Gulf sturgeon are found close to shore, exposure to any oil from OCS spills would likely be from oil that is days old that was transported from offshore. Oil becomes more dispersed with time and the weathering and consolidation of oil with sediments and other materials causes the properties of the oil to change and become less adhesive to body surfaces. Although contact with oil is still possible, we do not expect a high level of direct oiling as we do with species with larger offshore distributions and surface habits. Oil from OCS sources would have to be transported to nearshore waters by wind and currents. Oil reaching nearshore environments will be submerged and diluted oil in contrast to offshore areas that will be exposed to fresher and thicker oil. Still, a spill occurrence closer to shore could have the potential to oil sturgeon to the extent to cause heavy oiling and fouling of gills that could kill some individuals.

8.8.1.4 Oceanic Whitetip Shark and Giant Manta Ray

Oceanic whitetip sharks and giant manta rays are likely to encounter oil if it is the water column in the area that they are feeding or if an individual happens to break the surface under a slick.

While the densities of these two species are unknown, they are both generally thought to be uncommonly encountered in the Gulf of Mexico.

We expect similar effects of oil on oceanic whitetip sharks and giant manta rays because they are both elasmobranchs with similar physiology and are expected to be widely dispersed, if present, in the action area. These species are free-swimming, often in deeper, pelagic waters and may aspirate oil dispersed in the water column through their gill filaments. They could ingest oil in contaminated prey either by filter feeding for giant manta rays or ingesting upper food chain prey such as fish and squid for oceanic whitetip sharks. Oil could contact the skin beneath the water surface or should these animals breach the surface. Oil and dispersants could affect prey availability for oceanic whitetip sharks and giant manta rays. Those effects would be dependent on timing, size and location of the spill proximity to the prey.

Oceanic whitetip sharks are a highly migratory species that had higher historical catch rates, however it is thought that their numbers have greatly declined in the Gulf of Mexico and that occurrences are much more rare now than historically. Their highest abundance is in the deep central waters of the Gulf of Mexico where the more recent pelagic longline fisheries have reported fewer encounters (Young et al. 2016).(Young et al. 2016) The likelihood of any particular individual being in the area of a spill large enough to have oil remaining in the water column is very small, but some individuals found in the footprint of such a spill would likely be affected. Some small number of oceanic whitetip sharks are likely to be exposed to oil, and those exposures would likely result in effects similar to other marine species such as those displayed in Figure 87, including fitness reduction and possibly leading to mortality. Because there are no abundance estimates for oceanic whitetip sharks in the Gulf of Mexico, we are not able to quantify an estimated number of oil spill exposures or mortalities for this species. Giant manta rays are found at FGBNMS as well as occasionally in shallower waters. They are also thought to be more pelagic or open-ocean than the smaller species of manta ray, which is not known to exist in the Gulf of Mexico. There are no known breeding aggregations in the Gulf of Mexico and when evaluating general encounter data from scientists that are searching specifically for this species, individuals are thought to be relatively sparse (pers. Comm. K. Hull, Mote Marine Laboratory, October 6, 2017). The likelihood of an individual being in the area of an oil spill is small and only those individuals found in the footprint of an oil spill would be affected. A small number of giant manta rays are likely to be exposed to oil, and those exposures would likely result in effects similar to other marine species such as those displayed in Figure 87, including fitness reduction and possibly leading to mortality. Because there are no abundance estimates for giant manta rays for the Gulf of Mexico beyond the 70 individuals documented at FGBNMS, we are not able to quantify an estimated number of oil spill exposures or mortalities for this species.

8.8.1.5 Summary of the Effects of Oil Spills

According to our analyses above, we conclude that oil spills are likely to adversely affect sperm whales, Bryde's whales, sea turtles (Green [North and South Atlantic DPSs], Kemp's ridley, hawksbill, leatherback, and loggerhead [Northwest Atlantic Ocean DPS] sea turtles), oceanic whitetip sharks, giant manta rays, and Gulf sturgeon.

Table 119. Estimated number of exposures from oil spills expected over 50 years of the proposed action.

Species	Oil spill exposures
Sperm whale	712
Bryde's whale	3.68
Kemp's ridley	484,562
Loggerhead	334,841
Green	90,297
Leatherback	9,015
Hawksbill	150,649
Hardshell	5,665
Gulf sturgeon	1,200
Oceanic whitetip shark	TBD*
Giant manta ray	TBD*

**To be determined because we do not currently have abundance estimates for these two species.*

8.8.1.6 Effects of Oil Spill Response Planning and Implementation in Avoiding or Minimizing Adverse Effects to Listed Species

Oil spill response is generally seen as having overall beneficial effects in that it removes oil and thus lessen the effects discussed above. However, there are several aspects of response that introduce novel stressors. Oil spill response plans (OSRPs) are an important planning tool to enable a quick and effective response once oil spills occur. BSEE's preparedness standard operating procedure can be found at https://www.bsee.gov/sites/bsee.gov/files/bsee-sop-approved-2017-edition.pdf. We expect some response activities to have positive effects, but they can also introduce negative effects (as we discuss below). Given that both are expected, and the complicated nature and lack of information on effects, we are unable to quantify this so we provide an overall discussion of potential impacts based on the best available information. Our exposure analysis is assumed to include all animals that would be affected by oil spills directly and/or by response activities.

Oil recovered, chemically dispersed, or burned off would vary, but planning for such responses is intended to ensure that adequate equipment and resources are available to be quickly deployed in the event a very large spill occurs. In the case of the DWH event, the Oil Budget Calculator Science and Engineering Team of the Federal Interagency Solutions Group (Group 2010), estimated that more than one quarter (29 percent) of the oil released was naturally or chemically dispersed into Gulf waters. Meanwhile burning, skimming, and direct recovery from the wellhead removed one quarter (25 percent) of the oil released. Approximately 17 percent of the recovered oil was directly recovered from the wellhead and likely had no contact with listed species (Group 2010). Other recovered oil still persisted for several days or weeks before being removed and had the potential for exposure to animals while it was present. We do not have other data available on the recovery of oil from deepwater blowouts; this data constitutes the best and current available information we have upon which to base our analysis. However, the Group (2010) report states that the tool developed to estimate DWH oil removal is not to be used for anything other than for use by incident command; therefore, we are not including a removal rate for cleanup efforts. Removing or dispersing oil as quickly as possible limits the exposure time and could reduce the severity of oiling of some listed species that come into contact with oil, or limit the amount of oil that is transported by wind and currents to locations where important species' habitats are found. Oil recovery and removal is beneficial to listed species and their habitats; however, there are some possible unintended consequences of using dispersants and burning of oil that are considered below.

Effects of Mechanical Removal of Oil

Containment boom deployments, and surface skimmer response operations may occur in the same areas as ESA-listed species and their designated critical habitats if an oil spill occurs. We consider the effects of mechanical removal operations to be minimal compared to other oil spill response methods, such as the use of dispersants and in-situ burning. The use of boom and skimmers can only recover 40 percent of an oil spill, at best (ORR 2018), meaning their use is often coupled with other cleanup methods. It is possible that using boom and skimmers could result in interaction with listed species or critical habitat during equipment deployment from a response vessel or if an animal needs to be captured for rescue. Vessels associated with oil spill response in the immediate vicinity of a spill are expected to be moving very slowly, so we would not expect vessel strike risk from response vessels in the vicinity of the spill to affect listed species. Given that an animal trapped inside a boom during operations will likely have already been exposed to oil, other interactions such as capture would be expected to be mainly beneficial. Therefore, we expect the effects of mechanical removal of oil on listed species to be so minor that they cannot be meaningfully evaluated, meaning they would be insignificant. Effects to designated critical habitat will be addressed in Section 8.8.1.5.

Effects of Dispersants

Dispersants are a group of chemicals designed to break up oil spills and that generally contain two components: a surfactant and a solvent (ITOPF 2011). The solvent carries the surfactant through the layer of oil to the oil/water interface. The surfactant reduces the surface tension by binding with both the oil molecules and the water molecules (ITOPF 2011). Chemical dispersants may be used to promote the breakup of the crude oil into smaller droplets which then may more readily disperse throughout the water column (Fingas 2008). The USEPA regulates the use of dispersants[66], and has acknowledged that the environmental effects are largely unknown (Kilduff and Lopez 2011). The USEPA is in the process of updating their National Contingency Plan Subpart J[67] relating to emergency response to oil spills to include the application of dispersants. In the discussion of the effects of oil on listed species above, the trends in the data suggest that although both oil and dispersant have some toxic effects independently, the dispersant-oil mixtures are more toxic to animals (Anderson et al. 2014; Hansen et al. 2012; McIntosh et al. 2014).

The application of dispersants to oil allows small droplets of oil to break away from the larger slick. Since the dispersants are less dense than sea water, the dispersed oil droplets remain positively buoyant (Graham et al. 2016). After dispersant application, a complex, multi-phase mixture of dissolved dispersants, dissolved petroleum hydrocarbons, oil/dispersant droplets, and bulk undispersed oil remains in the water (NRC 2005b). Although exposure to thicker slicks of oil is reduced by using dispersants, listed species may continue to be exposed to oil/dispersant mixtures. For very large spills, exposure to oil/dispersant mixtures could be quite high. The use of dispersants in the DWH spill response was unprecedented: 18,379 barrels of dispersant were used subsea, and 25,505 barrels were applied to oil on the surface. In May 2012, the U.S. Government Accountability Office (GAO) released a report on the use of chemical dispersants. Experts, agency officials, and specialists were asked about chemical dispersants and their effectiveness. Those surveyed agreed that while there is a lot of information known about the use and effectiveness of dispersants to break up surface oil, very little is known about the impacts and effectiveness applying dispersant to subsurface oil (GAO 2012).

Toxicity of dispersed oil in the environment will depend on many factors, including the effectiveness of the dispersant, temperature, salinity, the degree of weathering, type of dispersant and degree of light penetration in the water column (NRC 2005b). The GAO (2012) noted that most tests on acute toxicity have shown crustaceans and mollusks are more sensitive than fish, and larval stages of fish are more sensitive than adults. Experts have noted that there are significant data gaps in regards to chronic effects (GAO 2012). Most studies have focused on acute toxicity rather than long-term effects. The lack of information on chronic effects makes it difficult to understand how the entire ecosystem is impacted by chemically dispersed oil and the dispersants themselves over the long term (GAO 2012). Dispersing oil has both positive and negative effects. The positive effect is that the oil, once dispersed, is more available to other degraders and it may prevent a surface slick from reaching shore. The negative effect is that the oil, once dispersed, is more bioavailable to other organisms, which may temporarily increase its toxicity. OSRPs provide for applying dispersants, but the plans also require taking necessary actions to reduce the likelihood of harm to listed species. Important habitat areas could be avoided or sea turtles could be rescued from the areas that are targeted for dispersants.

[66] https://www.epa.gov/emergency-response/dispersing-agents
[67] https://www.epa.gov/emergency-response/national-contingency-plan-subpart-j

Dispersants can directly affect ESA-listed species by irritating skin, by injuring their respiratory system through inhalation (Matkin et al. 2008), and by damaging the gastrointestinal tract, including liver and kidneys, through incidental ingestion and absorption (Geraci 1988). While modern dispersants are generally classified as “slightly” toxic or “practically nontoxic” to aquatic species (Hemmer et al. 2011), recent studies have shown that a dispersant-oil mix may be more toxic to aquatic species than either crude oil or dispersants alone (Khan and Payne 2005; Luna-Acosta et al. 2011; Rico-Martínez et al. 2013; Schein A. et al. 2009). This is because the application of dispersants to an oil spill increases the amount of oil in the water column, and thus the availability of PAH toxins to marine species (George-Ares and Clark 2000; Ramachandran 2005).

A study investigating dispersants showed adverse effects on hatchling sea turtles (Harms et al. 2014). Hatchling sea turtles were exposed to a control, oil, dispersant, and oil/dispersant exposures for one day or four days. Turtles were placed in individual basins and exposed to oil (Gulf Coast – Mixed Crude Oil Sweet, CAS #8002-05-9, 0.833 mL/L) and/or dispersant (Corexit 9500A, 0.083 mL/L). Hatchlings exposed to both dispersant alone, and the dispersant oil mixture showed greater adverse effects than controls. The animals experienced dehydration, blood chemistry changes, and a failure to gain weight. The adverse effects of exposure were most severe in the combined oil/dispersant exposures at four days (Harms et al. 2014).

Surface and sub-sea application of dispersants can facilitate the movement of a dispersant-oil plume many miles from the point of their use and expose sea turtles, sperm whales, and the prey of these species. Dispersant-oil mixtures have not been shown to adversely affect large whales such as sperm whales, but the mixtures may have effects associated with habitat change or degradation (Peterson et al. 2012). The contamination of sperm whale prey species by dispersed PAH toxins could provide a route of contamination to sperm whales through ingestion. The bioaccumulation of hydrocarbons at the base of the planktonic food web could increase exposure of higher-trophic-level organisms to dispersant related chemicals, with potentially delayed effects (Abbriano et al. 2011; Wolfe et al. 1998).

Dispersed oil in the water column could have localized lethal effects on the *Saragssum* community. The death or contamination of the *Sargassum* community would have a direct negative consequence of the ability of post-hatchling and subadult sea turtles to feed and find shelter, and could lead to increased predation risks. Diluted plumes can reach coastal waters and impact Gulf sturgeon and nearshore habitats of sea turtles. If the oil and oil dispersant mixture were to reach shorelines, benthic communities and seagrass communities could be affected (Gilfillan et al. 1985). Although much of the oil that reached nearshore habitats during DWH was likely dispersed offshore, only 60 of 4,850 water samples and six of 412 sediment samples detected dispersant. None of the concentrations of dispersant-related chemicals found in the samples exceeded the benchmarks for toxicity (OSAT 1 2010). Therefore, it is more likely that only the nearshore use of dispersants would be present in concentrations that would pose any significant risk to nearshore habitats. Potential effects on seagrass communities from dispersants, oil and/or oil/dispersant mixtures include: direct mortality due to fouling and smothering, uptake of oil and dispersant toxins, effects to the fitness of animals due to adverse effects to habitat or adequate food resources, and uptake of oil and dispersants into tissues which would lower plant stress tolerance. Oil spills could have a direct effect on prey availability that could slow growth of animals. The use of dispersants are helpful for controlling areas of large spills, but the dispersed oil and toxic chemicals in the dispersants would be expected to adversely affect marine fauna and their prey.

Effects of In Situ Burning of Oil

The effects on sea turtles and marine mammals from *in situ* burning of oil have not been well documented. Effects may result from inhalation of smoke and particulate matter in the air or inadvertent exposure of listed species to oil burning at the surface. A review of smoke inhalation cases in other animals shows that smoke can irritate or inflame airways, denude mucosal surfaces, and cause systemic toxicity which can lead to lung-induced morbidity and potentially mortality (Demling 2008). Animals are submerged a good portion of the time, but could be exposed to hazardous particulates and irritants during breathing periods at the surface. Some adverse effects expected are irritation to the lungs and associated respiratory system, inhalation of hazardous particulates, and changes to blood chemistry. During the DWH response, there were concerns that oceanic juvenile sea turtles were inadvertently being concentrated into areas of oil that was being burned off the surface. The rescue of sea turtles in oil that is targeted for *in situ* burns was inhibited by a lack of any response plans that included avoiding adverse impacts of the activity and to rescue sea turtles. Although there is no direct evidence that sea turtles were burned with oil, it is likely that small, heavily oiled turtles went undetected that could have been rescued by wildlife responders. With adequate response planning requirements, the potentially adverse effects of *in situ* burning could be more closely monitored, and sea turtles could be rescued from certain death. We will discuss wildlife response planning further in the following section.

The uncertainty associated with when, where, and how response efforts will occur does not allow for quantification of response effects of dispersants and in-situ burning.

Role of Oil Spill Response Plans in Mitigating the Effects of Oil Spills on Listed Species

Above, we discussed the types of response activities that may be employed to prevent oil loss from wellheads (i.e., loss of well control) ever contacting listed species. OSRPs could further limit the severity of effects, or avoid oil exposure through wildlife rescue and rehabilitation if adequate planning occurs in advance. As mentioned in section 3.1.5.4, wildlife plans are required of the oil and gas industry and must be approved by BSEE prior to a company’s conducting any exploration, development, or production on a lease on the Outer Continental Shelf.

Our review of OSRPs as an earlier part of the 1,100 reviews NMFS conducted during the reinitiation period interim procedures (presented in Section 1.1) shows that wildlife plans associated with individual oil and gas activities consistently do not demonstrate sufficient preparedness to respond to ESA-listed species should they require rescue and/or rehabilitation. We requested to review more recent versions of OSRPs to determine if there were updates, but BOEM did not provide examples.

The capability to survey for, capture, rehabilitate oiled animals, and have immediate access to the necessary resources, directly influences the outcome of the health and survival of oiled animals. During the early stages of the DWH response, it quickly became apparent that the sea turtle and marine mammal wildlife response requirements in the applicable OSRP were highly inadequate. NMFS worked with agency partners and through the incident command structure to mobilize the necessary resources to conduct turtle rescues, transport of animals, rehabilitation, and release of sea turtles. A significant amount of resources were dedicated to securing the personnel and equipment necessary to conduct turtle rescues that should have been directed toward surveys for oiled animals, captures, and rehabilitation of animals. Of the approximately 456 visibly oiled and 80 not visibly oiled live sea turtles rescued during DWH, nearly 90 percent were successfully rehabilitated and released, demonstrating the great potential for avoiding mortality from oil spills.

Specifically, we have found during initial phases of our 1,100 interim procedural reviews of individual Oil and Gas Program activities that OSRPs do not demonstrate:

- Adequate consideration for protecting sea turtles and marine mammals from dispersants, *in situ* burns, boom deployment, and other response activities
- Adequate planning with authorized wildlife responders, rehabilitators, and stranding networks
- Adequate plan for communications with NMFS during a response specifically regarding impacts to ESA resources
- Adequate access to local and/or readily available resources needed to be mobilized during a response
- Adequate planning for staging areas to treat animals prior to transport to long-term care facilities
- Adequate access to resources available to survey for oiled animals
- Adequate resources to retrieve and transport dead oiled animals
- Adequate resources to rescue or capture live animals
- Adequate resources to treat and rehabilitate protected species
- Adequate resources to medically sample and complete diagnostics on oiled animals
- Adequate plan to rapidly train and increase the number of authorized wildlife responders during large spills

In 2016, GAO released a report (GAO 2016) regarding BSEE oversight regarding their investigative capabilities. The main points of this report were that BSEE's ongoing restructuring:

  - Has made limited progress enhancing its investigative capabilities;

  - Risks weakening its environmental compliance capabilities;
  - Has made limited progress addressing long-standing deficiencies in its enforcement capabilities;

The report also made recommendations for improving effectiveness of BSEE's oversight responsibilities which included that BSEE (1) complete and update its investigative policies and procedures, (2) conduct and document a risk analysis of the regional-based reporting structure, and (3) develop procedures for enforcement actions. The result of these enhancements could improve the review processes for OSRPs.

Based on the above information, we expect that the current approach to OSRPs in the Gulf of Mexico will have minimal beneficial impact in avoiding or reducing the impacts to listed species resulting from oil spills and are not adequate to meet the bullets listed above.

9 Effects of the Action on Designated Critical Habitat

In this section we analyze the effects of the proposed action on the identified essential physical and biological features of designated critical habitat for the Northwest Atlantic DPS of loggerhead sea turtle and Gulf sturgeon. Table 120 below provides a "roadmap" of our effects determinations for each activity (or stressor) and designated critical habitat for these species (see Section 8.1.3 for explanation of the roadmap).

As part of this analysis, we evaluate the effects of oil spills on loggerhead and Gulf sturgeon designated critical habitat. For each identified essential physical and biological feature of critical habitat, we assess the likelihood and potential impact of stressors including exposure to oil and oil dispersants as a result of the proposed action. Because we cannot discount the risk that a major spill will occur (see Section 8.8), our analysis of the effects of oil spills on loggerhead and Gulf sturgeon critical habitat includes our estimated median spill volume of the largest predicted spill (i.e., 1.1 million bbl). As noted above, we also assume that the largest predicted spill will impact nearshore marine habitats within 30 days. Information from DWH oil spill damage assessment reports was used to inform our analysis (Trustees 2016). Although the largest oil spill assumed in our effects analysis is smaller (in spill volume and duration) by comparison, the DWH spill event represents the best available information on the effects of a major spill on designated critical habitat in the GOM. We also recognize that, besides the spill volume and duration, other variables (e.g. spill location, season, currents, and winds), that are often difficult to predict, will influence the amount of loggerhead and Gulf sturgeon critical habitat that could be exposed to the effects of oil spills resulting from the proposed action.

Table 120. Summary of effects determinations for each activity (or stressor) and critical habitat evaluated.

	Critical Habitat	
Activity or Stressor	**NW Atlantic DPS of Loggerhead**	**Gulf Sturgeon**
Other G&G activities producing sound (e.g. HRG, AUV, hazard surveys)	NE	NE
CSEM survey activities	NE	NE
Entanglement in seismic survey equipment – ocean bottom nodes (OBN)[68]	NE	NE
Entanglement in other seismic survey equipment (hydrophones, geophones, cables, other)[69]	NE	NE
G&G sediment sampling	NE	NE
Vessel strike	NE	NE
Vessel sound and operation	NLAA	NLAA
Aircraft sound and operation	NE	NE
Offshore Infrastructure/ Pile Driving	NE	NE
Other construction and operation sound sources	NE	NE
Air emissions discharges	NE	NE
NPDES water discharges	NLAA	NLAA
Oil spill < 1 bbl	NLAA	NE
Pre-severance activities: sediment disturbance and increased turbidity	NE	NE
Structure severance: explosives	NE	NE
Structure severance: nonexplosive methods	NE	NE
Post structure removal site clearance - trawling	NE	NE

[68] Use of equipment that has entanglement or entrapment risk including but not limited to moon pools or other gear without turtle guards require a step-down review under this programmatic consultation (see Section 3.5).
[69] Use of equipment that has entanglement or entrapment risk including but not limited to moon pools or other gear without turtle guards require a step-down review under this programmatic consultation (see Section 3.5).

Activity or Stressor	Critical Habitat	
	NW Atlantic DPS of Loggerhead	Gulf Sturgeon
Discharge of marine debris	NLAA	NLAA
Entrapment in moon pools[70]	NE	NE

Effects determinations key: NLAA = Not likely to adversely affect; NE = No effect.

Activity or Stressor	Critical Habitat	
	NW Atlantic DPS of Loggerhead	Gulf Sturgeon
Seismic surveys: airguns and boomers	LAA	NE
Oil spill 1 to 1,000 bbl	LAA	NLAA
Oil spill > 1,000 bbl	LAA	LAA

Effects determinations key: LAA = Likely to adversely affect; NLAA = Not likely to adversely affect; NE = No effect.

9.1 Northwest Atlantic DPS of Loggerhead Sea Turtles

As described previously, Northwest Atlantic DPS of loggerhead critical habitat includes six nearshore reproductive habitat units within the action area that extend from the shore to 1.6 km seaward, and a *Sargassum* critical habitat unit that covers a large portion of the Northern Gulf of Mexico (see Section 6.2.16 for details). The essential physical and biological features associated with nearshore reproductive habitat are: (1) waters directly off the highest density nesting beaches to one mile offshore, (2) waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone, and (3) waters with minimal man-made structures that could promote predators, disrupt wave patterns necessary for orientation, and/or create excessive longshore currents. The essential physical and biological features associated with loggerhead *Sargassum* critical habitat are: (1) convergence zones, surface-water downwelling areas, and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads, (2) *Sargassum* in concentrations that support adequate prey abundance and cover, and (3) available prey and other material associated with *Sargassum* habitat such as, but not limited to, plants and

[70] See footnote 47 above.

cyanobacteria and animals endemic to the *Sargassum* community such as hydroids and copepods.

9.1.1 Effects of Vessel Sound and Operation

While loggerhead nearshore reproductive habitat units are outside of BOEM's jurisdiction for leasing and geophysical activities, vessels associated with the proposed action may transit through nearshore reproductive habitat and may present temporary obstructions, but any potential effects to essential habitat features are expected to be temporary and localized with no lasting effects over extended periods. Therefore, any effects of vessel activity on loggerhead nearshore reproductive critical habitat as part of the proposed action are likely to be insignificant.

Vessel activity as part of the proposed action could also potentially overlap with the loggerhead *Sargassum* designated critical habitat unit in the Gulf of Mexico. We anticipate that vessel operators would actively avoid *Sargassum* patches within the action area, as coming near or in contact with *Sargassum* may have detrimental impacts on vessel operation (e.g. slow or jam propellers or clog engine cooling water intakes). Some vessels may still come in direct contact with *Sargassum,* temporarily disturbing the biotic community (including available prey for juvenile loggerheads) and other materials associated with this habitat. However, such disturbances are likely to be very short in duration, cover a relatively small area, and result in no lasting detrimental effect on the affected *Sargassum* community. Any effects of vessel activity on loggerhead *Sargassum* designated critical habitat as part of the proposed action are likely to be insignificant. Therefore, we determine that vessel sounds and operation as part of the proposed action may affect but are not likely to adversely affect Northwest Atlantic Ocean DPS of loggerhead designated critical habitat.

9.1.2 Effects of Seismic Surveys

Seismic surveys conducted under the proposed action will not overlap spatially with loggerhead nearshore reproductive critical habitat. Therefore, we determine that effects to nearshore reproductive habitat segment of the Northwest Atlantic Ocean DPS of loggerhead designated critical habitat from seismic surveys as part of the proposed action are insignificant.

A recent study suggests that seismic airguns may lead to significant mortality of zooplankton, including copepods (McCauley et al. 2017), which can affect the *Sargassum* prey community that juvenile loggerheads rely on. Seismic survey activity as part of the proposed action overlaps spatially with loggerhead sea turtle (Northwest Atlantic Ocean DPS) *Sargassum* designated critical habitat. Considering that copepod prey are identified as an essential physical and biological feature of *Sargassum* critical habitat, it is possible that the proposed action may affect this critical habitat unit. According to McCauley et al. (2017), for seismic activities to have a significant impact on zooplankton at an ecological scale, the spatial or temporal scale must be large in comparison to the ecosystem in question due to the naturally high turnover rate of zooplankton. We anticipate that seismic survey operators would actively avoid *Sargassum* patches within the action area, as coming near or in contact with any *Sargassum* may destroy the towed seismic equipment, and at the very least may cause a loss in data so that crew can disentangle *Sargassum* from the seismic equipment. Avoidance of *Sargassum* patches will not entirely eliminate the potential effects of seismic activity on loggerhead prey within critical habitat since effects to zooplankton have been observed out to 1.2 km (McCauley et al. 2017). Avoidance will likely reduce those effects to some extent. While the proposed seismic surveys may temporarily alter copepod abundance in designated loggerhead *Sargassum* critical habitat, we expect such effects to be short-term given the high turnover rate of zooplankton, and spatially limited area affected compared to the *Sargassum* habitat available to juvenile sea turtles in the Gulf of Mexico. Furthermore, we expect that ocean currents will periodically circulate undisturbed *Sargassum* into designated *Sargassum* critical habitat (Gower and King 2011b), which will further reduce overall effects of seismic activity on this habitat (see Richardson et al. 2017 for simulations based on the results of McCauley et al. 2017 that suggest ocean circulation greatly reduced the impact of seismic surveys on zooplankton at the population level). In summary, based on the best available information, we find that any effects of seismic surveys on the essential physical and biological features of loggerhead *Sargassum* critical habitat are likely to adversely affect zooplankton prey abundance in *Sargassum* patches.

9.1.3 Effects of Water Discharges

Nearshore reproductive habitat waters do not overlap areas that could be affected by offshore water discharges. Discharges from offshore oil and gas structures are expected to dissipate and/or sink to the bottom and extremely unlikely to reach nearshore waters. Therefore, we determine that effects of water discharges to loggerhead nearshore reproductive habitat are insignificant.

While it is possible that *Sargassum* habitat could overlap areas where there are discharges, we would expect dilution to be such that discharges reaching *Sargassum* patches would be so little as to be measurable above levels expected for toxicity, therefore insignificant. As discussed above in Section 10.4.1, we find that the effects of NPDES regulated discharges on protected species and their designated critical habitats will be insignificant based on the following: (1) all discharges must meet permit requirements for acceptable toxicity levels and other restrictions set forth in the permit, which are intended to protect all aquatic life, including protected species and prevent unreasonable degradation of the marine environment; (2) discharges are expected to quickly dilute and disperse in the vast receiving waters; (3) restrictions will limit many chemicals and nutrients from entering the receiving waters (i.e. no free oil, no floating solids, no garbage, no foam, phosphate free soap and detergents, sanitary waste treated with chlorine); (4) the standard use of curbs, drip pans, and other pollution prevention equipment on offshore structures; (5) toxicity limits are required for facilities intending to discharge drilling fluids, drill cuttings, and/or produced waters to the sea; (6) USEPA regulations to prevent unreasonable degradation to the marine environment; and (7) based on the USEPA, BOEM, and bioaccumulation studies cited previously, there have been no reported significant adverse environmental impacts resulting from the proposed types of discharges from oil or gas platforms within the Gulf of Mexico, and no adverse effects to NMFS' protected resources have been reported. Therefore, we determine that water discharges as part of the proposed action may affect but are not likely to adversely affect Northwest Atlantic Ocean DPS of loggerhead designated critical habitat.

9.1.4 Effects of Marine Debris

Based on the anticipated types of debris accidentally lost offshore (e.g., plastic strapping, various wood items, lines, smaller plastics), we believe it is unlikely that these items would be transported to nearshore coastal areas. Since it is unlikely that marine debris resulting from the proposed action would be transported to coastal areas, it follows that the effects of marine debris on loggerhead nearshore reproductive critical habitat are discountable. It is possible that floating marine debris (e.g., plastic and wood) from oil and gas operations could become entangled in *Sargassum*. However, any effects of marine debris on the essential physical and biological features of *Sargassum* critical habitat, including available loggerhead prey, are expected to be so minimal as to be unmeasurable, or insignificant. In summary, we determine that marine debris resulting from the proposed action may affect but is not likely to adversely affect Northwest Atlantic Ocean DPS of loggerhead designated critical habitat.

9.1.5 Effects of Oil Spills and Spill Response

In Section 10.7 above we quantified the anticipated effects of oil spills on individual loggerhead sea turtles that are initially exposed to oil as the estimated number of lethal and sublethal takes by life stage.

Physical processes, such as convergent currents and fronts that play a role in transporting, retaining, and concentrating *Sargassum*, are the same processes that act to concentrate oil, thus increasing the exposure of *Sargassum* associated organisms to oil (Trustees 2016). Powers et al. (2013) found three pathways to oil spill related injuries in *Sargassum* dependent communities: (1) *Sargassum* accumulated oil on the surface exposing animals to high concentrations of contaminants; (2) application of dispersant can sink *Sargassum*, thus removing the habitat and potentially transporting oil and dispersant vertically; and (3) low oxygen surrounding the habitat potentially stressing animals that reside in the alga. Removal of large numbers of individual clumps, patches, or lines of *Sargassum* through sinking could reduce concentrations that support adequate prey abundance and cover.

Much of the *Sargassum* critical habitat within the northern GOM is at risk of oil exposure considering (1) the large spatial overlap between *Sargassum* critical habitat and oil and gas leasing areas and (2) the physical processes bringing both surface oil and *Sargassum* together. The DWH oil spill resulted in an estimated 1,296 square kilometers of oiled *Sargassum* within areas where the surface was covered by “heavy” (i.e., greater than five percent thick) oil (Trustees 2016). This represented the loss of approximately 23 percent of the *Sargassum* in the northern Gulf of Mexico (at the time of the spill) due to direct exposure to DWH oil on the ocean surface (Trustees 2016). Floating *Sargassum* samples collected up to 100 miles from the wellhead were shown to have been impacted by DHW oil (McDonald and Powers 2015). An additional measure of *Sargassum* injury from oil spills is the surface area foregone due to lost growth caused by oil exposure. An estimated 6,958 square kilometers of *Sargassum* surface area was foregone as a result of the DWH oil spill. The loss of *Sargassum* habitat during DWH was likely exacerbated by the use of oil dispersants (Powers et al. 2013).

Unlike loggerhead nearshore reproductive critical habitat, which is only likely to be exposed to oil from larger offshore spills, *Sargassum* floating in offshore areas could be exposed to oil from smaller spills as well. Small-scale oil spills, which occur more frequently in the northern Gulf of Mexico, could affect localized *Sargassum* communities, however it is expected that those patches would recover quickly. An extremely large spill, such as DWH, would likely result in widespread, sea-scape level impacts that could make it difficult for juvenile turtles to locate suitable *Sargassum* habitat, particularly if dispersants are used in the aftermath of such a spill.

Containment of *Sargassum* patches within booms or skimmers would result in some reduction of patch concentration and prey availability. Dispersants could cause sinking of patches and directly affect prey abuncance. In-situ burning could also cause destruction of patches.

Based on the best available information, it is likely that oil spills and spill response resulting from the proposed action will adversely affect concentrations of *Sargassum* habitat and available prey and other material associated with *Sargassum* habitat. Immediate effects of *Sargassum* exposure to oil and oil and dispersant mixtures on *Sargassum* will likely include reduced prey abundance, reduced cover, and reduced developmental and foraging habitat.

To fully assess both the short-term and long-term effects of oil spills on the essential features of *Sargassum* critical habitat, we need to consider aspects of the algae's life cycle including seasonal movements and drift rate within the action area, growth rate, longevity, and resiliency to environmental disturbances. Unlike more fixed types of critical habitat (e.g., river stretches, or nesting beaches), *Sargassum* is a highly mobile habitat, The movement of *Sargassum* over many months is consistent from year to year, and can be explained by prevailing surface currents and winds. Satellite data from 2003 to 2007 indicates that *Sargassum* starts growing each year in the Gulf of Mexico around March, and dies about a year later in the Atlantic in the area northeast of the Bahamas (Gower and King 2011b). The rapid increase in the amount of *Sargassum* in the northwest Gulf each year from March to July strongly suggest that the Gulf of Mexico is the dominant source of new *Sargassum* growth which occurs cyclically. Satellite data clearly indicate strong growth early in the year in the Gulf of Mexico, with *Sargassum* advected by the Loop Current and Gulf Stream into the Atlantic each year in July and August (Gower and King 2011b). *Sargassum* species in the northern Gulf of Mexico grow at an estimated rate of four percent per day (Lapointe 1986).

The amount of *Sargassum* exposed to an oil spill within the action area will depend, to a large extent, on the time of year given the seasonality and cyclical movement of *Sargassum* in the northern Gulf of Mexico. Continuous exposure of a particular *Sargassum* patch to oil could last days, weeks, or months depending on the size and location of the spill and other factors (e.g., wind speed and direction, season, and type of oil). For example, the full range of area affected by the DWH oil spill covered 26,025 to 45,825 square kilometers (Trustees 2016). More heavily oiled patches that are closer to the spill source at the time of the spill, and areas exposed to both oil and oil dispersants, will likely die-off and/or sink to the ocean bottom. DWH oil impacted floating *Sargassum* samples collected up to 100 miles from the wellsite (Trustees 2016).

Given its fast growth rate, continuous motion, and somewhat ephemeral nature, we would expect a relatively high turnover rate for *Sargassum* patches under normal conditions. *Sargassum* habitat that is lost due to an oil spill will likely be replaced over time by the combination of movement by unexposed (or lightly exposed) existing patches and through new growth. While the adverse effects of a major oil spill on *Sargassum* communities within a given annual life cycle (described above) are well documented, the longer-term impacts in subsequent years or decades are not known. Although nearly one-quarter of all *Sargassum* habitat in the northern Gulf of Mexico was heavily exposed to oil after the 2010 DWH spill, follow-up aerial surveys in 2011 and 2012 documented a four-fold increase in *Sargassum* abundance since DWH. These results suggest that *Sargassum* can repopulate in the Gulf of Mexico within a year or two of an extremely large oil spill.

BOEM oil and gas leasing areas do not overlap directly with loggerhead nearshore reproductive critical habitat units, which are exclusively in state waters. While the likelihood of smaller spills affecting nearshore habitats is considered less likely, larger spills, including a major spill, could potentially reach areas designated as loggerhead nearshore reproductive critical habitat. Nearshore areas could be directly exposed to oil from a large spill, and depending on location of the spill, could affect waters directly off the highest density nesting beaches. Therefore, effects of oil spills resulting from the proposed action are likely to affect the essential physical and biological features of loggerhead nearshore reproductive critical habitat.

In summary, it is likely that oil spills and spill response resulting from the proposed action will adversely affect essential physical and biological features of loggerhead *Sargassum* critical habitat (i.e., concentrations of *Sargassum* habitat and available prey and other material associated with *Sargassum* habitat). An extremely large oil spill can have detrimental effects to *Sargassum* communities that juvenile turtles depend on for food and shelter. The effects of oil exposure on *Sargassum* critical habitat can be severe and last for days, weeks or even months in the case of a major oil spill. However, the ephemeral nature and annual cycle of rapid growth, movement, and subsequent die-off, allows *Sargassum* to repopulate in the Gulf of Mexico in the years subsequent to an extremely large oil spill. Therefore, overall we do not expect it will affect *Sargassum*'s ability to support adequate prey abundance and cover for loggerhead turtles.

9.2 Gulf Sturgeon

The action area encompasses all seven of the marine and estuarine units of Gulf sturgeon designated critical habitat. For this analysis, we consider the effects on the essential habitat features found in the marine and estuarine units of Gulf sturgeon designated critical habitat: (1) abundant food items; (2) water quality necessary for normal behavior, growth, and viability of all life stages; (3) sediment quality necessary for normal behavior, growth, and viability of all life stages; and (4) safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats.

9.2.1 Effects of Vessel Sound and Operation

While Gulf sturgeon critical habitat units are outside of BOEM's jurisdiction for geophysical activities, vessels associated with the proposed action may briefly transit through Gulf sturgeon critical habitat. The operation of vessels transiting through areas containing Gulf sturgeon critical habitat would not significantly alter water quality, sediment quality or the availability of Gulf sturgeon prey because they would be moving through quickly and any effects would be localized and temporary. While it is possible that vessel activity may briefly delay sturgeon migration by causing an obstruction to migratory pathways, this effect will be temporary and will not likely result in any long-term effects to essential habitat features. Any effects of vessel activity on Gulf sturgeon designated critical habitat as part of the proposed action are likely to be insignificant.

9.2.2 Effects of Water Discharges

As discussed above in Section 10.4.1, we find that the effects of NPDES regulated discharges on protected species and their designated critical habitats will be insignificant based on the following: (1) all discharges must meet requirements for acceptable toxicity levels and other restrictions set forth in the permit, which are intended to protect all aquatic life, including protected species and prevent environmental degradation; (2) discharges are expected to quickly dilute and disperse in the vast receiving waters; (3) restrictions will limit many chemicals and nutrients from entering the receiving waters (i.e. no free oil, no floating solids, no garbage, no foam, phosphate free soap and detergents, sanitary waste treated with chlorine); (4) the standard use of curbs, drip pans, and other pollution prevention equipment on offshore structures; (5) toxicity testing is required for facilities intending to discharge drilling fluids, drill cuttings, and/or produced waters to the sea; (6) USEPA regulations to prevent unreasonable degradation to the marine environment; and (7) based on the USEPA, BOEM, and bioaccumulation studies cited previously, there have been no reported significant adverse environmental impacts resulting from the proposed types of discharges from oil or gas platforms within the Gulf of Mexico, and no adverse effects to NMFS' protected resources have been reported. Therefore, we determine that water discharges as part of the proposed action may affect but are not likely to adversely affect Gulf sturgeon designated critical habitat.

9.2.3 Effects of Marine Debris

Based on the anticipated types of debris accidentally lost offshore (e.g., metal grating, plastic strapping, various wood items, lines, smaller plastics), we believe it is unlikely that these items would be transported to nearshore coastal areas. Because most oil and gas related debris would be expected to sink or be transported into current convergence zones and remain in deeper water, it is unlikely that marine debris resulting from the proposed action would be transported to coastal areas. Therefore, the effects of marine debris on Gulf sturgeon critical habitat are discountable. In summary, we determine that marine debris resulting from the proposed action may affect but is not likely to adversely affect Gulf sturgeon designated critical habitat.

9.2.4 Effects of Oil Spills and Spill Response

In addition to the effects of oil exposure on individual Gulf sturgeon (see Section 10.7.1.3 above), oil spills may also affect Gulf sturgeon critical habitat within the action area. For this analysis, we consider the effects of oil spills and oil dispersants on the essential habitat features found in the marine and estuarine units of Gulf sturgeon designated critical habitat, as described above. BOEM oil and gas leasing areas do not overlap directly with Gulf sturgeon critical habitat because critical habitat for this species is found exclusively in state waters. For critical habitat to be affected, oil from OCS sources would have to be transported to nearshore waters by wind and currents. Smaller offshore spills (i.e., < 1,000 bbl) are not expected to impact the essential physical and biological features of Gulf sturgeon critical habitat, and are therefore considered discountable. BOEM estimates a one to four percent chance of an offshore oil spill contacting Gulf sturgeon marine habitat based on a spill size of 1,000-10,000 bbl. Larger spills (i.e., > 10,000 bbl) would have a higher risk of impacting coastal waters, depending on many factors such as the buoyancy of the spilled fluid, distance from the spill, currents, and duration of the spill. Almost all types of nearshore ecosystem habitats in the northern Gulf of Mexico were oiled and injured as a result of the DWH oil spill, including shallow unvegetated habitats utilized by Gulf sturgeon. Oil was observed on more than 1,300 miles (2,113 kilometers) of shoreline from Texas to Florida (Trustees 2016). Although the largest oil spill assumed in our analysis for this opinion is smaller than the DWH spill, based on the DWH damage assessment it is likely that Gulf sturgeon critical habitat would be exposed to an oil spill resulting from the proposed action.

Essential features of Gulf sturgeon critical habitat, including abundant benthic prey, sediment quality and water quality, could also be exposed to oil from an offshore spill on the magnitude of the largest spilled analyzed in this opinion. Since oil can persist in sediments for some time after a spill has occurred prey could be exposed to oil through contaminated sediment from spills. Dissolved oil in the water column, sunken oil, and oil that remains in sediments could all negatively impact Gulf sturgeon critical habitat. Diluted oil would be available for the duration of the spill, whereas sunken oil would persist for longer periods of time. Some proportion of buoyant oil typically reaches sediments after a spill, leading to exposure and contamination of zooplankton, benthic invertebrates, and benthic fish (Teal and Howarth 1984). Oil contamination often results in decreased abundance and diversity of benthic communities. Many benthic animals ingest sediment routinely as part of their normal feeding behavior and also as part of burrowing into and reworking sediments, a process known as bioturbation. Unusually low tidal events, increased wave energy, and the use of oil dispersants can increase the risk of impact with bottom-feeding and/or bottom-dwelling fauna (NMFS 2007). Benthic communities could be affected by oil and oil dispersant mixtures (Trustees 2016). Although much of the oil that reached nearshore habitats during DWH was likely dispersed offshore, only 60 of 4,850 water samples and six of 412 sediment samples detected dispersant. None of the concentrations of dispersant-related chemicals found in the samples exceeded the benchmarks for toxicity (Trustees 2016). Therefore, it is more likely that only the nearshore use of dispersants would be present in concentrations that would pose any significant risk to nearshore habitats (Trustees 2016).

Oil contamination could impact Gulf sturgeon essential habitat features related to sediment quality and benthic prey abundance. Related ecosystem function effects that could result from oil spills include impaired cycles of organic matter and nutrients from the water column to oil-contaminated bottom sediments, and altered transfer of energy and nutrients from coastal to offshore ecosystems. Oil spills can also reduce water quality within Gulf sturgeon critical habitat, although the effects would likely be of shorter duration compared to the potentially longer-term impacts on sediment and benthic prey.

Offshore spills, in general, are expected to have a smaller impact on Gulf sturgeon critical habitat because much of the critical habitat is protected by barrier islands, shoals, shorelines, and currents (NMFS 2007). Oil that does reach nearshore environments occupied by Gulf sturgeon will likely be significantly diluted and in lower concentrations compared to thicker, more concentrated oil in offshore areas closer to the spill source. Damage assessment studies conducted after the DWH oil spill found that exposure of the vast majority of soft-bottom benthos along the continental shelf to spill-related constituents appeared to be relatively low (Trustees 2016). In addition, oil becomes more dispersed with time, and the weathering and consolidation of oil with sediments and other materials causes the properties of the oil to change, thus reducing the potential adverse effects to benthic organisms.

In summary, we find that oil spills and oil spill dispersants resulting from the proposed action will likely adversely affect the following essential features of Gulf sturgeon designated critical habitat: benthic prey abundance, sediment quality and water quality. Considering the location of this critical habitat in relation oil and gas activities, the likely dilution of oil reaching nearshore areas, and the on-going weathering and dispersal of oil over time, we do not anticipate the effects from oil spills will appreciably diminish the value of Gulf sturgeon designated critical habitat for the conservation of the species.

10 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 CFR §402.02). Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

During this consultation, we searched for information on future state, tribal, local, or private (non-federal) actions reasonably certain to occur in the action area. We did not find any information about non-federal actions other than actions already described in the *Environmental Baseline* (Section 7), which we expect will continue in the future. Non-federal activities anticipated to continue into the future include commercial and recreational fishing, vessel traffic, oil and gas activities, scientific research, ocean sound, and pollution. An increase in these activities could similarly increase their effect on ESA-listed resources and for some, an increase in the future is considered reasonably certain to occur. Given current trends in global population growth, threats associated with climate change, pollution, fisheries, bycatch, aquaculture, vessel strikes and approaches, and sound are likely to continue to increase in the future, although any increase in effect may be somewhat countered by an increase in conservation and management activities. In contrast, more historic threats such as whaling and sea turtle harvest are likely to remain low or potentially decrease. For the remaining activities and associated threats identified in the *Environmental Baseline*, and other unforeseen threats, the magnitude of increase and the significance of any anticipated effects remain unknown. The best scientific and commercial data available provide little specific information on any long-term effects of these potential sources of disturbance on ESA-listed species. Thus, this consultation assumed effects in the future would be similar to those in the past and, therefore, are reflected in the anticipated trends described in the *Status of Species and Critical Habitat Analyzed Further* and *Environmental Baseline* sections 6.2 and 7, respectively.

11 Integration and Synthesis for Species

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species and their designated critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 8) to the *Status of Species and Critical Habitat Analyzed Further* (Section 6.2), the *Environmental Baseline* (Section 7), and predicted *Cumulative Effects* (Section 10). This synthesis incorporates conservation measures described in the *Description of the Proposed Action* (section 3.1.6) and in section 8.3, *Effects of Conservation Measures*. Combining these elements, we formulate the agency's opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of an ESA-listed or proposed for ESA-listing species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species. We treat the information from the status of the species, environmental baseline, and cumulative effects, as "risk modifiers," in that the effects described in the effects analysis section may be modified by the condition of the species; the condition of the environmental baseline, and the anticipated cumulative effects. The key questions addressed include:

1) Status of the Species:
    - Is the species listed as threatened, or endangered?
    - Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?
2) Environmental Baseline
    - Within the action area, what are existing stressors to the species that may increase in severity by the proposed action?
3) Cumulative Effects
    - What are the likely future changes and their impact on ESA-listed species and their critical habitats in the action area?

As discussed in Section 6.2, several ESA-listed species and designated critical habitat occur within the action area. Several ESA-listed species are not expected to be affected by the proposed action or may be affected by the proposed action but are not likely to be adversely affected because the effects are insignificant or discountable. In addition, some activities evaluated individually, were determined to have insignificant or discountable effects, and thus were not likely to adversely affect some ESA-listed species, though in this integration we consider whether insignificant effects from some stressors may be exacerbated by other effects of the action to produce adverse effects. Other Oil and Gas Program stressors and activities were found likely to adversely affect ESA-listed species occurring in the action area. See Section 9.1.4 *Effects Analysis Roadmap* (Table 40 and Table 41) for a summary of effects determinations for each activity (or stressor) and species evaluated.

The following discussions summarize the probable risks the proposed action poses to threatened and endangered species in total, integrating the exposure and response with the species status, environmental baseline, and cumulative effects. Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been defined by the ESA. Because the continued existence of ESA-listed species depends on the fate of the populations that comprise them, the viability (that is, the probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations is determined by the fate of the individuals that comprise them. Our risk analysis for each species (or DPS) begins by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analysis then integrates those individual risks to identify consequences to the populations those individuals represent. Our analysis concludes by determining the consequences of those population-level risks to the species those populations comprise. We consider the combined effects of the action, to include an aggregate of all stressors that may affect listed species (i.e., LAA and NLAA stressors), and identify whether the species is likely to be jeopardized by any part of the action. Stressors that are determined not likely to adversely affect a species are included because they are still contributing to the overall effects by the Oil and Gas Program. As referred to above, to be jeopardized is to mean the effects of the action would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the species in the wild [50 CFR §402.02].

11.1 Marine Mammals

Two ESA-listed marine mammal species are likely to be found within the action area: the Gulf of Mexico Bryde's whale and the sperm whale. While these two species differ in morphology, physiology, behavior, and ecology, they are both resident to the action area and expected to be exposed to many of the same stressors. In addition, each species is expected to be exposed to unique stressors based on their distinct distribution and biology. In this section, we first describe a recently developed framework for assessing the population-level consequences of exposure to multiple stressors for marine mammals, and then summarize the stressors which Gulf of Mexico Bryde's whales and sperm whales will be exposed to. Following this, we detail our integration and synthesis for each species, in which we rely on and summarize information presented in the *Effects of the Action on Species*, the *Species Status*, the *Environmental Baseline*, and the *Cumulative Effects* Sections presented above.

In 2017, the National Academies of Science (NAS) reported on the challenges of understanding the combined effects of sound and other stressors on marine mammals (NAS 2017). The NAS noted the difficulties in quantitatively predicting the effects of exposure to multiple stressors and developed a conceptual framework for assessing population-level consequences to identify potential stressors to reduce to bring the ecosystem or population to a more favorable state (NAS 2017). The NAS (2017) assessed short or infrequent exposure in the context of other stressors, and chronic exposure in the context of other stressors. Figure 91 displays the NAS framework for a single stressor, for a single individual. Each box represents a variable that can change over time and arrows represent causal flows. There are several pathways by which a marine mammal's vital rates (e.g., survival, fecundity, age at first reproduction, etc.) can be affected. At the most basic level, exposure to a stressor can result in a physiological change in an individual. Depending on the nature of the physiological change, there may be direct (acute) affects to vital rates, or indirect effects to vital rates mediated by a behavioral change or impacts to the individual's health. This framework can be expanded to evaluate the effects of multiple stressors on vital rates, and ultimately be applied to multiple individuals to understand the population-level consequences of exposure to multiple stressors (Figure 92).

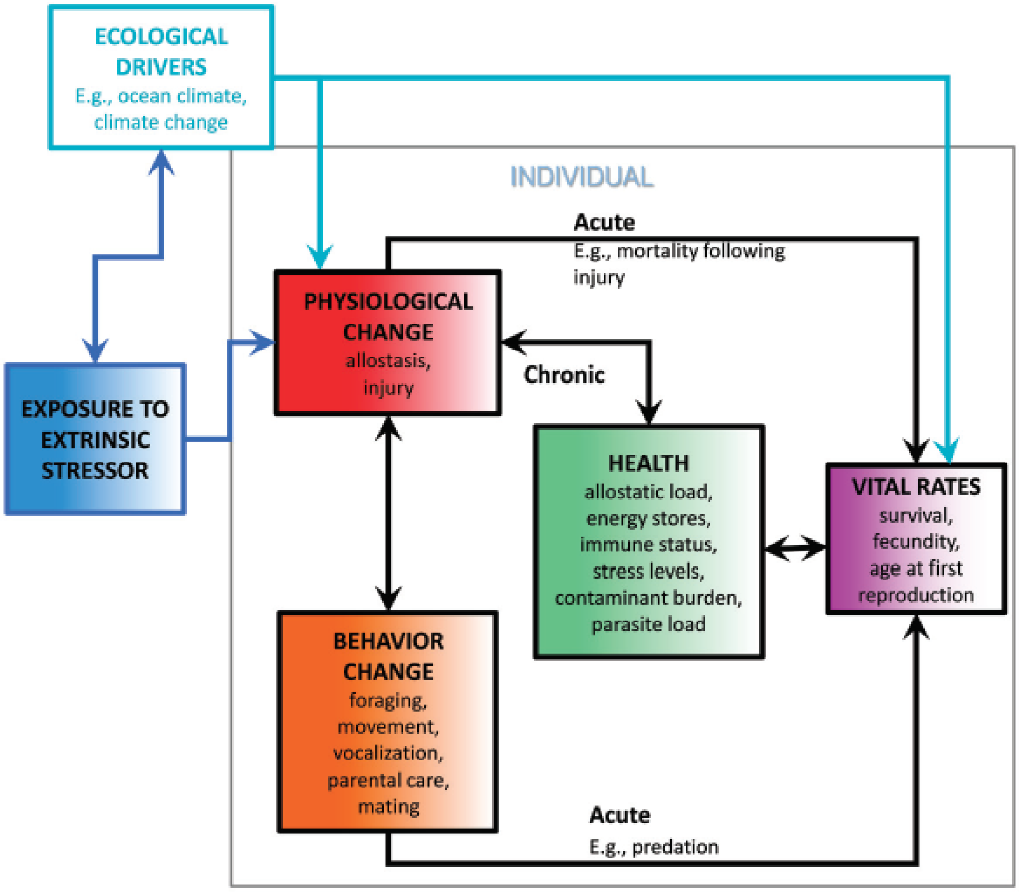


Figure 91. Population Consequences of Multiple Stressors framework for a single individual exposure to one stressor (NAS 2017).

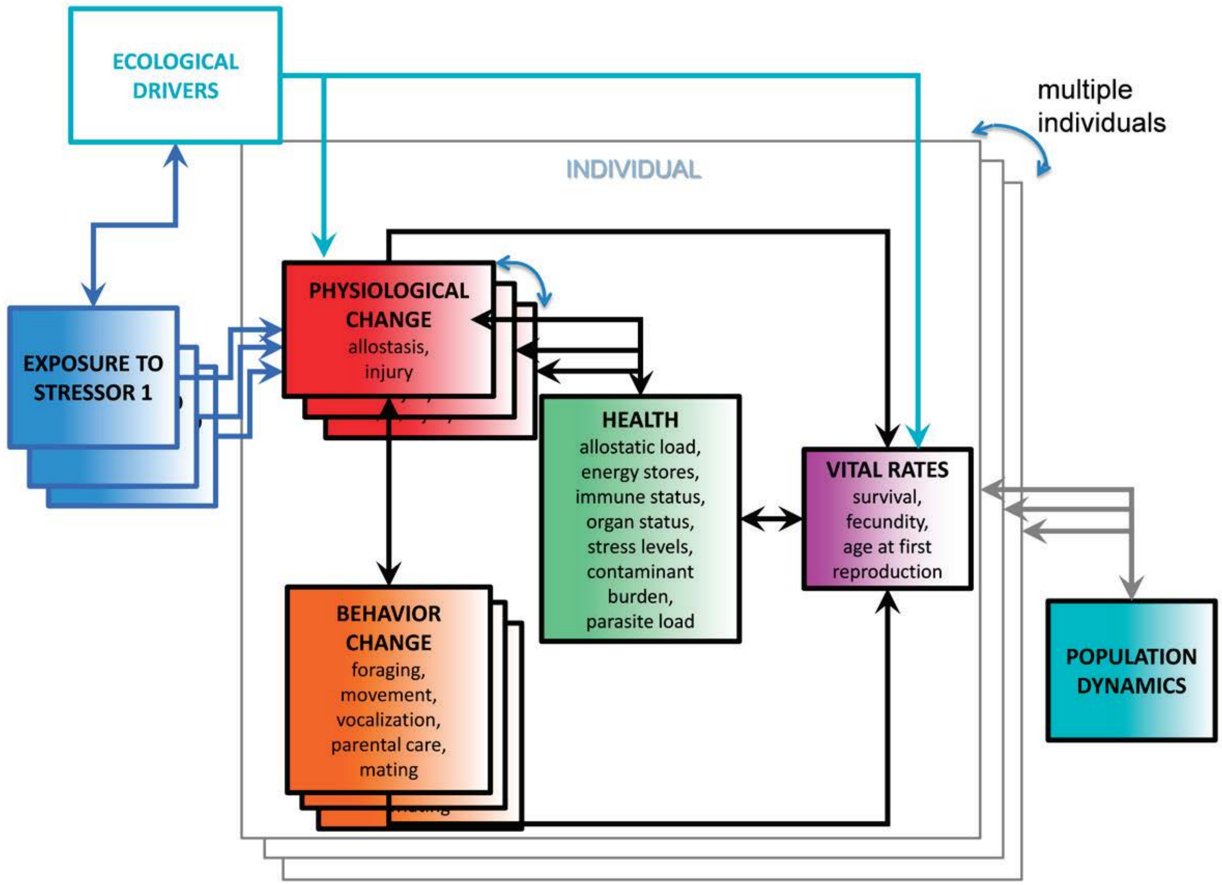


Figure 92. An expanded version of the NRC framework shown in Figure 91 that includes multiple individuals and population-level consequences (NAS 2017).

In our integration and synthesis for marine mammals, we rely on the NAS conceptual framework to evaluate whether the exposure to multiple stressors produced by the proposed action would affect individuals' vital rates and have population-level consequences by affecting the vital rates of multiple individuals. Specifically, we consider how exposure to the stressors associated with the proposed action may affect vital rates through the pathways identified in Figure 91, and where effects to vital rates are expected, we evaluate the population-level consequences of those effects. Importantly, and as depicted in Figure 91, we also consider effects to the Gulf of Mexico environment and ecosystem that may indirectly impact the vital rates of Gulf of Mexico Bryde's and sperm whales such as increases in overall anthropogenic noise that may alter the soundscape in the Gulf of Mexico in ways that could indirectly affect the species.

An example of a risk modifier is climate change, which may enhance risk of some of the present anthropogenic and natural stressors. Figure 93 presents an example of climate change pathways that may ultimately affect cetacean fitness in the Mediterranean Sea, which can be compared with the Gulf of Mexico as an analogous enclosed ocean basin with similar stressors as well as many cetacean inhabitants. We consider and integrate this information as part of the baseline when synthesizing our summaries for effects of the proposed action on the two ESA-listed marine mammals in the Gulf of Mexico.

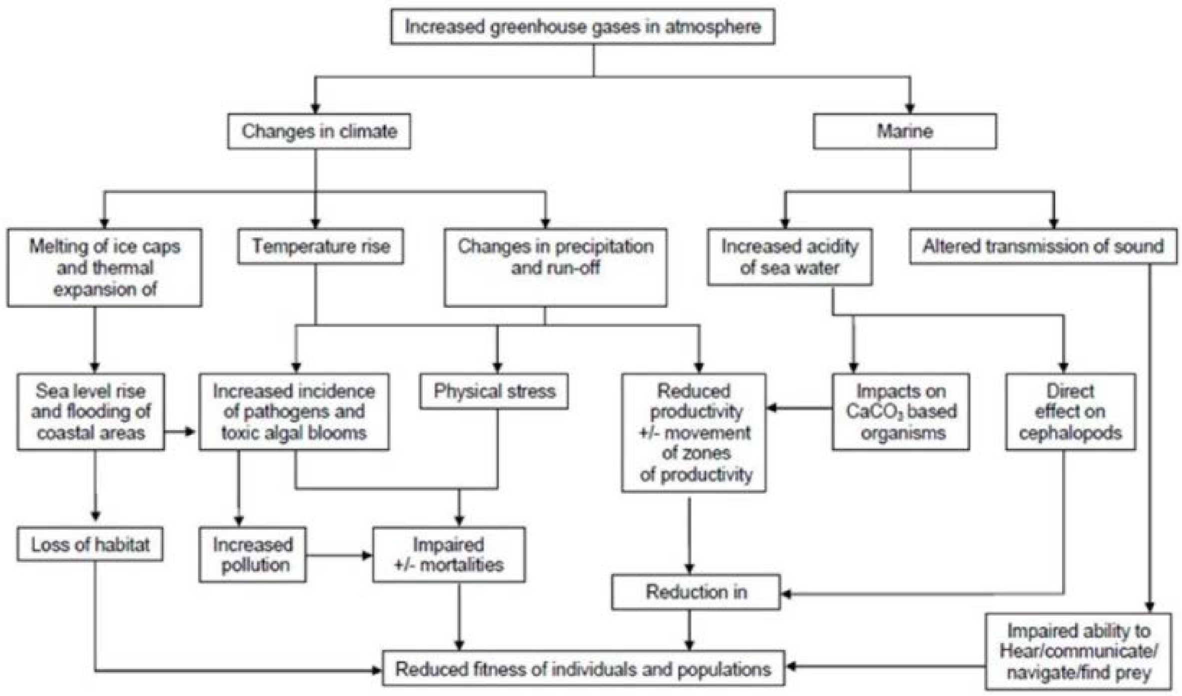


Figure 93. Pathways of marine mammal fitness reductions as a result of climate change in the Mediterranean Sea (Simmonds et al. 2012).

Throughout this analysis, we make full consideration of how the status of the species, the environmental baseline, and the expected cumulative effects interact with the stressors caused by the proposed action in order to evaluate whether the proposed action is likely to jeopardize the continued existence of Gulf of Mexico Bryde's whales and sperm whales either directly or indirectly, by appreciably reducing the likelihood of both the survival and recovery of these species in the wild by reducing their reproduction, numbers, or distribution.

From our *Effects Analysis*, we identified several activities and associated stressors that are likely to adversely affect Gulf of Mexico Bryde's whales and sperm whales in the action area. We briefly summarize these here, and provide more details regarding exposure levels and population-level impacts for each species in the subsections below.

1. Vessel strike – Both Gulf of Mexico Bryde's whales and sperm whales will likely be adversely affected by vessel strikes associated with the proposed action. Vessel strikes are expected to result in mortality and sub-lethal injuries that may reduce individual fitness depending on the nature of the injury.
2. Geological and Geophysical survey sound – Both Gulf of Mexico Bryde's whales and sperm whales are expected to be exposed to sounds from seismic airgun surveys that

would result in behavioral harassment, which may disrupt critical behaviors such as foraging, feeding, and mating, as well as TTS. In addition, Gulf of Mexico Bryde's whales could be exposed to sounds from seismic airgun surveys that would result in PTS, and sperm whales are expected to be exposed to sounds from HRG sound sources that would result in behavioral harassment and/or TTS. In addition to these adverse effects, exposure to chronic sound from geological and geophysical survey sounds is expected to elicit a stress response in Gulf of Mexico Bryde's whales and mask important biological and environmental sounds. While no lethal effects are expected for either species from exposure to geological and geophysical survey sounds, given the overall high level of repeat exposure, and the importance of acoustics to marine mammals, impacts to individual fitness are expected in some cases.

3. Sounds from Oil and Gas Program vessels – Given the frequencies at which sperm whales and Gulf of Mexico Bryde's whales are expected to hear best, only Gulf of Mexico Bryde's whales are expected to be adversely affected by sound from oil and gas program vessels. The entire population of Gulf of Mexico Bryde's whales is expected to be exposed to chronic noise from vessels associated with the oil and gas program, which is likely to result in chronic stress and masking of important biological and environmental sounds, both of which may impact individual Gulf of Mexico Bryde's whale fitness.
4. Pile driving sound – Sperm whales are expected to be exposed to sounds from pile driving that would result in harassment and TTS. When repeat exposure is expected, there may be impacts to individual sperm whale fitness. Given the expected location of pile driving and the distribution of Gulf of Mexico Bryde's whales, this species is not expected to be exposed to sound from pile driving at levels that would have adverse effects.
5. Marine debris ingestion and/or entanglement – Both Gulf of Mexico Bryde's whales and sperm whales are expected to be exposed to marine debris produced by the proposed action and be affected through ingestion and/or entanglement. Both species are expected to experience sublethal injuries that may adversely affect individual fitness, and sperm whales are expected to experience mortality due to exposure to this stressor.
6. Exposure to oil spills and dispersants – Gulf of Mexico Bryde's whales and sperm whales are expected to be exposed to oil spills and the use of dispersants associated with the proposed action. For sperm whales, the effects of exposure to oil spills and dispersants is expected to range from minor injuries to reductions in fitness, severe injury, and death. Given that there is less potential for overlap of the distribution of Gulf of Mexico Bryde's whales with where oil spills are expected to be most probable, effects to this species are expected to be minor, with no effects to fitness expected.

Uncertainty

While our analysis and conclusions in this opinion rely on the best available scientific and commercial data regarding the exposure, response, and potential consequences of Oil and Gas Program activities on endangered whales, there is uncertainty. We describe the aspects of greatest uncertainty in this section. First, quantifying the fitness consequences of sub-lethal impacts from acoustic stressors is exceedingly difficult for marine mammals, including sperm whales and Gulf of Mexico Bryde's whales, as few studies have been conducted. We do not currently have data to conduct a quantitative analysis on the likely consequences of such sub-lethal impacts.

Second, although the modeling conclusions from the BOEM analysis represent the best available data on exposure of marine mammals to acoustic stressors from geophysical surveys, the model assumes that proposed activities occur in generalized locations based on BOEM's assessment of where these activities are most likely to occur over the next 50 years. NMFS does not currently have the ability to confirm that activities will be implemented in the same areas and at the same time of year as they were modeled. This means that the take estimates produced by the BOEM modeling may not represent realized take.

Third, there is uncertainty regarding confirmed observations of Bryde's whales outside of the area where this species is primarily found. There has been at least one confirmed sighting in the western Gulf and unconfirmed observations west of their predominant habitat area. Because of this uncertainty regarding confirmed observations, we were not able to use the information for Bryde's whales outside the habitat preference area towards our jeopardy analysis (see Section 14 for more information).

Fourth, the final MMPA rule will not be completed at the time the biological opinion is released. The opinion may need to be amended once the MMPA rule is finalized depending on the contents of the final rule.

Fifth, regarding the vessel strike analysis, there is relatively high uncertainty in the density model for Bryde's whales outside the Bryde's whale area (defined in Section 8.1.2.1), as indicated by the high coefficient of variation for the model parameters (Figure 94). This may come from the relatively few sightings of baleen whales outside that area that were used to develop the density models for the Bryde's whale. Furthermore, many of the sightings outside the area are actually observations of baleen whales that were unconfirmed but assumed to be Bryde's whales. Therefore, while we examined overall effects of vessel strike and estimated potential strike events using the density model, we determined that potential strike events outside the Bryde's whale area, where we have lower confidence in the density estimates, would not be used for the jeopardy analysis. That said, observation data for sperm whales in the Gulf of Mexico are considered more reliable. For sperm whales, we did not discount vessel strikes for the jeopardy analysis in any particular area given that the sperm whale density model has relatively low uncertainty over most of the action area (Figure 95).

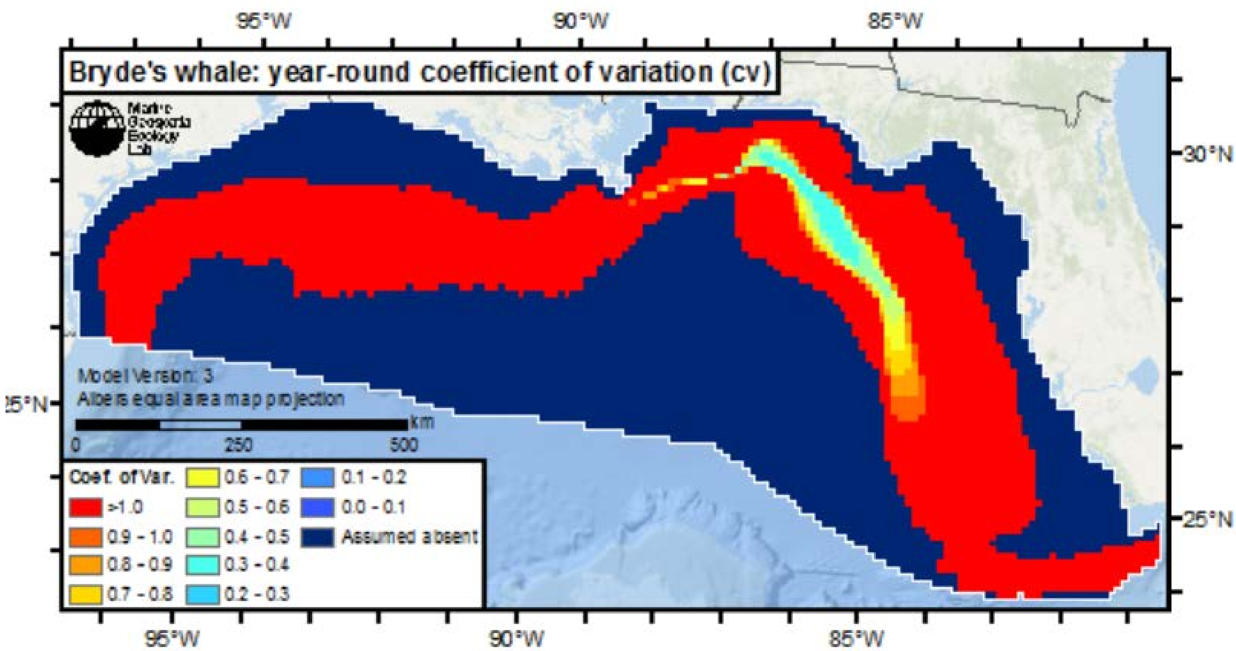


Figure 94. Bryde's whale density model coefficient of variation (Roberts et al. 2016b).

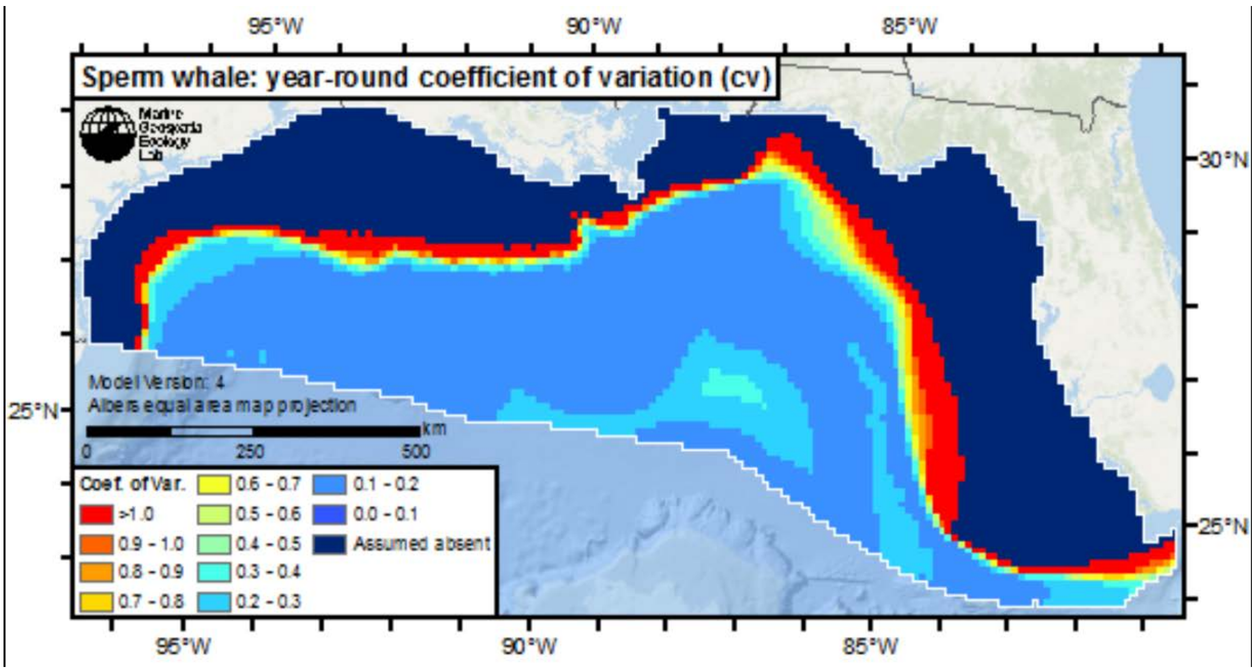


Figure 95. Sperm whale density model coefficient of variation (Roberts et al. 2016b).

For our effects analysis for sound, we did not discount exposures outside of the Bryde's whale area for the Bryde's whale jeopardy analysis. This is because the effects of sound are much broader ranging and have wide overlapping ensonified areas. Additionally, because sound from G&G activities is ongoing, can occur over long durations and propagate over long distances, it is much more likely to affect Bryde's whales that, on occasion, travel outside the core area. For a vessel strike to occur outside the preferred habitat, a Bryde’s whale and moving vessel must both be present and interact at the exact same time and place, which we find to be a less certain scenario to predict. Thus, the probability of Bryde’s whales crossing the paths of vessels and being struck outside of the Bryde’s whale area is much lower than the probability of Bryde’s whales being exposed to sound from seismic vessels that would result in meaningful effects. The effects of sound outside the Bryde’s whale area resulting from the proposed activity are then considered towards the jeopardy analysis.

11.1.1 Gulf of Mexico Bryde’s whales

A summary of all the expected exposures over 50 years and their associated effects for Gulf of Mexico Bryde’s whales is given below in Table 121.

Table 121. Summary of effects of the proposed action on the Gulf of Mexico Bryde’s whale over 50 years. The G&G exposure estimates do not account for BOEM’s revised action, which removed the area under the GOMESA moratorium.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS as noted)	TTS, behavioral harassment and/or stress
Sound from G&G activities	0	600* (PTS)	22,550*
Entanglement or entrapment	0	0	0
Vessel strike	17	6	0
Pile driving	0	0	0
Oil spills	0	4	0
Explosive severance	0	0	0
Marine debris	0	1	0

** Estimates do not account for removal of the GOMESA moratorium area.*

As discussed in the *Status of the Species and Critical Habitat Analyzed Further* (Section 6.2), the Gulf of Mexico Bryde’s whale is listed as endangered under the ESA primarily because of very low population numbers. The listing rule also identifies the most serious threats to the species as small population size, energy exploration, development, and production, oil spills and oil spill responses, vessel collision, anthropogenic noise, and fishing gear entanglement.

The most recent estimate from 2009 estimates the population size at 33 individuals (Rosel 2016). Based on habitat model density estimates that incorporate visual survey data from 1992 to 2009, Roberts et al. (2016a) estimated 44 individuals, which is what we focused on for our analyses. Given the best available scientific information, and allowing for the uncertainty in Gulf of Mexico Bryde's whale occurrence in non-U.S. waters of the Gulf of Mexico, there are likely less than 100 individuals (Rosel 2016). While there is no information on the population trend, they are thought to have recently experienced a decline due to the DWH oil spill (Trustees 2016).

Section 6.2 *Status of Species and Critical Habitat Analyzed Further* and Section 7 *Environmental Baseline* identified historical commercial whaling, vessel strikes, anthropogenic noise, fisheries interactions, and oil and gas development as the primary reasons for the small population's proposed endangered status. The status review (Rosel 2016) and the listing rule for the Gulf of Mexico Bryde's whale concluded that this species "has a high risk of extinction." Although large-scale commercial whaling no longer occurs in the Gulf of Mexico, the other threats identified above continue. Anthropogenic noise from vessel traffic and seismic exploration threaten the subspecies ability to communicate, and vessel traffic also poses a risk of vessel strike. Furthermore, the population is likely still subject to threats due to fisheries interactions and is thought to have been heavily impacted by the 2010 DWH oil spill. *Cumulative Effects* expected to affect the Gulf of Mexico Bryde's whale in the future include effects from activities similar to those identified in the Section 6.2 and Section 7, the most prominent of these being vessel strike, anthropogenic noise, and oil and gas development, which are expected to continue in the future at similar levels.

Based on our *Effects Analysis* (Section 8), we estimate the following exposure and responses of Gulf of Mexico Bryde's whales from the proposed action. For vessel strike, we estimate 17 mortalities and six sublethal strikes over the 50-year period of the program. However, because many of the estimated strike events would be expected to occur outside the area that Bryde's whales are typically found (i.e., the Bryde's whale area described in section 8.1.2.1) and because of the uncertainty associated with information regarding confirmed sightings and where these animals are expected to be found outside that area, we did not use estimated vessel strike events outside the Bryde's whale area towards our jeopardy analysis. Even after eliminating those potential strikes from further consideration, the proposed action would still result in vessel strikes in the Bryde's whale area.

For sound associated with G&G surveys, we expect, on average based on BOEM's modeling, 12 annual exposures at levels that would result in auditory injury (PTS) (600 over the 50-year period) and 451 annual exposures at levels that would result in harassment (TTS and/or behavioral disturbance) (22,550 over the 50-year period). However, these estimates do not take into account the removal of the area under the GOMESA moratorium from the proposed action. Assuming that Bryde's whales would avoid being exposed to PTS levels of G&G-associated sounds, we rely on the Ellison et al. (2016) 80 percent aversion value (i.e., 80 percent of PTS exposures will be avoided) to estimate that up to 120 (of the total 600 estimated exposures) individuals could be exposed to sound levels that cause hearing loss over the 50 years of the proposed action without the proposed closure. These PTS exposures could be reduced (to harassment level exposures) and perhaps avoided given the GOMESA area was removed from the proposed action. However, individual whales may travel outside the bounds of the GOMESA moratorium area. Associated with the estimated exposures (Section 8.5.2.1), we expect individuals to experience stress responses, with a greater stress response for PTS compared to TTS and behavioral disturbance.

We anticipate that PTS may have long-term effects on individuals' ability to hear important biological and environmental sounds, and thus may have effects on the fitness of at least some of the individuals exposed to PTS inducing levels. While single exposures to TTS and/or behavioral disturbance sound levels is only expected to produce minor, short-term effects on individuals and no fitness consequences, our analyses indicate that individuals would be repeatedly exposed to TTS and/or behavioral disturbance sound levels from geological and geophysical surveys within a single year and chronically exposed to such levels over the 50-year period. This high level of exposure to TTS/behavioral disturbance sound levels from geological and geophysical surveys is expected to negatively affect the fitness of at least some individuals through masking and/or chronic stress responses. For sound from oil and gas program vessels, we expect the entire population to be chronically exposed to sound levels that would mask important biological and environmental sounds and result in chronic stress of individuals, both of which are expected to impact the fitness of at least some individuals in the population. For marine debris, we estimate one sublethal injury over the 50-year period of the proposed action (0.02 annually), which may impact the fitness of the affected individual. Finally, for oil spills and dispersants, our spatially explicit approach estimated that up to 19 exposures to oil spills and dispersants would occur, and based on our approach that framed the severity of these exposures, most individuals are expected to experience only minor exposure, with no effects to fitness anticipated. Based on these exposure levels, the proposed action will reduce the numbers and reproduction of Gulf of Mexico Bryde's whales.

Hearing loss resulting from temporary exposure to PTS-causing sound levels is not expected to deafen animals, but will likely affect the hearing ability of whales in the frequencies of the sound that caused the damage. For airgun sound, the main energy that can produce PTS is between 10 and 2,000 Hz, depending on the proximity of a whale to the airguns. Hearing loss at these lower frequencies may inhibit an animal's ability to hear lower frequency sounds produced by ships, construction activities, seismic surveys, or communication signals of animals. The ability to detect human sounds may be important to provide information of the location and direction of human activities, and may provide a warning of nearby activities that may be hazardous. Permanent hearing impairment will likely have some adverse consequences on affected animals. However, data are not readily available to evaluate how such permanent hearing threshold shifts directly relate to individual fitness.

Chronic stress may lead to an overall reduction in health and could have negative effects on reproduction (Rolland et al. 2017; Rolland et al. 2012; Rolland et al. 2016). Based on the available data, we expect all Bryde's whales will experience chronic exposure to sounds associated with seismic activity. Such exposure is expected to result in chronic stress in some individuals, which may have impacts on health and ultimately fitness. Chronic exposure to seismic sound is also expected to interfere with Bryde's whale communication and mask important biological cues, which is expected to negatively affect the fitness of individual Bryde's whales by interfering with individuals' abilities to find mates and disrupting mother-calf communication. While it is possible that Bryde's whales may adjust their communication to cope with changes in ambient sound, as has been suggested in North Atlantic right whales (Parks et al. 2007; Parks et al. 2011; Tennessen and Parks 2016), if such changes occur, we expect them to occur over many years and not without negative effects to individuals along the way.

The modeling results show that the potential to harass Bryde's whales from HRG surveys is exceedingly low. As shown in Table 76 for Bryde's whales over 50 years, the total number of individuals is less than one.

While harassment is expected to result in some avoidance of areas impacted by the proposed action, given that the vast majority of habitat predicted to be suitable for the species appears to be currently occupied (see Figure 22), we do not expect the proposed action will have significant impacts on the distribution of the species. In fact, as discussed in Section 6.2.3, the current, isolated distribution of the majority of Bryde's whales in the northeastern portion of the Gulf of Mexico may indeed be the result of long-term avoidance of areas of heavy oil and gas development.

Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. The Gulf of Mexico Bryde's whale population is extremely small (approximately 44 individuals), likely recently experienced a significant decline due to the DWH incident, has low genetic diversity, and experiences numerous anthropogenic threats, many of which are expected to continue in the future. Given this precarious status, any effects that are expected to reduce the fitness of individuals or result in mortality are of great concern. For example, the death of one female, which would constitute an acute effect on vital rates in the framework presented in Figure 91, would constitute the loss of approximately five percent of the breeding population (assuming the sex ratio is at 1:1 (Rosel 2016), making population level effects likely; see Figure 92).

Based on our *Effects Analysis*, assuming no mitigation, we estimated that every four to seven years approximately 2.3 percent of the population (one individual whale, assuming stable population size of approximately 44 individuals) would be removed from the population due to a lethal vessel strike from a vessel associated with the proposed action (acute effects in Figure 91). For the time period covered under the program, every individual in the population is expected to be harassed several times per year (on average) due to sound exposure and chronically exposed to vessel noise associated with the proposed action.

Based on the combined effects of exposure to the stressors produced by the proposed action over the entire 50-year period, we expect that all individual Gulf of Mexico Bryde's whales not killed by vessel strikes associated with the proposed action (or by other means) are likely to experience chronic stress and behavioral disruption associated with noise from the proposed action, significant masking, and hearing loss, all of which are expected to reduce the fitness of individuals by reducing their reproduction and/or survival (i.e., effects to vital rates mediated through health impacts as in Figure 91 and scaled for multiple stressors and multiple individuals as in Figure 92). From mortality, we expect associated reductions in calf production, hence population decline. In addition to experiencing these effects, one individual is expected to also ingest or become entangled in marine debris, and several individuals are also expected to be exposed to oil spills and dispersants. In isolation (i.e., considering no other stressors), only minor effects from oil spill and dispersant exposure are expected, but given the multitude of stressors oil exposed individuals are expected to experience, it is possible that exposure to oil spills and dispersants may further impact individual whale fitness.

In summary, over the course of the 50-year proposed action, the entire small, isolated of Gulf of Mexico Bryde's whales is expected to experience a reduction in fitness from combined stressors resulting from the proposed action. There is uncertainty about the number of individuals that are expected to be killed by vessels under the proposed action, but the combination of all other stressors is considered. Given these wide-ranging, combined multiple effects to the small and likely declining population of this species, we find that the proposed action is likely to jeopardize the continued existence of the Gulf of Mexico Bryde's whale by appreciably reducing the likelihood of both the survival and recovery of this species in the wild.

11.1.2 Sperm Whale

A summary of all the expected exposures as a result of the proposed action over 50 years and their associated effects for sperm whales is shown in Table 122.

Table 122. Summary of effects of the proposed action on the sperm whale over 50 years. The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS as noted)	TTS, behavioral harassment and/or stress
Sound from G&G activities	0	0	1,610,105
Entanglement or entrapment	0	0	0
Vessel strike	16	6	0
Pile driving	0	0	0
Oil spills	712 exposures which will likely result in a range of responses including mortality (at least one), injury, reproductive failure, impairment, and harassment		
Explosive severance	0	0	0
Marine debris	1	3	0

Most harassment to sperm whales from seismic sound is expected to occur in the CPA where both the greatest amount of survey activity is proposed and the greatest concentrations of sperm whales are expected to occur. However, sperm whales are found throughout the northern Gulf of Mexico and may be adversely affected anywhere a G&G survey occurs. Our estimate for the most individuals harassed per year is 2,128, which consists of the entire population of sperm whales in the Gulf of Mexico. The number of days each whale is harassed is expected to be variable, but will average 16 days/yr for the entire population. From the perspective of the daily additive effects of reduced foraging success resulting from repeated disturbance of foraging dives, and disturbance of mom/calf pairs, the duration of the effect of disturbance on individuals could have some consequences on the fitness of individuals. Based on BOEM's modeling of seismic survey using multiple source vessels, the number of harassment days per year Gulfwide is not expected to increase over the course of the proposed action, but the duration of exposure each day can be prolonged when multiple source vessels are used. Approximately 35 percent of the total survey days proposed would involve four-vessel surveys. Therefore, the harassment resulting from multiple-vessel surveys can result in longer duration exposures per day that may have a heightened adverse reduction in daily foraging rates of sperm whales.

Sperm whales that are occasionally exposed to disturbing sound levels for short periods less than 30 minutes/day (sufficient duration of exposure that can disrupt one foraging dive) would be expected to have less severe consequences than if the disturbance occurred repeatedly over the course of many hours each day. Longer, intermittently repeated, or consecutive days of exposure would reduce an individual animal's foraging success and may not provide sufficient amounts of time for animals to compensate for or resume normal foraging dives over the disturbance period. However, the occurrence of the daily reductions on foraging are not expected to occur over long consecutive periods of time and will occur intermittently. For example, on average individual whales will be harassed an average of 16 days a year, and with only 35 percent of the total survey days involving four-vessel surveys, sperm whales on average would be exposed to four-vessel surveys on average only 5.6 days per year. Sperm whales and survey vessels would move in relation to each other over large oceanic areas such that harassment is less likely to occur over consecutive days. However, in the areas where survey effort is higher, repeated harassment is more likely. Over 50 years, individual animals could be harassed by repeat occurrences of reductions in foraging, which in turn could adversely affect those animals. We expect that an individual sperm whale exposed infrequently would recover quickly and be able to make up for the lost foraging time. However, a calf or pregnant or lactating mother that is exposed multiple times over a short span could have longer lasting effects to the extent of stillbirth, calf abandonment by the mother, or terminal starvation for an individual sperm whale.

The modeling results show that the potential to harass sperm whales from HRG surveys is exceedingly low. There is a potential for only one sperm whale to be harassed every ten years from an HRG survey, or five whales over the 50 years of the proposed action.

Individual sperm whales are likely to be adversely affected from exposure to marine debris (through entanglement or ingestion) as a result of the proposed action. Exposure to marine debris may have sublethal effects on individual whales, including reduced fitness.

The *Status of Species Analyzed Further* and *Environmental Baseline* (Sections 6.2 and 7) indicate the primary reason for sperm whale ESA-listed status is historical commercial whaling. With the threat of large-scale commercial whaling now gone, sperm whales have shown strong signs of recovery with higher estimates of their abundance perhaps approaching population sizes prior to commercial whaling. They still face several threats, however, including vessel interactions, incidental capture in fishing gear, habitat degradation (including pollution and sound), and military operations. Sperm whale occur in all oceans of the world. The best estimate of the current worldwide abundance of sperm whales is between 300,000 and 450,000 individuals (Whitehead 2002). Within the Atlantic, their abundance is estimated at 90,000 to 134,000 individuals and within the Gulf of Mexico, there are between 763 (NMFS 2015c) and 2,128 (Roberts et al. 2016a) resident whales. While there are no long-term estimates of abundance trends within the Gulf of Mexico, sperm whales in this region are thought to have been heavily impacted by the DWH oil spill, which may have resulted in a population decline (Chiquet et al. 2013). Sperm whales are still likely one of the most abundant large whale species, and on a global scale they show little genetic differentiation in terms of nDNA likely due to male sperm whales roaming widely. Within ocean basins, and even more so within semi-enclosed basins such as the Gulf of Mexico, sperm whales do show some genetic differentiation based on mtDNA, which is thought to be the consequence of shorter-ranging, in some cases resident, females. As none of the stocks for which data are available have high levels of genetic diversity, the species may be at some risk to inbreeding and 'Allee' effects, although the extent of this risk is currently unknown.

As noted above, sperm whales in the Gulf of Mexico were likely impacted by the 2010 DWH oil spill. *Cumulative Effects* expected to affect the sperm whales in the future include effects from activities similar to those identified in the *Status of Species Analyzed Further* and *Environmental Baseline* (Sections 6.2 and 7), the most prominent of these being vessel strike, fisheries interactions, and habitat degradation (including that due to sound and pollution), which are expected to continue in the future at similar levels.

Our *Effects Analysis* Section 8 estimated the following exposure and responses of sperm whales due to the proposed action. For vessel strike, we estimate an average of 0.32 mortalities per year (16 over the 50-year period) and an average of 0.12 non-lethal injuries per year (six over the 50-year period), which may reduce individual fitness depending on the nature of the injury. We expect about 70 percent of the vessel strikes, both non-lethal and lethal, will affect females. We further expect there will be an equal likelihood of vessels striking calves and adults, and that strikes with calves will always be lethal. The vessel strike protocol described in **Appendix C**, if implemented, in addition to the vessel strike NTL 2016-G01, should aid in the reduction of the likelihood of some of these potential strikes. For sound associated with geological and geophysical surveys (seismic surveys and HRG sources), we expect 32,202 annual exposures at levels that would result in harassment (TTS and/or behavioral disturbance) (1,610,100 over the 50-year period). Associated with these exposures, we expect individuals will also experience concurrent stress responses, with a more severe stress response likely to occur from more severe effects (i.e., greater stress response for TTS compared to behavioral disturbance). While single exposures to sound levels that could cause TTS and/or behavioral disturbances is only expected to produce minor, short-term effects on individuals and no fitness consequences, our analyses indicate that individuals would be repeatedly exposed to sound levels that cause TTS and/or behavioral disturbance sound levels from geological and geophysical surveys within a single year and chronically exposed to such levels over the 50-year period. This potential for multiple and high level of exposures that may cause TTS and/or behavioral disturbances from geological and geophysical surveys is expected to negatively affect the body condition of sperm whales and ultimately the fitness of at least some individuals through lost foraging opportunities and/or chronic stress. For marine debris, we estimate one lethal injury from debris ingestion and/entanglement over the 50-year period (0.02 annually), as well as three sublethal injuries over the 50-year period (0.06 annually), which may impact the fitness of the affected individual depending on the nature of the injury. Finally, for oil spills and dispersants, our spatially explicit approach estimated that up to 2,118 exposures to oil spills and dispersants would occur. Based on our approach that framed the severity of these exposures, most individuals are expected to experience minor exposure, with only approximately 10 percent expected to be exposed at levels that would affect fitness. Thus, the proposed action will result in reductions in numbers and reproduction of sperm whales.

While harassment is expected to result in some avoidance of areas impacted by the proposed action, we do not expect the proposed action will reduce the distribution of the species. Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. The overall effects of the proposed action on sperm whales in the Gulf of Mexico indicate that the entire population is likely to experience repeat harassment over the course of the 50-year proposed action, which if frequent enough, may have effects on sperm whale vital rates such as reproduction via behaviorally mediated responses (e.g., see Section 8.5.2.1 chronic effects). As discussed in Section 8.4, Farmer et al. (2018b), found that due to exposure to sounds associated only with geological and geophysical surveys, there were not significant effects at the population level (when relying on the Wood et al. step-function used in this opinion). However, there were significant impacts to body condition, which has implications for reproductive potential and calf size and fitness. Furthermore, at least some of the same sperm whales repeatedly harassed by geological and geophysical survey sounds are expected to experience additional harassment and/or TTS due to pile driving and minor exposure to oil spills and dispersants, with a smaller number further incurring sublethal injuries due to marine debris. Exposure to all of these additional stressors is expected to exacerbate the effects of being exposed to any single stressor. In addition, we estimate that on average four sperm whales will be killed by vessels associated with the proposed action annually and approximately 10 percent of the population are expected to experience a reduction in fitness directly as a result of exposure to oil spills and dispersants (i.e., acute effects depicted in Figure 87). Given that these additional factors were not considered in the Farmer et al. (2018b) analysis, the absence of population-level consequences found in their study underestimates the population consequences of the full proposed action on the species (also see Table 2 in (Farmer et al. 2018b)). Thus, in considering the full suite of stressors to which sperm whales in the Gulf of Mexico would be exposed from the proposed action, the current status of the species within the action area, effects of the environmental baseline as well as those of predicted future cumulative effects, we determined that the proposed action is likely to have negative population-level consequences to sperm whales in the Gulf of Mexico (i.e., lead to a population decline), though data are unavailable to quantitatively estimate the magnitude of these consequences.

In the Gulf of Mexico, there are estimated to be 763 to 2,128 individual sperm whales. At a maximum, this represents only two percent of all sperm whales in the Atlantic, and less than one percent of the species abundance globally. Since this resident population is only a small percentage of all sperm whales globally, any adverse effects to the Gulf of Mexico subpopulation are extremely small relative to the overall size of the listed species' population. As noted above in Section 6.2, sperm whales in the Gulf of Mexico are primarily composed of resident maternally-related groups of females and juveniles. Male sperm whales tend to be wide ranging and not resident to any particular area, which is likely why the species shows little genetic differentiation based on nDNA, despite clear evidence of matrilineal differentiation based on mtDNA. Given the global connectedness of sperm whale populations, genetic similarities across subpopulations, and the very small percentage the affected Gulf of Mexico subpopulation makes up of sperm whales globally, we find that the proposed action is not likely to jeopardize the continued existence of the sperm whales directly and indirectly, by appreciably reducing the likelihood of the survival and recovery of the species in the wild.

11.2 Sea Turtles

Adult sea turtles use large oceanic areas, and displacement from the area of a seismic survey is not expected to result in a decrease in foraging success or increase in predation risk to individuals, hence displacement should not matter much to adult turtles. However, due to the repeated nature of seismic survey sound over long periods and ranges, we expect the disturbance to both adults and oceanic juveniles to have adverse effects on sea turtles. As a result of the proposed action, individual turtles may be affected by temporary hearing loss once or multiple times in their lives, and there may be numerous behavioral responses to many individuals.

The information in Section 8 *Effects of the Action on Species* indicates that ESA-listed sea turtles may become entangled in seismic equipment. There is considerable uncertainty regarding the frequency of such entanglements, as the available data mostly remain anecdotal (Keatos Ecology 2009; Nelms et al. 2016; Weir 2007). A literature review by Nelms et al. (2016) was conducted to look at potential impacts of seismic survey gear to sea turtles. The paper identified seismic gear entanglement as a potential physical risk and noted that research was relatively minimal when compared with other marine animal groups (Nelms et al. 2016).

As discussed in the *Status of Species Analyzed Further* and *Environmental Baseline* (Sections 6.2 and 7) sections, the major anthropogenic stressors that contributed to the sharp decline of sea turtle populations in the past include habitat degradation, direct harvest, commercial fisheries bycatch, and marine debris. While sea turtle populations are still at risk, efforts made over the past few decades to reduce the impact of these threats have slowed the rate of decline for many populations (see Section 8.6.2 for details). Bycatch reduction devices have reduced the incidental take of sea turtles in many U.S. commercial fisheries. Turtle excluder devices, which are required in federal shrimp trawl fisheries, are estimated to have reduced mortality of sea turtles by approximately 95 percent (NMFS 2014b). Mitigation measures required in other federal and state fisheries (e.g., gill net, pelagic longline, pound nets) have also resulted in reduced sea turtle interactions and mortality rates. Increased conservation awareness at the international scale has led to greater global protection of sea turtles. While vessel strikes, power plants, dredging, pollutants, and oil spills still represent sources of mortality, sea turtle mortalities resulting from these activities within the action area are expected to either remain at current levels, or possibly decrease with additional research efforts, conservation measures, and the continued implementation of existing environmental regulations. Based on our *Cumulative Effects* analysis (Section 11), it is likely that some current threats to sea turtles will increase in the future. These include global climate change, marine debris, and habitat degradation. However, it is difficult to predict the magnitude of these threats in the future or their impact on sea turtle populations.

All sea turtle life stages are important to the survival and recovery of the species; however, it is important to note that one life stage may not be equivalent to other life stages. For example, the take of male juveniles may affect survivorship and recruitment rates into the reproductive population in any given year, and yet not significantly reduce the reproductive potential of the population. For sea turtles, a very low percent of hatchlings is typically expected to survive to reproductive age; therefore, the loss of hatchlings from a population level standpoint is not as significant with respect to the survivial and recovery of the species as the loss of older life stages. The death of mature, breeding females, however, can have an immediate effect on the reproductive rate of the species. Sublethal effects on adult females may also reduce reproduction by hindering foraging success, as sufficient energy reserves are probably necessary for producing multiple clutches of eggs in a breeding year.

In our *Effects Analysis* (Section 8) we identified the activities and associated stressors from the proposed action that would likely affect ESA-listed sea turtles in the action area. We briefly summarize these stressors here, and provide more details regarding exposure levels, life stages, and population level impacts for each species (or DPS) in the subsections below. While mitigations may not be quantifiable, we consider them qualitatively in this *Integration and Synthesis*.

1. Seismic survey sound - All five sea turtle species would likely be exposed to sounds from seismic airgun surveys at pressure levels at or above 175 dB re: 1 μPa (rms). Seismic surveys may be conducted in the Gulf of Mexico 24-hours per day, seven days a week, year-round resulting in a high number of estimated exposures to species. Although seismic surveys would likely affect a large number of individual sea turtles, and multiple exposures of individual turtles is likely over the course of the proposed action, the effects of this stressor are expected to be short-term and relatively minor. Anticipated sea turtle responses to seismic survey sound are harassment and TTS.
2. Pile driving sound - All five sea turtle species would likely be exposed to sound from pile driving. Anticipated sea turtle responses to pile driving sound are PTS and disturbance. PTS will likely lead to reduced fitness or survival for at least some of the individual sea turtles that experience this response.
3. Vessel strike - Vessel strikes associated with the proposed action would likely have both lethal and sublethal effects on a large number of sea turtles within the action area.
4. Entanglement in equipment - We expect a small number of sea turtles (i.e., less than two per species) would be lethally entangled in OBN survey equipment as a result of the proposed action.
5. Capture in nets – Site clearance activities involving trawl nets would likely result in the capture of all sea turtle species within the action area, except hawksbills. These interactions are expected to be sublethal due to the BOEM trawl tow time limit of 30 minutes. Anticipated responses of captured sea turtles include increased stress and potential injury.
6. Marine debris ingestion and/or entanglement – All five sea turtle species would likely be exposed to adverse effects associated with marine debris produced by the proposed action. For most individual sea turtles exposed, marine debris would likely result in sublethal effects. We estimate that about 15 percent of those exposed would result in mortality.
7. Exposure to sound and/or impact from explosives – All five sea turtle species would likely be exposed to adverse effects from explosives used for structure severance. Both lethal and sublethal effects are anticipated from this activity. Lethal injuries result from massive trauma or combined trauma to internal organs as a result of close proximity to the point of detonation. Non-lethal effects from explosives include eardrum rupture, permanent hearing loss or impairment, bruising, temporary immobilization of severely stunned animals, and behavioral disturbance. In some cases, non-lethal injuries would reduce individual sea turtle fitness by affecting reproduction, foraging, and other critical life functions.
8. Exposure to oil spills and dispersants – Oil spills associated with the proposed action would likely have both lethal and sublethal effects on a large number of sea turtles within the action area. The anticipated effects on sea turtles exposed to oil range from minor to severe depending on the spill volume and exposure level. The large majority (~ 90 percent) of exposures are expected to have minimal to moderate effects on individual sea turtles. These include light to moderate irritation to eyes, skin, and respiratory organs, incidental oil ingestion, and contamination of *Sargassum* and benthic habitats. Based on

> our analysis, we estimated approximately ten percent of oil spill exposures would result in more severe sublethal or lethal effects. Moderate to high levels of oil exposure are more likely to result in fitness consequences for individual sea turtles exposed. Anticipated effects include: impairment of feeding, swimming, and mating behaviors; high degree of irritation to eyes, ears, and respiratory structures; ingestion of large amounts of oil; and large patches of *Sargassum* killed.

Different age classes may experience varying rates of mortality and resilience. We summarize the combined effects of the proposed action by type of effect (i.e., *mortality*, *sublethal physical injury or impairment*, and *behavioral harassment or stress*) and life stage (i.e., adult or neritic juvenile, and oceanic juvenile) in the tables below for each sea turtle species or DPS (Table 123 through Table 128). *Mortality* includes severely oiled turtles (that we anticipate would eventually die) and all other stressors resulting in direct sea turtle mortality. *Sublethal physical injury or impairment* includes moderate to high oil exposure, injuries that could lead to fitness consequences, and sound induced hearing loss (PTS or TTS, as noted). While PTS is not necessarily indicative of a serious injury (e.g., minor hearing range loss), in some instances it can lead to reduced fitness or survival (e.g. impair the ability to hear predators, approaching vessels, or environmental acoustic cues used in navigation). Since we do not have information on the severity of PTS, and since some instances of PTS may be considered serious injury and affect sea turtle fitness, we conservatively combine it with *serious injury* for purposes of our jeopardy analysis. B*ehavioral harassment or stress* includes minimal to moderate oil exposure, sublethal effects of marine debris ingestion, and behavioral harassment.

Estimates shown in Table 123 through Table 128 represent the anticipated number of exposures resulting in each type of effect over 50 years. Since we anticipate multiple or repeated exposures of some turtles to the sublethal effects from a particular stressor, these numbers do not represent the number of individual turtles affected. For mortality, the number of exposures is equal to the number of individual turtles exposed since this effect cannot be repeated on an individual. We conservatively rounded all exposure estimates up to the nearest whole integer.

While the 50-year aggregated estimates are very high for each species (except for leatherback, relatively speaking), care must be taken when comparing those totals with current abundance estimates, which are a snapshot based on annual nesting data (adult females and hatchlings only) and/or aerial surveys (detecting adults only). There are a multitude of factors that play into sea turtle population dynamics from year to year, so we mainly discuss annual reductions as they relate to survival and recovery. There is even more uncertainty when discussing oil spills, as an annual average may not actually represent what is occurring over time. In years where there are no major spills, this number may be overestimated, and conversely, in years where major spills occur, the annual number may be underestimated. While average annual estimates of take are provide for each species as a best approximation, we recognize that there will be fluctuation from year to year and for some stressors this variation can be considerable.

11.2.1 Green Sea Turtle North Atlantic DPS

We summarize the combined effects of the proposed action on the green sea turtle North Atlantic DPS by type of effect (i.e., *mortality*, *sublethal physical injury or impairment*, and *behavioral harassment or stress*) and life stage (i.e., adult or neritic juvenile, and oceanic juvenile) in Table 123 below.

Table 123. Summary of the combined effects of the proposed action on the green sea turtle North Atlantic DPS by type of effect and life stage (values shown represent the number of exposures resulting in each type of effect over 50 years). These values include the breakdown of the hardshell turtle category as described in Section 8.5.6 and include only the North Atlantic DPS. The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Sound from G&G activities*	0	10,244,328 (TTS) 435,025 adult / neritic juv. 9,810,384 oceanic juv.	73,751,790 3,124,061 adult / neritic juv. 70,627,728 oceanic juv.
Entanglement or entrapment	5 adult / neritic juv.	0	528 adult / neritic juv.
Vessel strike	405,696 18,672 adult / neritic juv. 387,024 oceanic juv.	203,952 9,408 adult / neritic juv. 194,544 oceanic juv.	0
Pile driving	0	4,896 (PTS) 48 adult / neritic juv. 4,848 oceanic juv.	1,536 oceanic juv.
Oil spills	87,148 exposures which will likely result in a range of responses including mortality, injury, impairment, and harassment		
Explosive severance	193** 44 adult / neritic juv. 149 oceanic juv.	243 44 adult / neritic juv. 199 oceanic juv.	396 oceanic juv.
Marine debris	26,771 532 adult / neritic juv. 26,239 oceanic juv.	157,465 3,120 adult / neritic juv. 154,345 oceanic juv.	0

** Exposures to G&G sound are high and multiple exposures of individual turtles is likely over the course of the proposed action. Sound from G&G surveys also found to likely adversely affect juvenile sea turtle prey.*

*** The estimated number of takes resulting in mortality and physical injury were combined for the analysis of explosive effects on sea turtles. For our risk analysis, we conservatively assume that all such incidences of physical injury from explosives could lead to mortality.*

The green sea turtle was initially listed as threatened under the ESA on July 28, 1978 (except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered). On May 6, 2016, 11 DPSs of this species were listed, including the North Atlantic DPS which was listed as threatened.

From our *Effects Analysis* (Section 9) we estimated over 8,000 adult and neritic juvenile exposures and over 200,000 oceanic juvenile exposures of North Atlantic DPS green sea turtles annually to sound levels that could cause TTS from airgun surveys. We anticipate many green sea turtles will experience repeated exposures to seismic airgun sound both within a given year and over the individual's life span. Of those individuals exposed, we expect the large majority would only experience short-term behavioral harassment effects, while the other would experience TTS. We estimated that 98 North Atlantic DPS green sea turtles (mostly oceanic juveniles) would experience a permanent reduction in hearing abilities (PTS) annually due to exposure to pile driving sound; another 31 oceanic juveniles would be harassed annually by pile driving sound. Based on our analysis, we estimated there would be 373 lethal and two non-lethal vessel strikes of adult and neritic juvenile North Atlantic DPS green sea turtles annually under the proposed action. We also estimated that the proposed action would result in 7,740 lethal and 3,891 non-lethal vessel strikes of ocean juveniles of this DPS annually. About nine North Atlantic DPS green sea turtles (mostly oceanic juvenile life stage) would be exposed annually to underwater explosives used for structure removal, with a range of effects including disturbance, impairment, injury and mortality. Site clearance trawling activity is expected to result in the sublethal capture of an estimated 11 adult or neritic juvenile North Atlantic DPS green sea turtles annually. We also estimate up to one North Atlantic DPS green sea turtle mortality per year from entanglement in seismic survey equipment, for a total of five estimated over the 50 year proposed action. Marine debris discharged as a result of the proposed action would likely affect over 3,685 North Atlantic DPS green sea turtles annually. The large majority (i.e., 98 percent) affected by marine debris would be smaller (oceanic life stage) juveniles. We anticipate lethal effects for about 15 percent of green sea turtles exposed to marine debris. We estimated over 1,743 adult and neritic juvenile North Atlantic DPS green sea turtle exposures to oil annually as a result of the proposed action. Over 99 percent of green sea turtles exposed to oil would likely experience only minor to moderate effects; about one percent would experience more serious fitness consequences or lethal effects.

Over the next fifty years, we estimate there will be over 19,000 deaths of adult and neritic juvenile green sea turtles in the North Atlantic DPS as a result of the Oil and Gas Program. Thus, the proposed action will result in a reduction in numbers of North Atlantic DPS green sea turtles. Many more individuals will experience decreased fitness from sublethal effects including serious injury and PTS. Because many of the turtles that will be killed or experience decreased fitness will be females, the proposed action will also result in a reduction in reproduction of this DPS. For oceanic juveniles North Atlantic DPS green sea turtles, an estimated 413,412 deaths will occur, while many more will be adversely affected from a combination of effects including sublethal injuries, impairment, behavioral harassment and stress. Thus, every individual green sea turtle in the North Atlantic DPS will likely be harassed and many will be injured or killed as a result of the proposed action. Harassment or minor injury resulting from the proposed action is expected to be temporary, and serious injury or mortality is expected to be spread across the action area. We expect an increased likelihood of consequential effects when exposures and associated effects are long-term and repeated, occur in locations where the animals are conducting critical activities, and when the animal affected is in a compromised state.

Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 annual nesting females (Seminoff et al. 2015). This underestimates the number of adult females since mature females return to their natal beaches to lay eggs every two to four years (Balazs 1983). The total adult and neritic population size of this DPS, which includes inter-nesting females, adult males, and neritic juveniles is, therefore, likely several times larger than the 167,424 estimate of annual nesting females. Compared to the total adult and neritic juvenile population size, the estimated number of adults or neritic juveniles that would likely be killed or seriously injured (363) annually is extremely small. Conservatively, we estimate that less than 0.1 percent of the adult and neritic population would be killed or seriously injured annually as a result of the proposed action. We estimate that 3,299 oceanic juvenile North Atlantic DPS green sea turtles would be killed or seriously injured annually as a result of the proposed action. Based on the sea turtle density data used in our effects analysis, we estimated there are 897,529 oceanic life stage juvenile North Atlantic DPS green sea turtles in the action area. Therefore, we estimate that less than 0.4 percent of the oceanic juveniles in the action area would be killed or seriously injured annually as a result of the proposed action. Since oceanic juveniles from this DPS are widely distributed throughout the Atlantic, Caribbean and the entire Gulf of Mexico, the proportion of oceanic juveniles for the DPS as a whole that would be killed or seriously injured is likely even smaller than 0.4 percent. In summary, although the anticipated mortalities would result in a reduction in absolute population numbers, the overall abundance and reproduction of the green sea turtle North Atlantic DPS would not be substantially reduced.

A significantly larger proportion of the green sea turtle North Atlantic DPS would likely be exposed to stressors that result in harassment or minor injury, including temporary hearing impairment. The large majority of TTS and behavioral harassment effects on green sea turtles would be from seismic survey activity. Although seismic surveys would likely affect a large number of individual sea turtles, and multiple exposure of some individual turtles is likely over the course of the proposed action, the effects of this stressor would be short-term and relatively minor. In most instances, exposure to seismic survey sound would not likely result in the reduced fitness or survival of individual green sea turtles. Similarly, green sea turtles adversely affected by minor injuries or disturbance resulting from oil spills and the use of dispersants would be expected to recover with little to no lasting effects on individual fitness or survival.

While green sea turtles from the North Atlantic DPS regularly use the northern Gulf of Mexico area where the proposed action would occur, this DPS is widely distributed throughout the entire Gulf of Mexico, Caribbean, and Atlantic. The proportion of this DPS within the action area at any given time is relatively low. Evidence from mitochondrial DNA studies indicates that the North Atlantic DPS includes at least four independent nesting subpopulations in Florida, Cuba, Mexico and Costa Rica (Seminoff et al. 2015). The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts 79 percent of nesting females for the DPS (Seminoff et al. 2015). Although a major oil spill in the Northern Gulf of Mexico would result in adverse impacts to large numbers of North Atlantic DPS green turtles in a short period of time, the relative proportion of the DPS that is expected to be exposed to and directly impacted by a major oil spill is relatively small. In addition, the impacts would primarily be to smaller (oceanic life stage) juveniles with lower reproductive value compared to adults and larger (neritic life stage) juveniles, thus reducing the overall impact to the population.

While the major threats to green sea turtles within the action area (e.g., vessel strikes, marine debris, habitat loss, climate change, oil spills, and fisheries bycatch) will likely continue over the next 50 years, the cumulative impact of these threats is expected to either remain at current levels, or possibly decrease with additional research efforts and conservation measures. Based on recent population trends, the green sea turtle North Atlantic DPS appears to be somewhat resilient to future perturbations. Nesting beach monitoring data and a Population Viability Analysis indicate that there is a 0.3 percent probability that this population will fall below the trend reference point (50 percent decline) at the end of 100 years, and a zero percent probability that this population will fall below the absolute abundance reference (100 females per year) at the end of 100 years (Seminoff et al. 2015).

Available data indicate an increasing trend in nesting for the North Atlantic DPS (NMFS 2017g; Seminoff et al. 2015). According to data collected from Florida's index nesting beach survey from 1989 to 2016, green sea turtle nest counts across Florida have increased approximately 100-fold from a low of 267 in the early 1990s to a high of 27,975 in 2015. Modeling by Chaloupka et al. (2008a) using data sets of 25 years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9 percent, and the Tortuguero, Costa Rica, population growing at 4.9 percent. Given the extremely small proportion of the population that we expect would be killed or seriously injured, we believe the proposed action will not have a measureable effect on the increasing trend in nesting abundance for this DPS. Although a substantial proportion of the DPS would likely experience harassment (including TTS), the effects on individual sea turtles would likely be minor, short-term and are not expected to result in fitness consequences. Depending on the exact location and other factors (i.e. time of year, spill volume, oceanographic conditions), a major oil spill could impact large numbers of North Atlantic DPS green sea turtles within the action area. However, since the DPS is widely distributed throughout the entire Gulf of Mexico, Caribbean, and Atlantic, we expect the number of green sea turtles within the oil spill footprint to be relatively small compared to the DPS population as a whole. The largest nesting subpopulation by far is in Costa Rica, which is a considerable distance from the action area (Seminoff et al. 2015). Overall, based on our integration and synthesis of the relevant factors, we do not expect that the reductions in numbers and reproduction expected to result from the proposed action would reduce appreciably, the likelihood of both the survival and recovery of the green sea turtle North Atlantic DPS in the wild.

11.2.2 Green Sea Turtle South Atlantic DPS

We summarize the combined effects of the proposed action on the green sea turtle South Atlantic DPS by type of effect (i.e., *mortality*, *sublethal physical injury or impairment*, and *behavioral harassment or stress*) and life stage (i.e., adult or neritic juvenile, and oceanic juvenile) in Table 123 below.

Table 124. Summary of the combined effects of the proposed action on the green sea turtle South Atlantic DPS by type of effect and life stage (values shown represent the number of exposures resulting in each type of effect over 50 years). The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Sound from G&G activities*	0	426,847 (TTS) 19,000 adult / neritic juv. 408,766 oceanic juv.	3,072,991 130,169 adult / neritic juv. 2,942,822 oceanic juv.
Entanglement or entrapment	0	0	22 adult / neritic juv.
Vessel strike	16,904 778 adult / neritic juv. 16,126 oceanic juv.	8,498 392 adult / neritic juv. 8,106 oceanic juv.	0
Pile driving	0	204 (PTS) 2 adult / neritic juv. 202 oceanic juv.	64 oceanic juv.
Oil spills	3,631 exposures which will likely result in a range of responses including mortality, injury, impairment, and harassment		
Explosive severance	8** 2 adult / neritic juv. 6 oceanic juv.	10 2 adult / neritic juv. 8 oceanic juv.	17 oceanic juv.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Marine debris	1,115 22 adult / neritic juv. 1,093 oceanic juv.	6561 130 adult / neritic juv. 6,431 oceanic juv.	0

** Exposures to G&G sound are high and multiple exposures of individual turtles is likely over the course of the proposed action. Sound from G&G surveys also found to likely adversely affect juvenile sea turtle prey.*

*** The estimated number of takes resulting in mortality and physical injury were combined for the analysis of explosive effects on sea turtles. For our risk analysis, we conservatively assume that all such incidences of physical injury from explosives could lead to mortality.*

The green sea turtle was initially listed as threatened under the ESA on July 28, 1978 (except for the Florida and Pacific coast of Mexico breeding populations, which were listed as endangered). On May 6, 2016 11 DPSs of this species were listed, including the South Atlantic DPS which was listed as threatened. As noted in the *Status of Species* Section 6.2.5, we expect that approximately four percent of the green sea turtles in the Gulf of Mexico are part of the South Atlantic DPS, whereas the other 96 percent are made up of North Atlantic DPS individuals.

From our *Effects Analysis* (Section 9) we estimated over 2,983 adult and neritic juvenile exposures and more than 67,000 oceanic juvenile exposures of South Atlantic DPS green sea turtles annually to the effects of sound from airgun arrays. We anticipate many green sea turtles will experience repeated exposures to seismic airgun sound both within a given year and over the individual's life span. Of those individuals exposed, we expect the large majority (i.e., 88 percent) would only experience short-term behavioral harassment effects, while the other 12 percent would experience TTS. We estimated that about four South Atlantic DPS green sea turtles (mostly oceanic juveniles) would experience a permanent reduction in hearing abilities (PTS) annually due to exposure to pile driving sound; another two oceanic juveniles would be harassed annually by pile driving sound. Based on our analysis, we estimated there would be about 15 lethal and eight non-lethal vessel strikes of adult and neritic juvenile South Atlantic DPS green sea turtles annually under the proposed action. We also estimated that the proposed action would result in 323 lethal and 162 non-lethal vessel strikes of ocean juveniles of this DPS annually. Less than one oceanic juvenile South Atlantic DPS green sea turtle would be exposed annually to underwater explosives used for structure removal, with a range of effects including disturbance, impairment, injury and mortality. Site clearance trawling activity is expected to result in the sublethal capture of less than one adult or neritic juvenile South Atlantic DPS green sea turtles annually. Marine debris discharged as a result of the proposed action would likely affect about 22 South Atlantic DPS green sea turtles annually. The large majority (i.e., 98 percent) affected by marine debris would be smaller (oceanic life stage) juveniles. We anticipate lethal effects for about 15 percent of green sea turtles exposed to marine debris. We estimated about 73 adult and neritic juvenile South Atlantic DPS green sea turtle exposures to oil annually as a result of the proposed action. Over 99 percent of green sea turtles exposed to oil would likely experience only minor to moderate effects; about one percent would experience more serious fitness consequences or lethal effects.

Over the next fifty years, we estimate there will be over 800 deaths of adult and neritic juvenile green sea turtles from the South Atlantic DPS as a result of the Oil and Gas Program. Thus, the proposed action will result in a reduction in numbers of South Atlantic DPS green sea turtles. Other individuals will experience decreased fitness from sublethal effects including serious injury and PTS. Because many of the turtles that will be killed or experience decreased fitness will be females, the proposed action will also result in a reduction in reproduction of this DPS. For oceanic juvenile South Atlantic DPS green sea turtles, an estimated 17,225 deaths will occur over 50 years, while many more will be adversely affected from a combination of effects including sublethal injuries, impairment, behavioral harassment and stress. Harassment or minor injury resulting from the proposed action is expected to be temporary, and serious injury or mortality is expected to be spread across the action area. We expect an increased likelihood of consequential effects when exposures and associated effects are long-term and repeated, occur in locations where the animals are conducting critical activities, and when the animal affected is in a compromised state.

Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. Much of the green sea turtle South Atlantic DPS is data poor with only occasional or incomplete nesting surveys. In the 2015 status review, Seminoff et al. (2015) could only estimate female abundance for 14 of the 51 identified nesting areas for this DPS. A minimum estimate of abundance, based only on the 14 areas with abundance data, is approximately 66,351 annual nesting females (Seminoff et al. 2015). This underestimates the number of adult females since it does not include females from 37 other known nesting areas, nor does it include inter-nesting females (Balazs 1983). The total adult and neritic population size of this DPS, which includes inter-nesting females, adult males, and neritic juveniles is, therefore, likely several times larger than the 66,351 estimate of nesting females from 14 nesting areas. Compared to the total adult and neritic population size, the estimated number of adults or neritic juveniles that would likely be killed or seriously injured annually is extremely small. The estimate of annual mortality and serious injury for adults and juveniles combined still represent an extremely small proportion of the DPS abundance (i.e., << 0.1 percent). In summary, although the anticipated mortalities would result in a reduction in absolute population numbers, the overall abundance and reproduction of the green sea turtle South Atlantic DPS would not be substantially reduced.

A larger proportion of South Atlantic DPS green sea turtles, particularly oceanic juveniles, would likely be exposed to stressors that result in harassment or minor injury, including temporary hearing impairment. The large majority of TTS and behavioral harassment effects on green sea turtles would be from seismic survey activity. Although seismic surveys would likely affect a large number of individual sea turtles, and multiple exposure of some individual turtles is likely over the course of the proposed action, the effects of this stressor would be short-term and relatively minor. In most instances, exposure to seismic survey sound would not likely result in the reduced fitness or survival of individual green sea turtles. Similarly, green sea turtles adversely affected by minor injuries or disturbance resulting from oil spills and the use of dispersants would be expected to recover with little to no lasting effects on individual fitness or survival.

The South Atlantic DPS boundary begins at the border of Panama and Colombia (77° W, 7.5° N), heads due north to77° W, 10.5° N, then northeast to 63.5° W, 19° N, and along 19° N latitude to Mauritania in Africa, to include the U.S. Virgin Islands in the Caribbean. It extends along the coast of Africa to South Africa, with the southern border being the 40° S latitude. Nesting occurs on beaches along eastern South America from Brazil to the Caribbean portion of the South Atlantic including Caribbean South America, along the western coast of Africa from mid-Mauritania to South Africa, and in the middle of the South Atlantic on Ascension Island. Therefore, although South Atlantic DPS green sea turtles are occasionally found within the action area, their primary range and all nesting beaches are found quite a distance from the northern Gulf of Mexico. For purposes of our effects analysis, we assumed that only four percent of the green sea turtles within the action area were from this DPS.

While the major threats to green sea turtles within the action area (e.g., vessel strikes, marine debris, habitat loss, climate change, oil spills, and fisheries bycatch) will likely continue over the next 50 years, the cumulative impact of these threats is expected to either remain at current levels, or possibly decrease with additional research efforts and conservation measures. Population trends cannot be estimated for this DPS due to the lack of long-term monitoring data (Seminoff et al. 2015). However, considering that the action area represents only a marginal portion of the DPS range, and given the extremely small proportion of the population that we anticipate would be killed or seriously injured, we believe the proposed action will not have a measureable effect on the population trend for this DPS. Overall, based on our integration and synthesis of the relevant factors, we do not expect that the reductions in numbers and reproduction expected to result from the proposed action would reduce appreciably, the likelihood of both the survival and recovery of the green sea turtle South Atlantic DPS in the wild.

11.2.3 Kemp's Ridley Sea Turtle

The Kemp's ridley sea turtle was listed as endangered on December 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA. We summarize the combined effects of the proposed action on the kemp's ridley sea turtle by type of effect (i.e., *mortality*, *sublethal physical injury or impairment*, and *behavioral harassment or stress*) and life stage (i.e., adult or neritic juvenile, and oceanic juvenile) in Table 125 below.

Table 125. Summary of the combined effects of the proposed action on Kemp's ridley sea turtles by type of effect and life stage (values shown represent the number of exposures resulting in each type of effect over 50 years). The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Sound from G&G activities*	0	10,924,459 (TTS) 2,221,309 adult / neritic juv. 8,703,150 oceanic juv.	78,648,278 15,991,877 adult / neritic juv. 62,656,400 oceanic juv.
Sound from vessels	0	0	0
Entanglement or entrapment	20 adult / neritic juv.	0	4,150 adult / neritic juv.
Vessel strike	105,000 10,100 adult / neritic juv. 94,900 oceanic juv.	197,850 19,050 adult / neritic juv. 178,800 oceanic juv.	0
Pile driving	0	10,100 (PTS) 5,800 adult / neritic juv. 4,300 oceanic juv.	1,400 oceanic juv.
Oil spills	487,151 exposures which will likely result in a range of responses including mortality, injury, impairment, and harassment		
Explosive severance	454** 322 adult / neritic juv. 132 oceanic juv.	544 368 adult / neritic juv. 176 oceanic juv.	352 oceanic juv.
Marine debris	29,496 415 adult / neritic juv. 29,081 oceanic juv.	173,516 2,450 adult / neritic juv. 171,066 oceanic juv.	0

** Exposures to G&G sound are high and multiple exposures of individual turtles is likely over the course of the proposed action. Sound from G&G surveys also found to likely adversely affect juvenile sea turtle prey.*

*** The estimated number of takes resulting in mortality and physical injury were combined for the analysis of explosive effects on sea turtles. For our risk analysis, we conservatively assume that all such incidences of physical injury from explosives could lead to mortality.*

From our *Effects Analysis* (Section 9) we estimated over 364,000 adult and neritic juvenile exposures and over 1.4 million juvenile exposures of Kemp's ridley sea turtles annually to the effects of sound from airgun arrays. We anticipate many Kemp's ridley sea turtles will experience repeated exposures to seismic airgun sound both within a given year and over the individual's life span. Of those individuals exposed, we expect the large majority (i.e., 88 percent) would only experience short-term behavioral harassment effects, while the other 12 percent would experience TTS. We estimated that 116 adult and neritic juvenile and 86 oceanic juvenile Kemp's ridley sea turtles would experience a permanent reduction in hearing abilities (PTS) annually due to exposure to pile driving sound; another 28 oceanic juveniles would be harassed annually by pile driving sound. Based on our analysis, we estimated there would be 202 lethal and 381 non-lethal vessel strikes of adult and neritic juvenile Kemp's ridley sea turtles annually under the proposed action. We also estimated that the proposed action would result in 1,898 lethal and 3,576 non-lethal vessel strikes of ocean juveniles annually. While injuries caused by vessel strike could have an indirect adverse effect on hatchling numbers, we would not expect the impact to be so much as to cause population-level effects. A small number (i.e., about eight per year) of Kemp's ridley sea turtles would be exposed annually to underwater explosives used for structure removal, with a range of effects including disturbance, impairment, injury and mortality. Site clearance trawling activity is expected to result in the sublethal capture of an estimated 83 adult or neritic juvenile Kemp's ridley sea turtles annually. We also estimate up to one Kemp's ridley sea turtle mortality per year from entanglement in seismic survey equipment. Marine debris discharged as a result of the proposed action would likely affect an estimated 4,060 Kemp's ridley sea turtles annually. The large majority (i.e., 98 percent) affected by marine debris would be smaller (oceanic life stage) juveniles. We anticipate lethal effects for about 15 percent of Kemp's ridley sea turtles exposed to marine debris. We estimated over 16,000 adult and neritic juvenile Kemp's ridley sea turtle exposures and nearly 5,000 oceanic juvenile exposures to oil annually as a result of the proposed action. Over 99 percent of those exposed to oil would likely experience only minor to moderate effects; about one percent would experience more serious fitness consequences or lethal effects.

Over the next fifty years, we estimate there will be nearly 11,000 deaths of adult and neritic juvenile Kemp's ridley sea turtles as a result of the Oil and Gas Program. Thus, the proposed action will result in a reduction in numbers of Kemp's ridley sea turtles. Other individuals will experience decreased fitness from sublethal effects including serious injury and PTS. Because many of the turtles that will be killed or experience decreased fitness will be females, the proposed action will also result in a reduction in reproduction of this species. For oceanic juvenile Kemp's ridley sea turtles, an estimated 124,113 deaths will occur over 50 years, while many more will be adversely affected from a combination of effects including sublethal injuries, impairment, behavioral harassment and stress. Every individual Kemp's ridley will likely be harassed and many will be injured or killed as a result of the proposed action. Harassment or minor injury resulting from the proposed action is expected to be temporary, and serious injury or mortality is expected to be spread across the action area. We expect an increased likelihood of consequential effects when exposures and associated effects are long-term and repeated, occur in locations where the animals are conducting critical activities, and when the animal affected is in a compromised state.

Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. In 2014, there were an estimated 10,987 Kemp's ridley nests from three primary nesting beaches in Mexico (NMFS 2015b). Based on an average 2.5 nests per nesting female, this corresponds to 4,395 nesting females. In 2017, index nesting beaches in Mexico and in Texas reached the highest record of nests (22,415) since 1965 for Kemp's ridley turtles (Caillouet Jr. et al. 2018). To be conservative we used the 2014 nesting estimate. Because Kemp's ridley adult females return to natal beaches to nest every two years, on average, we double this number (i.e., 8,790) to estimate the total number of adult females. To get to the total adult and neritic population size, we need to add adult males and neritic juveniles to the estimate of adult females. If females comprise 76 percent of the population (Gallaway et al. 2013), the number of adults (females and males) is estimated at 11,566. NMFS et al. (2011a) determined the best estimate of age to maturity for Kemp's ridley sea turtles was 12 years. Based on this information, the neritic juvenile life stage would include most Kemp's ridleys ranging in age from about two to four years old (i.e., when they return to nearshore waters after concluding their oceanic phase) to about 12 years old when they become adults. Gallaway et al. (2013) used a demographic model to estimate the total population of age 2+ Kemp's ridley sea turtles at 248,307 in 2012. While this estimate may include some oceanic juveniles that are older than two years, since Kemp's ridley turtles typically return to nearshore coastal habitats around age two (Ogren 1989), the majority of the estimated 248,307 turtles are likely either neritic juvenile or adults. Thus, compared to the total adult and neritic population size (i.e., likely greater than 200,000), the estimated number of adults or neritic juveniles that would likely be killed or seriously injured annually is very small. Conservatively, we estimate that less than 0.2 percent (i.e., 2 out of every 1,000) of the adult and neritic population would be killed or seriously injured annually as a result of the proposed action. We also estimated that over 2,500 oceanic juvenile Kemp's ridley sea turtles would be killed or seriously injured annually as a result of the proposed action. Based on the sea turtle density data used in our effects analysis, we estimated there are 764,381 oceanic life stage juvenile Kemp's ridley sea turtles in the action area. By comparison, the estimated number of oceanic juveniles that would likely be killed or seriously injured (2,138) annually is very small. We conservatively estimate that less than 0.4 percent of the oceanic juvenile Kemp's ridley population would be killed or seriously injured annually as a result of the proposed action. Therefore, although the anticipated adult and juvenile mortalities would result in a reduction in absolute population numbers, the overall abundance and reproduction of the Kemp's ridley population would not be substantially reduced.

A significantly larger proportion of the Kemp's ridley sea turtles would likely be exposed to stressors that result in harassment or minor injury, including temporary hearing impairment. The large majority of TTS and behavioral harassment effects on Kemp's ridley sea turtles would be from seismic survey activity. Although seismic surveys would likely affect a large number of individual sea turtles, and multiple exposure of some individual turtles is likely over the course of the proposed action, the effects of this stressor would be short-term and relatively minor.

Exposure to seismic survey sound would not likely result in the reduced fitness or survival of individual turtles. Similarly, Kemp's ridley sea turtles adversely affected by minor injuries or disturbance resulting from oil spills and the use of dispersants would be expected to recover with little to no lasting effects on individual fitness or survival.

Based upon data beginning in 1966, the number of Kemp's ridley nests increased steadily through 2009 when 19,163 nests were observed at the primary nesting beaches in Mexico (Gallaway et al. 2013). During this period the average annual rate of increase was around 19 percent. The number of nests in Padre Island, Texas have also increased over the past two decades from one nest observed in 1985 to 119 in 2014 (NMFS and USFWS 2015). In 2010, the observed numbers of nests dropped to 12,377, increased back to 19,368 in 2011 and 20,197 in 2012, and then subsequently decreased again to 16,385 nests in 2013 and 10,987 in 2014 (NMFS 2015b).

The Kemp's ridley population is particularly vulnerable to anthropogenic mortality due to the species' limited range and low global abundance. Despite significant continuing threats, the Kemp's ridley population showed signs of steady improvement in recent decades up until 2009. The increase in Kemp's ridley sea turtle nesting seen during this period is likely due to a combination of management measures including elimination of direct harvest, nest protection, the use of TEDs, reduced trawling effort in Mexico and the United States, and possibly other changes in vital rates. After 2009 there appears to be no clear population trend as estimates at the major nesting sites have fluctuated between 10 and 20 thousand nests. Following the 2010 DWH oil spill, unprecedented numbers of Kemp's ridley sea turtles stranded on northern Gulf of Mexico beaches and the number of nests recorded on the primary nesting beaches were far below expected levels (Gallaway et al. 2016b). Depending on the exact location and other factors (i.e. time of year, spill volume, oceanographic conditions), another major oil spill in the northern Gulf of Mexico could impact large numbers of Kemp's ridley sea turtles. In the 2015 five-year status review, NMFS recommended that the Recovery Priority Number for Kemp's ridley sea turtles be changed from '5' to a '1' (NMFS 2015b) A recovery priority '1' is defined as follows: *a species whose extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction, whose limiting factors and threats are well understood and the needed management actions are known and have a high probability of success, and is a species that is in conflict with construction or other developmental projects or other forms of economic activity*.

We expect the stressors associated with oil and gas activities in the northern Gulf of Mexico to adversely affect Kemp's ridley sea turtles. While the major threats to Kemp's ridley sea turtles (e.g., vessel strikes, marine debris, habitat loss, climate change, oil spills, cold-stunning and fisheries bycatch) will likely continue over the next 50 years, the cumulative impact of these threats is expected to either remain at current levels, or possibly decrease with additional research efforts and conservation measures. Given the relatively small proportion of the population that we expect would be killed or seriously injured (i.e., less than 0.4 percent annually), we believe the proposed action will have only a minor effect on population abundance for this species. Although a larger number will experience harassment (including TTS), the effects on individual sea turtles would likely be minor, short-term and are not expected to result in fitness consequences. Overall, based on our integration and synthesis of the relevant factors, we do not expect that the reductions in numbers and reproduction that will result from the proposed action would reduce appreciably, the likelihood of both the survival and recovery of the Kemp's ridley sea turtle in the wild.

11.2.4 Hawksbill Sea Turtle

The hawksbill sea turtle was listed as endangered throughout its entire range on June 2, 1970 under the Endangered Species Conservation Act of 1969, a precursor to the ESA.

We summarize the combined effects of the proposed action on the hawksbill sea turtle by type of effect (i.e., *mortality*, *sublethal physical injury or impairment*, and *behavioral harassment or stress*) and life stage (i.e., adult or neritic juvenile, and oceanic juvenile) in Table 126 below.

Table 126. Summary of the combined effects of the proposed action on hawksbill sea turtles by type of effect and life stage (values shown represent the number of exposures resulting in each type of effect over 50 years). The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Sound from G&G activities*	0	1,069,797 (TTS) 764,847 adult / neritic juv. 304,950 oceanic juv.	7,701,625 5,506,325 adult / neritic juv. 2,195,300 oceanic juv.
Sound from vessels	0	0	0
Entanglement or entrapment	7 adult / neritic juv.	0	0
Vessel strike	550 400 adult / neritic juv. 150 oceanic juv.	20,350 14,850 adult / neritic juv. 5,500 oceanic juv.	0
Pile driving	0	350 (PTS) 200 adult / neritic juv. 150 oceanic juv.	50 oceanic juv.
Oil spills	151,454 exposures which will likely result in a range of responses including mortality, injury, impairment, and harassment		
Explosive severance	51** 46 adult / neritic juv. 5 oceanic juv.	6 oceanic juv.	12 oceanic juv.
Marine debris	1,479	8,726	0

	973 adult / neritic juv. 506 oceanic juv.	5,750 adult / neritic juv. 2,976 oceanic juv.

** Exposures to G&G sound are high and multiple exposures of individual turtles is likely over the course of the proposed action. Sound from G&G surveys also found to likely adversely affect juvenile sea turtle prey.*

*** The estimated number of takes resulting in mortality and physical injury were combined for the analysis of explosive effects on sea turtles. For our risk analysis, we conservatively assume that all such incidences of physical injury from explosives could lead to mortality.*

From our *Effects Analysis* (Section 9) we estimated over 125,000 adult and neritic juvenile exposures and over 50,000 oceanic juvenile exposures of hawksbill sea turtles annually to the effects of sound from airgun arrays. We anticipate many hawksbill sea turtles will experience repeated exposures to seismic airgun sound both within a given year and over the individual's life span. Of those individuals exposed, we expect the large majority (i.e., 88 percent) would only experience short-term behavioral harassment effects, while the other 12 percent would experience TTS. We estimated that about four adult and neritic juvenile and three oceanic juvenile hawksbill sea turtles would experience a permanent reduction in hearing abilities (PTS) annually due to exposure to pile driving sound. Based on our analysis, we estimated there would be about eight lethal and 297 non-lethal vessel strikes of adult and neritic juvenile hawksbill sea turtles annually under the proposed action. We also estimated that the proposed action would result in three lethal and 110 non-lethal vessel strikes of ocean juveniles annually. A small number (i.e., less than two per year) of hawksbill sea turtles would be exposed annually to underwater explosives used for structure removal, with a range of effects including disturbance, impairment, injury and mortality. We also estimate up to one hawksbill sea turtle mortality per year from entanglement in seismic survey equipment. Marine debris discharged as a result of the proposed action would likely affect an estimated 135 adult (or neritic juvenile) and 71 oceanic juvenile hawksbill sea turtles annually. We anticipate lethal effects for about 15 percent of hawksbill sea turtles exposed to marine debris. We estimated 3,030 hawksbill sea turtle exposures to oil annually as a result of the proposed action. Oil exposure as a result of the proposed action would affect an estimated 3,030 hawksbills annually. Over 99 percent of those exposed to oil would likely experience only minor to moderate effects; about one percent would experience more serious fitness consequences or lethal effects.

Over the next fifty years, we estimate there will be nearly 1,400 deaths of adult and neritic juvenile hawksbill sea turtles as a result of the Oil and Gas Program. Thus, the proposed action will result in a reduction in numbers of hawksbill sea turtles. Other individuals will experience decreased fitness from sublethal effects including sublethal injury and PTS. Because many of the turtles that will be killed or experience decreased fitness will be females, the proposed action will also result in a reduction in reproduction of this species. For oceanic juvenile hawksbill sea turtles, over 660 deaths are estimated to occur over 50 years, while many more will be adversely affected from a combination of effects including sublethal injuries, impairment, behavioral harassment and stress. Harassment or minor injury resulting from the proposed action is expected to be temporary, and serious injury or mortality is expected to be spread across the action area.

We expect an increased likelihood of consequential effects when exposures and associated effects are long-term and repeated, occur in locations where the animals are conducting critical activities, and when the animal affected is in a compromised state.

Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. Based on surveys conducted at 88 nesting sites worldwide, approximately 25,500 female hawksbills nest annually (NMFS and USFWS 2013a). For hawksbills that would likely be found within the action area we focus on nesting sites within the Atlantic and Caribbean. The estimated total number of nesting females annually across 33 sites within Atlantic and Caribbean is 4,867 (i.e., midpoint of range from 3,626 to 6,108) (NMFS and USFWS 2013a). Since female hawksbills typically return to their natal beaches every two to three years to nest (van Dam et al. 1991; Witzell 1983), the total number of adult females in the population is likely between two and three times this estimate. Conservatively, we estimate the number of adult females in the Atlantic basin to be around 10,000. To get to the total adult and neritic population size, we need to add adult males and neritic juveniles to the estimate of adult females. Sex ratio studies indicate that hawksbill populations in the Atlantic and Caribbean are female biased, with reported female to male ratios ranging from 2:1 to nearly 8:1 (Hawkes et al. 2013). If we assume a 5:1 sex ratio, the estimated number of adult males in the Atlantic basin is around 2,000. Age to maturity for this species is very long, ranging between 20 and 40 years depending on the region (Chaloupka and Musick 1997; Limpus and Miller 2000). Although population abundance data for non-nesting hawksbills are not available, we would expect a relatively large demographic in the neritic juvenile life stage. Based on sea turtle density data used in our effects analysis, we estimate there are 69,071 adult and neritic juvenile hawksbills within the action area. Compared to this estimate of the adult and neritic population within the action, the estimated number of adults or neritic juveniles that would likely be killed or seriously injured (28) annually is very small. Conservatively, we estimate that less than 0.05 percent (i.e. 5 out of 10,000 individuals) of the adult and neritic population within the action area would be killed or seriously injured annually as a result of the proposed action. We also estimated that 69 oceanic juvenile hawksbill sea turtles would be killed or seriously injured annually as a result of the proposed action. Based on the sea turtle density data used in our effects analysis, we estimated there are 26,782 oceanic life stage juvenile hawksbill sea turtles in the action area. By comparison, the estimated number of oceanic juveniles that would likely be killed or seriously injured (13) annually is very small. We conservatively estimate that less than 0.05 percent of the oceanic juvenile hawksbill population would be killed or seriously injured annually as a result of the proposed action. Therefore, although the anticipated adult and juvenile mortalities would result in a reduction in absolute population numbers, the overall abundance and reproduction of the hawksbill population in the Atlantic basin would not be substantially reduced.

A significantly larger proportion of the hawksbill sea turtles would likely be exposed to stressors that result in harassment or minor injury, including temporary hearing impairment. The large majority of TTS and behavioral harassment effects on hawksbill sea turtles would be from seismic survey activity. Although seismic surveys would likely affect a large number of individual sea turtles, and multiple exposure of some individual turtles is likely over the course of the proposed action, the effects of this stressor would be short-term and relatively minor. Exposure to seismic survey sound would not likely result in the reduced fitness or survival of individual turtles. Similarly, hawksbill sea turtles adversely affected by minor injuries or disturbance resulting from oil spills and the use of dispersants would be expected to recover with little to no lasting effects on individual fitness or survival.

The historical decline of hawksbill sea turtles is primarily attributed to centuries of exploitation for the species' ornate shell (Parsons 1972). The continuing demand for the hawksbills shells, as well as other products derived from the species, represents an ongoing threat to its recovery. Due to their preference to feed on sponges associated with coral reefs, hawksbill sea turtles are particularly sensitive to losses of coral reef communities. There are currently no reliable estimates of population abundance and trends for non-nesting hawksbills at the time of this consultation; therefore, nesting beach data is currently the primary information source for evaluating trends in global abundance. Although greatly depleted from historic levels, several nesting populations in the Atlantic Ocean basin have shown signs of improvement in recent years (NMFS and USFWS 2013a). Based on recent trend data (i.e., within the past 20 years), out of 33 hawksbill nesting sites in the Atlantic basin, 10 show an increasing population trend, 10 a decreasing trend, and for 13 there is insufficient data to determine the trend (NMFS and USFWS 2013a). From 1980 to 2003, the number of nests at three primary Mexico nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS and USFWS 2013a).

Substantial international cooperation and community-based programs to conserve and protect hawksbills exist (e.g., South Pacific Regional Environment Programme, East Pacific Hawksbill Initiative, Inter-American Convention for the Protection and Conservation of Sea Turtles) (NMFS and USFWS 2013a). These and other conservation efforts have resulted in an increased nesting population trend in recent years for half of the Atlantic basin nesting sites for which trend data are available. However, threats from manmade and natural sources remain, including the tortoiseshell trade, poaching, incidental capture in commercial and artisanal fisheries, climate change, and coastal development. While the major threats to hawksbill sea turtles will likely continue over the next 50 years, the cumulative impact of these threats is expected to either remain at current levels, or possibly decrease with additional research efforts and conservation measures. We expect the stressors associated with oil and gas activities in the northern Gulf of Mexico to adversely affect hawksbill sea turtles. Given the relatively small proportion of the population that we expect would be killed or seriously injured (i.e., less than 0.05 percent annually), we believe the proposed action will have only a minor effect on nesting abundance for this species. Although a large number will experience harassment (including TTS), the effects on individual sea turtles would likely be minor, short-term and are not expected to result in fitness consequences. Overall, based on our integration and synthesis of the relevant factors, we do not expect that the reductions in numbers and reproduction expected to result from the proposed action would reduce appreciably, the likelihood of both the survival and recovery of the hawksbill sea turtle in the wild.

11.2.5 Loggerhead Northwest Atlantic Distinct Population Segment

The loggerhead sea turtle was listed as a threatened species throughout its global range on July 28, 1978. NMFS and USFWS published a final rule designating nine DPSs for loggerhead sea turtles on September 22, 2011. The Northwest Atlantic DPS is listed as threatened. We summarize the combined effects of the proposed action on the loggerhead Northwest Atlantic DPS by type of effect (i.e., *mortality*, *sublethal physical injury or impairment*, and *behavioral harassment or stress*) and life stage (i.e., adult or neritic juvenile, and oceanic juvenile) in Table 127 below.

Table 127. Summary of the combined effects of the proposed action on loggerhead sea turtle Northwest Atlantic DPS by type of effect and life stage (values shown represent the number of exposures resulting in each type of effect over 50 years). The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Sound from G&G activities*	0	8,884,870 (TTS) 1,660,970 adult / neritic juv. 7,223,900 oceanic juv.	63,964,818 11,957,867 adult / neritic juv. 52,006,950 oceanic juv.
Sound from vessels	0	0	0
Entanglement or entrapment	19 adult / neritic juv.	25 adult / neritic juv.	1,400 adult / neritic juv.
Vessel strike	47,950 16,700 adult / neritic juv. 31,250 oceanic juv.	127,950 44,550 adult / neritic juv. 83,400 oceanic juv.	0
Pile driving	0	7,600 (PTS) 4,050 adult / neritic juv. 3,550 oceanic juv.	1,150 oceanic juv.
Oil spills	336,630 exposures which will likely result in a range of responses including mortality, injury, impairment, and harassment. *Sargassum* unit of loggerhead critical habitat will also likely be adversely affected.		
Explosive severance	846** 736 adult / neritic juv. 110 oceanic juv.	1,112 966 adult / neritic juv. 146 oceanic juv.	292 oceanic juv.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Marine debris	13,393 1,322 adult / neritic juv. 12,071 oceanic juv.	78,806 7,800 adult / neritic juv. 71,006 oceanic juv.	0

** Exposures to G&G sound are high and multiple exposures of individual turtles is likely over the course of the proposed action. Sound from G&G surveys also found to likely adversely affect juvenile sea turtle prey.*

*** The estimated number of takes resulting in mortality and physical injury were combined for the analysis of explosive effects on sea turtles. For our risk analysis, we conservatively assume that all such incidences of physical injury from explosives could lead to mortality.*

From our *Effects Analysis* (Section 9) we estimated nearly 273,000 adult and neritic juvenile exposures and over 1.2 million oceanic juvenile exposures of loggerhead sea turtles annually to the effects of sound from airgun arrays. We anticipate many loggerhead sea turtles will experience repeated exposures to seismic airgun sound both within a given year and over the individual's life span. Of those individuals exposed, we expect the large majority (i.e., 88 percent) would only experience short-term behavioral harassment effects, while the other 12 percent would experience TTS. We estimated that 81 adult and neritic juvenile and 71 oceanic juvenile loggerhead sea turtles would experience a permanent reduction in hearing abilities (PTS) annually due to exposure to pile driving sound. Another 23 oceanic juveniles may harassed annually as a result of pile driving. Based on our analysis, we estimated there would be about 334 lethal and 891 non-lethal vessel strikes of adult and neritic juvenile loggerhead sea turtles annually under the proposed action. We also estimated that the proposed action would result in 625 lethal and 1,668 non-lethal vessel strikes of ocean juveniles annually. A small number (i.e., about ten per year) of loggerhead sea turtles would be exposed annually to underwater explosives used for structure removal, with a range of effects including disturbance, impairment, injury and mortality. We also estimate up to one loggerhead sea turtle mortality per year from entanglement in seismic survey equipment. Marine debris discharged as a result of the proposed action would likely affect an estimated 183 adult (or neritic juvenile) and 1,663 oceanic juvenile loggerhead sea turtles annually. We anticipate lethal effects for about 15 percent of loggerhead sea turtles exposed to marine debris. We estimated 336,630 loggerhead exposures to oil annually as a result of the proposed action. Over 99 percent of those exposed to oil would likely experience only minor to moderate effects; about one percent would experience more serious fitness consequences or lethal effects.

Over the next 50 years, we estimate there will be over 19,000 deaths of adult and neritic juvenile Northwest Atlantic DPS loggerhead sea turtles as a result of the Oil and Gas Program. Thus, the proposed action will result in a reduction in numbers of Northwest Atlantic DPS loggerhead sea turtles. Other individuals will experience decreased fitness from sublethal effects including sublethal injury and PTS. Because many of the turtles that will be killed or experience decreased fitness will be females, the proposed action will also result in a reduction in reproduction of this species. For oceanic juvenile Northwest Atlantic DPS loggerhead sea turtles, over 43,000 deaths are estimated to occur over 50 years, while many more will be adversely affected from a combination of effects including sublethal injuries, impairment, behavioral harassment and stress. Harassment or minor injury resulting from the proposed action is expected to be temporary, and serious injury or mortality is expected to be spread across the action area. We expect an increased likelihood of consequential effects when exposures and associated effects are long-term and repeated, occur in locations where the animals are conducting critical activities, and when the animal affected is in a compromised state.

Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. Based on nesting data, the adult female population size of the loggerhead Northwest Atlantic DPS is estimated at 20,000 to 40,000 females (NMFS-SEFSC 2009a). To get to the total adult and neritic population size, we need to add adult males and neritic juveniles to the estimate of adult females. Applying a 1:1 sex ratio for this DPS (Conant et al. 2009), we estimate there are about 60,000 total adults (females and males) in the population. Mean age at first reproduction for Northwest Atlantic DPS loggerheads is 30 years, and juveniles spend about 19 years foraging in the neritic zone (Conant et al. 2009). Although population abundance data for non-nesting loggerheads are not available, we would expect a relatively large proportional demographic from the neritic juvenile life stage. Based on sea turtle density data used in our effects analysis, we estimate there are 191,733 adult and neritic juvenile loggerheads within the action area. Compared to this estimate of the adult and neritic population within the action, the estimated number of adults or neritic juveniles that would likely be killed or seriously injured (around 380) annually is very small. Conservatively, we estimate that less than 0.2 percent (i.e., 2 out of every 1,000) of the adult and neritic population would be killed or seriously injured annually as a result of the proposed action.

Based on the sea turtle density data used in our effects analysis, we estimated there are 634,462 oceanic life stage juvenile loggerhead sea turtles in the action area. A preliminary regional abundance survey of loggerheads within the northwestern Atlantic continental shelf estimated about 588,000 loggerheads (NEFSC 2011). This is likely a conservatively low estimate as it does not include unidentified turtles. Correcting for unidentified turtles, the estimate increased to about 801,000 loggerheads. Thus, our estimate of 634,462 oceanic juvenile loggerhead in the action area seems reasonable. By comparison, the estimated number of oceanic juveniles that would likely be killed or seriously injured (around 860) annually is very small. We conservatively estimate that less than 0.2 percent of the oceanic juvenile loggerhead population would be killed or seriously injured annually as a result of the proposed action. Therefore, although the anticipated adult and juvenile mortalities would result in a reduction in absolute population numbers, the overall abundance and reproduction of the Northwest Atlantic loggerhead population would not be substantially reduced.

A significantly larger proportion of the loggerhead sea turtles would likely be exposed to stressors that result in harassment or minor injury, including temporary hearing impairment. The large majority of TTS and behavioral harassment effects on loggerhead sea turtles would be from seismic survey activity. Although seismic surveys would likely affect a large number of individual sea turtles, and multiple exposure of some individual turtles is likely over the course of the proposed action, the effects of this stressor would be short-term and relatively minor. Exposure to seismic survey sound would not likely result in the reduced fitness or survival of individual turtles. Similarly, loggerhead sea turtles adversely affected by minor injuries or disturbance resulting from oil spills and the use of dispersants would be expected to recover with little to no lasting effects on individual fitness or survival.

As of 2009, all four recovery units for this DPS (Peninsular Florida, Northern, Northern Gulf of Mexico, and Greater Caribbean) were exhibiting negative population growth rates (Conant et al. 2009). The 2009 status review concluded that the loggerhead Northwest Atlantic DPS was at risk and likely to decline further due to declines in nest counts at index beaches in the U.S. and Mexico, and continued mortality of juveniles and adults from fishery bycatch (Conant et al. 2009). Lamont et al. (2014) predicted an overall population decline of 17 percent for the St. Joseph Peninsula, Florida subpopulation of the Northern Gulf of Mexico recovery unit (Lamont et al. 2014). The Peninsular Florida recovery unit produces over 80 percent of the nests within this DPS (Ehrhart et al. 2014). Since the start of the Florida Index Nesting Beach Survey program in 1989, counts of loggerhead nests on Florida beaches have ranged from a minimum of 28,876 in 2007 to a maximum of 65,807 nests in 2016 (note: these numbers do not represent Florida’s total annual nest counts because they are collected only on a subset of beaches and only during a 109-day time window) (FFWCC 2018). Following a 52 percent increase between 1989 and 1998, nest counts declined sharply (53 percent) over nearly a decade (1998-2007). However, annual nest counts showed a strong increase (65 percent) since then (2007-2017) (FFWCC 2018). Index beaches in the Florida Panhandle, which are not part of the set of core beaches, had the second highest loggerhead nest counts in 2017 since these surveys to detect trends began in that area in 1997. Based on the currently available information, NMFS categorizes the loggerhead Northwest Atlantic DPS population trend as being stable (NMFS 2017h).

In addition to bycatch, other ongoing threats to this DPS within the action area include vessel strikes, marine debris, habitat loss, climate change, and oil spills. While these threats will likely continue over the next 50 years, the cumulative impact of these threats is expected to either remain at current levels, or possibly decrease with additional research efforts and conservation measures. We expect the stressors associated with oil and gas activities in the northern Gulf of Mexico to adversely affect loggerhead sea turtles. Given the relatively small proportion of the population that we expect would be killed or seriously injured (i.e., less than 0.2 percent annually), we believe the proposed action will have only a minor affect on nesting abundance for this species. Although a substantial proportion of the DPS would likely experience harassment (including TTS), the effects on individual sea turtles would likely be minor, short-term and are not expected to result in fitness consequences. Overall, based on our integration and synthesis of the relevant factors, we do not expect that the reduction in numbers and reproduction expected to result from the proposed action would reduce appreciably, the likelihood of both the survival and recovery of the loggerhead Northwest Atlantic DPS sea turtle in the wild.

11.2.6 Leatherback Sea Turtle

The leatherback sea turtle was listed as endangered throughout its entire range on June 2, 1970, under the Endangered Species Conservation Act of 1969, a precursor to the ESA.

We summarize the combined effects of the proposed action on the leatherback sea turtle by type of effect (i.e., *mortality*, *sublethal physical injury or impairment*, and *behavioral harassment or stress*) and life stage (i.e., adult or neritic juvenile, and oceanic juvenile) in Table 128 below.

Table 128. Summary of the combined effects of the proposed action on leatherback sea turtles by type of effect and life stage (values shown represent the number of exposures resulting in each type of effect over 50 years). The G&G exposure estimates do not account for BOEM's revised action, which removed the area under the GOMESA moratorium.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Sound from G&G activities*	0	67,850 (TTS) adult / neritic juv.	488,350 adult / neritic juv.
Sound from vessels	0	0	0
Entanglement or entrapment	0	25 adult / neritic juv.	100 adult / neritic juv.
Vessel strike	500 adult / neritic juv.	1,400 adult / neritic juv.	0
Pile driving	0	50 (PTS) adult / neritic juv.	0
Oil spills	9,015 exposures which will likely result in a range of responses including mortality, injury, impairment, and harassment		
Explosive severance	46** adult / neritic juv.	46 adult / neritic juv.	0
Marine debris	51 adult / neritic juv.	300 adult / neritic juv.	0

** Exposures to G&G sound are high and multiple exposures of individual turtles is likely over the course of the proposed action. Sound from G&G surveys also found to likely adversely affect juvenile sea turtle prey.*

*** The estimated number of takes resulting in mortality and physical injury were combined for the analysis of explosive effects on sea turtles. For our risk analysis, we conservatively assume that all such incidences of physical injury from explosives could lead to mortality*

From our *Effects Analysis* (Section 10) we estimated over 11,000 adult and neritic juvenile exposures of leatherback sea turtles annually to the effects of sound from airgun arrays. We anticipate many leatherback sea turtles will experience repeated exposures to seismic airgun sound both within a given year and over the individual's life span. Of those individuals exposed, we expect the large majority (i.e., 88 percent) would only experience short-term behavioral harassment effects, while the other 12 percent would experience TTS. We estimated that about one adult or neritic juvenile leatherback sea turtle would experience a permanent reduction in hearing abilities (PTS) annually due to exposure to pile driving sound. Based on our analysis, we also estimated there would be about 10 lethal and 28 non-lethal vessel strikes of adult and neritic juvenile leatherback sea turtles annually under the proposed action. A small number (i.e., about two per year) of leatherback sea turtles would be exposed annually to underwater explosives used for structure removal, with a range of effects including disturbance, impairment, injury and mortality. We also estimate up to one leatherback sea turtle would be entrapped in moon pools per year with sublethal effects including injury and increased stress. An estimated two leatherbacks per year would also be sublethally captured in trawl nets used for site clearance. Marine debris discharged as a result of the proposed action would likely affect an estimated seven adult and neritic juvenile leatherback sea turtles annually. We anticipate lethal effects for about 15 percent of leatherback sea turtles exposed to marine debris. Oil exposure as a result of the proposed action would affect an estimated 180 adult and neritic juveniles annually. Over 99 percent of those exposed to oil would likely experience only minor to moderate effects; about one percent would experience more serious fitness consequences or lethal effects.

Over the next fifty years, we estimate there will be over 600 deaths of adult and neritic juvenile leatherback sea turtles as a result of the Oil and Gas Program. Thus, the proposed action will result in a reduction in numbers of leatherback sea turtles. Other individuals will experience decreased fitness from sublethal effects including sublethal injury and PTS. Because many of the turtles that will be killed or experience decreased fitness will be females, the proposed action will also result in a reduction in reproduction of this species. We do not expect harassment or mortality to oceanic juveniles of this species. Harassment or minor injury resulting from the proposed action is expected to be temporary, and serious injury or mortality is expected to be spread across the action area. We expect an increased likelihood of consequential effects when exposures and associated effects are long-term and repeated, occur in locations where the animals are conducting critical activities, and when the animal affected is in a compromised state.

Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. Because the available nesting information is inconsistent, it is difficult to estimate the total population size for Atlantic leatherbacks. Spotila et al. (1996) characterized the entire Western Atlantic population as stable at best and estimated a population of 18,800 nesting females. Spotila et al. (1996) further estimated that the adult female leatherback population for the entire Atlantic basin, including all nesting beaches in the Americas, the Caribbean, and West Africa, was about 27,600 (considering both nesting and interesting females), with an estimated range of 20,082 to 35,133. This is consistent with the estimate of 34,000 to 95,000 total adults (20,000 to 56,000 adult females; 10,000 to 21,000 nesting females) determined by the TEWG

(2007). Compared to the Atlantic basin adult leatherback population, the estimated number of adults that would likely be killed or seriously injured (around 12) annually is very small. Conservatively using the lower end of the adult population range (34,000), we estimate that less than 0.1 percent of the adult population would be killed or seriously injured annually as a result of the proposed action. Therefore, although the anticipated adult mortalities would result in a reduction in absolute population numbers, the overall abundance and reproduction of the leatherback population in the Atlantic basin would not be substantially reduced. The proposed action is also not expected to result in a reduction in distribution of this species because this species is widely distributed throught the Atlantic, Pacific and Indian Oceans. U.S. primary nesting colonies in the Atlantic are outside the action area.

A significantly larger proportion of the leatherback sea turtles would likely be exposed to stressors that result in harassment or minor injury, including temporary hearing impairment. The large majority of TTS and behavioral harassment effects on leatherback sea turtles would be from seismic survey activity. Although seismic surveys would likely affect a large number of individual sea turtles, and multiple exposure of some individual turtles is likely over the course of the proposed action, the effects of this stressor would be short-term and relatively minor. Exposure to seismic survey sound would not likely result in the reduced fitness or survival of individual turtles. Similarly, leatherback sea turtles adversely affected by minor injuries or disturbance resulting from oil spills and the use of dispersants would be expected to recover with little to no lasting effects on individual fitness or survival.

Currently available information suggests that the leatherback nesting population is stable in most nesting regions of the Atlantic Ocean (NMFS 2017h; NMFS 2013b). Ongoing threats to leatherback sea turtles in the action area include fisheries bycatch, vessel strikes, marine debris, habitat loss, climate change, and oil spills. While the major threats to leatherback sea turtles will likely continue over the next 50 years, the cumulative impact of these threats is expected to either remain at current levels, or possibly decrease with additional research efforts and conservation measures. We expect the stressors associated with oil and gas activities in the northern Gulf of Mexico to adversely affect leatherback sea turtles. Given the relatively small proportion of the population that we expect would be killed or seriously injured (i.e., less than 0.1 percent annually), we believe the proposed action will have only a minor effect on the population abundance for this species. Although a large number of leatherbacks will experience harassment (including TTS), the effects on individual sea turtles would likely be minor, short-term and are not expected to result in fitness consequences. Overall, based on our integration and synthesis of the relevant factors, we do not expect that the reductions in numbers and reproduction expected to result from the proposed action would reduce appreciably, the likelihood of both the survival and recovery of the leatherback sea turtle in the wild.

11.3 Gulf Sturgeon

A summary of all the expected exposures and their associated effects for Gulf sturgeon is given below in Table 129.

Table 129. Summary of effects of the proposed action on the Gulf sturgeon.

Type of Stressor	Lethal (including serious injury that could lead to mortality)	Sublethal physical injury or impairment (including PTS and TTS as noted)	Behavioral harassment or stress
Sound from G&G activities	0	0	0
Sound from vessels	0	0	0
Entanglement or entrapment	0	0	0
Vessel strike	5	1	0
Pile driving	0	0	0
Oil spills	1,200 exposures which will likely result in a range of responses including mortality, injury, impairment, and harassment		
Explosive severance	0	0	0
Marine debris	0	0	0

Gulf sturgeon are listed as threatened under the ESA. There are approximately 15,698 total individuals in the seven managed river populations (Table 31); however, the two populations closest to the majority of oil and gas activities (Pascagoula and Pearl Rivers) have the lowest population estimates. The available data show a roughly stable or slightly increasing population trend in the eastern portion of its range, in Florida river systems. The Escambia River population may have recently declined due to hurricane impacts, whereas the Suwannee River population appears to be slowly increasing. Trends for Pearl and Pascagoula River populations are uncertain (USFWS and NMFS 2009a).

The *Species Status* and *Environmental Baseline* (Sections 6.2 and 7), identified many threats to Gulf sturgeon including pollution, chemicals, bycatch, dredge activities, collisions from leaping out of water, river construction, climate change, red tide, and aquaculture. *Cumulative effects* could include collaborative research and management across states that may result in more information that can aid conservation of Gulf sturgeon. Given current trends in global population growth, threats associated with climate change, pollution, fisheries, vessel traffic, oil and gas activities, scientific research,bycatch, aquaculture, vessel strikes and approaches, and sound are likely to continue to increase in the future, although any increase in effect may be somewhat countered by an increase in conservation and management activities

From our *Effects Analysis*, we identified several activities and associated stressors that are likely to adversely affect Gulf sturgeon in the action area. We briefly summarize these here, and provide more details regarding exposure levels and population-level impacts for each species in the subsections below.

1. Vessel strike- As an emerging threat, Gulf sturgeon are expected to be affected by vessel strikes associated with the proposed action. Vessel strikes are expected to result in mortality and sub-lethal injuries that may reduce individual fitness depending on the nature of the injury.
2. Exposure to oil spills and dispersants- Gulf sturgeon are expected to be exposed to oil spills and the use of dispersants associated with the proposed action. Given that there is little overlap with the distribution of Gulf sturgeon and where oil spills are expected to occur, effects to individuals of this species are expected to range from minor to reductions in fitness, to severe injury and death.

The *Effects Analysis* for Gulf sturgeon estimated one nonlethal and 21 lethal vessel strikes would occur over 50 years as a result of vessels associated with the proposed action. Cumulative effects could include increases in vessel traffic and dredging for larger, deeper draft vessels.

Over the 50-year lifetime of the proposed action, 1,200 oil spill exposures are predicted, with an annual average of 24 exposures. However the severity of those exposures is unknown. The effects of oil on Gulf sturgeon include genotoxicity (fractured DNA) and imunosuppression which can lead to malignancies, cell death, susceptibility to disease, infections, and a decreased ability to heal (FWS 2015). We do not expect severe oiling and direct mortality of Gulf sturgeon since sturgeon do not occur directly within oil and gas leasing areas. Nontheless, we expect that up to 1,200 Gulf sturgeon would be adversely affected primarily through ingestion of contaminated prey or incidental ingestion of drifted oil, resulting in genotoxicity and immunosuppression. Such effects are expected to result in a reduction in fitness of exposed individuals. Thus, the proposed action will result in a reduction in numbers of Gulf sturgeon. Since some of the sturgeon that will be killed or experience decreased fitness will be females, the proposed action will also result in a reduction in reproduction of this species. The proposed action is not expected to result in a reduction in distribution of this species because this species mainly occurs in freshwater river systems and outside the action area. For injury and mortality to this species, we expect it to be across multiple vessel ports with higher number of instances in ports that have higher levels of oil and gas related traffic.

Whether the reduction in numbers and reproduction described above will appreciably reduce the species' likelihood of survival and recovery in the wild depends on the species' response to these reductions. Gulf sturgeon will continue to face the threats previously discussed into the foreseeable future such as habitat loss associated with dams and sills, habitat degradation associated with dredging, de-snagging, and contamination by pesticides, heavy metals, and other industrial contaminants. Effects of climate change also lead to accelerated changes in the habitats utilized by Gulf sturgeon. However, because Gulf sturgeon are long-lived species, adults can reproduce more than once, and no juveniles or spawning habitats are likely to be affect by the Oil and Gas Program activities, we expect future reproduction and recruitment rates to replace any individuals lost through lethal take during Program activities.

Overall, Gulf sturgeon are anticipated to be affected by vessel strikes and oil spills as a result of the proposed action, with vessel strikes resulting in injury and mortality, and oil spills resulting in reductions to fitness but no mortality. Effects of these exposures to Gulf sturgeon vary by population. Smaller populations such as those in the Pearl and Pascagoula Rivers are of higher concern because they have a lower number of individuals and are closer to where oil and gas activities are occurring. The estimated 21 mortalities from vessel strikes would constitute approximately seven to nine percent of the Pearl and Pascagoula rivers respectively, if all 21 individuals were from either of these single populations alone. However, we do not expect all vessel strikes to be of one population such actual percent mortality of individual populations is expected to be low. Across populations, the 21 mortalities represent 0.14 percent of the estimated species abundance. For oil spills, sublethal exposures (i.e., minor to moderate) are likely lead to reduced fitness and could also make individuals more vulnerable to other stressors. Based on our exposure estimate for oil spills, approximately eight percent of the species is expected to have sublethal effects from oil spills and dispersants over the 50-year time period. Thus together we expect that a small (less than one) percent of the population will be killed due to vessel strikes associated with the proposed action, and a slightly larger, but still small (approximately eight) percent would experience sublethal effects, some of which would result in the reduction of fitness for some individuals. Together, these effects are expected to have minimal overall impacts to the species given its abundance of over 15,000 and the increasing or stable trends for several of the larger populations of the species in the eastern portion of its range. Accordingly, we do not expect that the reductions in numbers and reproduction expected to result from the proposed action will reduce appreciably, the likelihood of both the survival and recovery of the Gulf sturgeon in the wild.

11.4 Listed Elasmobranchs

Two ESA-listed elasmobranch species are likely to be found within the action area, the giant manta ray and the oceanic whitetip shark. These two species differ in morphology, physiology, behavior, and ecology, but both are sparsely found within the action area, in relatively low numbers, and expected to be exposed to the same stressors from the proposed action. In this section, we first summarize the stressors giant manta rays and the oceanic whitetip sharks will be exposed to. Following this, we detail our integration and synthesis for each species in which we rely on and summarize information presented in the *Effects of the Action on Species,* the *Species Status*, the *Environmental Baseline*, and the *Cumulative Effects* Sections presented above.

From our *Effects Analysis*, we identified several stressors that are not likely to adversely affect giant manta rays and the oceanic whitetip sharks. These include effects from vessel strike, sound, emissions and discharges, entanglement and entrapment, and marine debris, which were all found to either be discountable, based on the low probability of an adverse effect, or insignificant, based on the magnitude of the expected effect. Taken together, and in consideration of the *Species Status*, the *Environmental Baseline*, and the *Cumulative Effects*, these activities and stressors are also not likely to adversely affect giant manta rays and the oceanic whitetip sharks. That is, even when considering the possible effects of all these stressors and activities together on any individual giant manta ray and the oceanic whitetip shark, we have determined that either adverse effects are extremely unlikely to occur (i.e., discountable) or the combined effect from these stressors are not likely to have a meaningful impact on the individual animal (i.e., insignificant). The only stressor found likely to adversely affect giant manta rays and oceanic whitetip sharks is that of oil spills and dispersants, which is expected to reduce the fitness of individuals exposed and possibly result in mortality depending on the severity of exposure.

11.4.1 Oceanic whitetip shark

The oceanic whitetip shark was recently (2018) listed as threatened under the ESA. This pelagic species is distributed worldwide in tropical and subtropical waters. While there is no range-wide abundance estimate available, it was once one of the most abundant sharks in the ocean. Catch data from individual ocean basins indicate that the populations have undergone significant declines (Young et al. 2017). In the Northwest Atlantic and Gulf of Mexico, the oceanic whitetip shark was described historically as widespread, abundant, and the most common pelagic shark in warm waters. Recent information, however, suggests the species is now relatively rare in this region, with declines estimated to be between 57 and 88 percent (Young et al. 2017). While little information on genetic diversity exists for the species, some data indicate they have low genetic diversity making the species susceptible to inbreeding and 'Allee' effects, although the extent to which is currently unknown. There is mixed evidence regarding genetic structuring and population differentiation across ocean basins, but to date there is no unequivocal evidence for genetic discontinuity or marked separation between Atlantic and Indo-Pacific subpopulations (Young et al. 2017).

In the *Status of Species Analyzed Further* and *Environmental Baseline* Sections, we identified fisheries interactions, from both targeted and non-targeted (i.e., bycatch) fisheries, as the main threat to the species. Due to the species vertical and horizontal distribution, oceanic whitetip sharks are frequently caught as bycatch in many commercial fisheries, including pelagic longline fisheries targeting tuna and swordfish, purse seine, gillnet, and artisanal fisheries. In addition, they are targeted by some fisheries for their large, morphologically distinct fins, which sell for a high price in the Asian fin market. Given the inadequacy of existing regulatory measures to manage these fisheries at a global scale, fisheries interactions are expected to remain a threat to the species as a cumulative effect for the foreseeable future.

As mentioned above, oceanic whitetip sharks are only expected to be adversely affected by the proposed action due to exposure to oil spills and dispersants. Oceanic whitetip sharks are free-swimming, often in deeper, pelagic waters and may aspirate oil and/or dispersants in the water column through their gill filaments. Some small number of oceanic whitetip sharks are likely to be exposed to oil, and those exposures would likely result in effects similar to other marine species such as those displayed in Figure 87, including fitness reduction and possibly leading to mortality. Because there are no abundance estimates for oceanic whitetip sharks in the Gulf of Mexico, we are not able to quantify an estimated number of oil spill exposures or mortalities for this species. Oil and/or dispersants could contact the species' skin, potentially having adverse consequences depending on the severity of exposure. Finally, oceanic whitetip sharks could also ingest oil and/or dispersants if their prey become contaminated, and oil and/or dispersants could also affect prey availability more generally. In our *Effects Analysis*, we were unable to quantitatively estimate the number of oceanic whitetip sharks likely to be exposed to oil spills and dispersants in a manner that would result in adverse effects due to the lack of abundance information within the action area. However, given that data indicate the species abundance is generally low within the action area, only a small number of individuals are expected to be exposed to oil spills and dispersants at levels that would impact fitness, with even fewer expected to be exposed to levels that would result in mortality.

Given the overall low exposure to oil spills and dispersants at levels that would impact individual fitness, we do not anticipate population-level effects to the greater Atlantic subpopulation. Therefore, we do not expect that the potential reduction in numbers that could result from the proposed action will reduce appreciably the likelihood of both survival and recovery of the oceanic whitetip shark in the wild.

11.4.2 Giant manta ray

Like oceanic whitetip sharks, the giant manta ray was recently (2018) listed as threatened under the ESA. It occupies tropical, subtropical, and temperate oceanic waters and productive coastlines throughout the world. They are commonly found offshore in oceanic waters, but sometimes in shallow waters during the day (Lawson et al. 2017; Miller and Klimovich 2017). There are at least 11 identified subpopulations with population size estimates ranging from 100 to 1,500 individuals based on anecdotal diver or fisherman observations (FAO 2012; Miller and Klimovich 2017). Abundance data from the Flower Garden Banks Marine Sanctuary in the Gulf of Mexico provides an estimate of more than 70 individuals (Miller and Klimovich 2017). While data on global trends of the species are unavailable, in the Indo-Pacific there have been decreases in landings of up to 95 percent (Miller and Klimovich 2017). The species is considered highly migratory, and thus genetically well-connected, but tagging, stable isotope, and genetic data from the Pacific Ocean off the coast of Mexico suggest population structuring between offshore and coastal giant manta rays (Stewart et al. 2016). In addition, some have suggested there may be a subspecies of giant manta ray resident to the Yucatán (Hinojosa-Alvarez et al. 2016). However, the best available data do not indicate genetic discreteness between giant manta rays in the Atlantic and those in the Indo-Pacific and eastern Pacific (Miller and Klimovich 2017).

As discussed in the *Status of Species Analyzed Further* and *Environmental Baseline* Sections, interactions with commercial fisheries are the main threat to the species. Along with other mobulids, giant manta rays are targeted for their gill rakers, which are dried and sold in Asian (O'Malley et al. 2017). Based on the doubling of the amount of mobulid gill rakers in Asian markets from 2011 to 2015, we expect targeted commercial fishing to remain a threat to the species as a cumulative effect for the foreseeable future. In addition to being targeted for their gill rakers, giant manta rays are also bycaught in industrial purse seine and artisanal gillnet fisheries, particularly in the eastern Pacific and the Indo-Pacific (Miller and Klimovich 2017).

Like oceanic whitetip sharks, giant manta rays are only expected to be adversely affected by the proposed action due to oil spills and dispersants. A small number of giant manta rays are likely to be exposed to oil, and those exposures would likely result in effects similar to other marine species such as those displayed in Figure 87, including fitness reduction and possibly leading to mortality. Because there are no abundance estimates for giant manta rays for the Gulf of Mexico beyond the 70 individuals documented at FGBNMS, we are not able to quantify an estimated number of oil spill exposures or mortalities for this species.

Effects to giant manta rays from exposure to oil and dispersants are similar to those previously described for oceanic whitetip sharks. These include aspiration of oil and/or dispersants, contact between oil and/or dispersants and an individual’s skin, ingestion of oil and/or dispersants through the ingestion of contaminated prey, and affects to prey availability. Given the lack of abundance information for most of the action area (except in the Flower Garden Banks Marine Sanctuary where majority of oil and gas activities are prohibited), in our *Effects Analysis*, we were unable to quantitatively estimate the number of giant manta rays likely to be exposed to oil spills and dispersants in a manner that would result in adverse effects. However, given that data indicate the species abundance is generally low within the action area, only a small number of individuals are expected to be exposed to oil spills and dispersants at levels that would impact fitness, with even fewer expected to be exposed to levels that would result in mortality.

As mentioned above, there is some evidence of population differentiation in certain areas, and some have even suggested a subspecies of giant manta rays exists off the coast of Yucatán peninsula (Hinojosa-Alvarez et al. 2016). However, currently, giant manta rays in the Atlantic, Indo-Pacific, and eastern Pacific are all considered to part of the same genetic population (Miller and Klimovich 2017). Thus, we consider population-level effects to be those effects to the global population/species level. Based on the estimated overall low exposure of giant manta rays to oil spills and dispersants at levels that would impact individual fitness, we do not expected effects at the global population, species level. Therefore, we do not expect that the potential reduction in numbers that could result from the proposed action will reduce appreciably the likelihood of both survival and recovery of the giant manta ray in the wild.

11.5 Species Integration and Synthesis Conclusions

Table 130 below summarizes conclusions for ESA-listed species determined to be adversely affected by some component of the proposed 50-year programmatic action. Of the species considered, the proposed action is likely to jeopardize the continued existence of the Gulf of Mexico Bryde's whale. For all other listed species adversely affected by the action, we have determined the effects from the various elements of the proposed action, individually or in combination, are not likely to jeopardize their continued existence.

Table 130. Summary of Integration and Synthesis for species.

Species	Jeopardy
Gulf of Mexico Bryde's Whale	Yes
Sperm Whale	No
Green Sea Turtle North Atlantic DPS Sea Turtle	No
Green Sea Turtle South Atlantic DPS Sea Turtle	No
Kemp's Ridley Sea Turtle	No
Hawksbill Sea Turtle	No
Leatherback Sea Turtle	No
Loggerhead Sea Turtle	No
Gulf Sturgeon	No
Oceanic Whitetip Shark	No
Giant Manta Ray	No

12 INTEGRATION AND SYNTHESIS FOR DESIGNATED CRITICAL HABITAT

The *Integration and Synthesis on Effects to Designated Critical Habitat* section describes NMFS' assessment of the likelihood the 50-year programmatic action will destroy or adversely modify designated critical habitat. As described in the *Assessment Framework*, "destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02). Two ESA listed species considered in this opinion have designated critical habitat in the action area. They are the Northwest Atlantic DPS of loggerhead sea turtles, and Gulf sturgeon.

This analysis takes into account the geographic and temporal scope of the proposed actions, recognizing that "functionality" of critical habitat necessarily means that it must now and must continue in the future to support the conservation of the species and progress toward recovery. Destruction or adverse modification does not depend strictly on the size or proportion of the area adversely affected, but rather on the role the action area serves with regard to the function of the overall critical habitat, and how that role is affected by the action.

In the *Status of Species and Critical Habitat Analyzed Further* and *Environmental Baseline* Sections 6.2 and 7, habitat loss or alteration is identified as one of the primary effects of climate change. Larger, more frequent storms threaten coastal and offshore habitats. Similar to how climate change was integrated above for species, we consider global climate change in addition to the other natural and anthropogenic stressors affecting critical habitats. In Sections 6.2 and 7, we identified the essential habitat features for Northwest Atlantic DPS of loggerhead turtles and Gulf sturgeon designated critical habitat and synthesize information for each below.

12.1 Northwest Atlantic DPS of Loggerhead Sea Turtles

As identified in Section 6.2.10, for the Northwest Atlantic DPS of loggerhead turtles (marine portions within NMFS' jurisdiction) critical habit found within the action area includes nearshore reproductive and *Sargassum* habitats. Our effects analysis determined that the effects of vessel traffic resulting from the proposed action are not likely to affect the essential physical and biological features (PBFs) of loggerhead reproductive critical habitat (i.e., insignificant effects). Similarly, effects from vessel traffic associated with the proposed action were determined to be insigificant to *Sargassum* habitat. However, seismic surveys and oil spills were determined likely to adversely affect *Sargassum* habitat. To conduct our adverse modification analysis, we must consider the essential physical and biological features of loggerhead critical habitat described above in Section 6.2.10, and evaluate the effects of the proposed action on those essential features, both in the short-term and long-term.

Loggerhead *Sargassum* habitat is described as developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially *Sargassum*. PBFs that support this habitat are (1) convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads; (2) *Sargassum* in concentrations that support adequate prey abundance and cover; (3) available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and (4) sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads (i.e., greater than 10 meters depth).

It is possible seismic survey activities will affect *Sargassum* habitat. There is expected to be some overlap between the surveys and where *Sargassum* occurs. McCauley et al. (2017) has demonstrated that seismic survey technology has adverse effects to zooplankton, including copepods. Copepod prey are identified as an essential PBF of the *Sargassum* designated critical habitat. However, and as noted previously, according to McCauley et al. (2017), for seismic activities to have a significant impact on zooplankton at an ecological scale, the spatial or temporal scale must be large in comparison to the ecosystem in question due to the naturally high turnover rate of zooplankton. We do not anticipate that seismic surveys will reduce prey abundance beyond what is adequate for foraging loggerheads.We anticipate that seismic survey operators would actively avoid *Sargassum* patches within the action area, especially large ones which would reduce effects, though not completely avoid them. While seismic surveys could reduce zooplankton in *Sargassum*, we would not expect that to rise to the extent of removing sufficient prey availability for sea turtles.

Sargassum habitat is vulnerable to oil spills and spill response related to the proposed action. Oil can be carried by currents into convergence zones where *Sargassum* is also accumulating. Physical processes, such as convergent currents and fronts that play a role in transporting, retaining, and concentrating *Sargassum*, are the same processes that act to concentrate oil, thus increasing the exposure of *Sargassum* associated organisms to oil. Indeed, *Sargassum* habitats could act as a natural boom to contain spilled oil. Oiled *Sargassum* would be then removed from the environment (as part of any clean-up response activity) along with the associated prey community. Consequently, reductions in this habitat are likely with any oil spill. The amount and breadth of the reduction depends on the location of the spill and is proportional to the size and the seasonal timing of the spill.

Much of the *Sargassum* critical habitat within the northern GOM is at risk of oil exposure considering (1) the large spatial overlap between *Sargassum* critical habitat and oil and gas leasing areas and (2) the physical processes bringing both surface oil and *Sargassum* together. The DWH oil spill resulted in a the loss of approximately 23 percent of the *Sargassum* in the northern Gulf of Mexico (at the time of the spill) due to direct exposure to DWH oil on the ocean surface (Trustees 2016). The loss of *Sargassum* habitat during DWH was likely exacerbated by the use of oil dispersants (Powers et al. 2013). A large catastrophic spill, such as DWH, would likely result in widespread, sea-scape level impacts that could make it difficult for juvenile turtles to locate suitable *Sargassum* habitat, particularly if dispersants are used in the aftermath of such a spill.

Based on the best available information, it is likely that oil spills resulting from the proposed action will adversely affect the following essential critical habitat features that provide adequate prey and cover for juvenile loggerheads: concentrations of *Sargassum* habitat and available prey and other material associated with *Sargassum* habitat.

In the *Effects Section*, we assessed both the short-term and long-term effects of oil spills on the essential features of *Sargassum* critical habitat, we considered aspects of the algae's life cycle including seasonal movements and drift rate within the action area, growth rate, longevity, and resiliency to environmental disturbances. As mentioned above, the amount of *Sargassum* exposed to an oil spill within the action area will depend to a large extent on the time of year given the seasonality and cyclical movement of *Sargassum* in the northern Gulf of Mexico. Continuous exposure of a particular *Sargassum* patch to oil could last days, weeks, or months depending on the size and location of the spill and other factors (e.g., wind speed and direction, season, and type of oil). For example, it took an estimated six weeks for *Sargassum* to cover the full range of area affected by the DWH oil spill (S. Powers, personal communication, September

16, 2015 cited in Trustees 2016). More heavily oiled patches that are closer to the spill source at the time of the spill, and areas exposed to both oil and oil dispersants, will likely die-off and/or sink to the ocean bottom.

Given its fast growth rate, continuous motion, and somewhat ephemeral nature, we would expect a relatively high turnover rate for *Sargassum* patches under normal conditions. *Sargassum* habitat that is lost due to an oil spill will likely be replaced over time by the combination of movement by unexposed (or lightly exposed) existing patches and through new growth. While the adverse effects of a major oil spill on *Sargassum* communities within a given annual life cycle (described above) are well documented, the longer-term impacts in subsequent years or decades are not known. Although nearly one-quarter of all *Sargassum* habitat in the northern Gulf of Mexico was heavily exposed to oil after the 2010 DWH spill, follow-up aerial surveys in 2011 and 2012 documented a four-fold increase in *Sargassum* abundance since DWH. These results suggest that *Sargassum* can repopulate in the Gulf of Mexico within a year or two of a very large oil spill.

It is likely that large oil spills resulting from the proposed action will adversely affect essential physical and biological features of loggerhead nearshore reproductive and *Sargassum* critical habitat (i.e., concentrations of *Sargassum* habitat and available prey and other material associated with *Sargassum* habitat). An oil spill on the magnitude of the largest spill analyzed in this opinion can have effects on *Sargassum* communities that juvenile sea turtles depend on for food and shelter. The effects of oil exposure on *Sargassum* critical habitat can be severe and last for days, weeks or even months in the case of a major oil spill. However, the ephemeral nature and annual cycle of rapid growth, movement, and subsequent senescence, allows *Sargassum* to repopulate in the Gulf of Mexico in the year subsequent to a very large oil spill.

Considering the effects to designated critical habitat for the Northwest Atlantic DPS of loggerhead sea turtles from oil spills and seismic surveys together, both are temporally and spatially localized activities that occur with a relatively high amount of uncertainty. It is unlikely that a seismic survey will transit through an oil spill, so co-occurrence is expected to be minimal. Nearshore reproductive habitat is not likely to be adversely affected by the proposed action. Further, we expect the adverse effects to *Sargassum* habitat from the combination of oil spills and seismic surveys to remain at a level that does not exceed the ability of *Sargassum* to grow new patches and counter those effects. Therefore, while oil spills and seismic surveys resulting from the proposed action could adversely affect the physical and biological features of designated critical *Sargassum* habitat for Northwest Atlantic loggerhead turtles, we do not anticipate the combined effects from seismic surveys and oil spills will appreciably diminish the value of loggerhead designated critical habitat for the conservation of the species.

12.2 Gulf Sturgeon

PBFs associated with designated critical habitat of the Gulf Sturgeon are those habitat components that support feeding, resting, and sheltering, reproduction, migration, and physical features necessary for maintaining the natural processes that support these habitat components. Those essential features pertinent to this consultation include (1) abundant prey items within riverine habitats for larval and juvenile life stages, and estuarine and marine habitats and substrates for juvenile, subadult, and adult life stages; (2) Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and (3) safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine and marine habitats; (4) water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics necessary for normal behavior, growth, and viability of all life stages. Vessel activity and oil spills are elements of the proposed action that may affect these PBFs. The action area encompasses all seven of the marine and estuarine units of Gulf sturgeon designated critical habitat. Effects of vessel activity on Gulf sturgeon designated critical habitat as part of the proposed action were analyzed in section 9.2 and determined to be insignificant.

Oil spills can potentially impact Gulf sturgeon habitat within the action area. In the effects analysis, we considered the effects of oil spills on the essential habitat features found in the marine and estuarine units of Gulf sturgeon designated critical habitat: abundant food items; water quality necessary for normal behavior, growth, and viability of all life stages; sediment quality necessary for normal behavior, growth, and viability of all life stages; and safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats.

BOEM oil and gas leasing areas do not overlap directly with Gulf sturgeon critical habitat because critical habitat is found exclusively in state waters. For critical habitat to be affected oil from OCS sources would have to be transported to nearshore waters by wind and currents. Small offshore spills (i.e., <1,000 bbl) are not expected to contact Gulf sturgeon critical habitat, and are therefore considered discountable. BOEM estimates a one to four percent chance of an offshore oil spill contacting Gulf sturgeon marine habitat based on a spill size of 1,000-10,000 bbl. Larger spills (i.e., > 10,000 bbl), however, would have a higher risk of impacting coastal waters, depending on many factors such as the buoyancy of the spilled fluid, distance from the spill, currents, and duration of the spill. Almost all types of nearshore ecosystem habitats in the northern Gulf of Mexico were oiled and injured from the DWH oil spill, including shallow unvegetated habitats utilized by Gulf sturgeon. Oil was observed on more than 1,300 miles (2,113 kilometers) of shorelines from Texas to Florida (Trustees 2016). Although the largest oil spill assumed in our analysis for this opinion is smaller than the DWH spill, based on the DWH damage assessment it is likely that Gulf sturgeon critical habitat could be exposed to an oil spill resulting from the proposed action.

Dissolved oil in the water column, sunken oil, and oil that remains in sediments could all negatively impact Gulf sturgeon critical habitat. Oil contamination often results in decreased abundance and diversity of benthic communities, and therefore could impact Gulf sturgeon essential habitat features related to sediment quality and benthic prey abundance. Related ecosystem function effects that could result from oil spills include impaired cycles of organic matter and nutrients from the water column to oil-contaminated bottom sediments, and altered transfer of energy and nutrients from coastal to offshore ecosystems. Oil spills can also reduce water quality within Gulf sturgeon critical habitat, although the effects would likely be of shorter duration compared to the potentially longer-term impacts on sediment and benthic prey.

In addition to the effects of spilled oil, Gulf sturgeon critical habitat could also be affected by oil spill response actions. The highly atypical flow of salinity control structures and river water over a sustained period greatly reduced salinity levels in Louisiana coastal areas during DWH spill response (Trustees 2016). Benthic communities could be affected by oil and oil dispersant mixtures, but only the nearshore use of dispersants would be present in concentrations that would pose any significant risk to nearshore habitats (Trustees 2016).

An oil spill would have to be of substantial volume and in relatively close proximity to make contact with and affect Gulf sturgeon critical habitat. As we projected in section 0, two very large spills, along with many smaller spills, are anticipated as result of the proposed action. With much of the production moving farther offshore into deeper water, there is less likelihood of one or both of those very large spills occurring in areas closer to shore and Gulf sturgeon critical habitat. Offshore spills, in general, are expected to have a smaller impact on Gulf sturgeon critical habitat because much of the critical habitat is protected by barrier islands, shoals, shorelines, and currents. Oil that does reach nearshore environments occupied by Gulf sturgeon will likely be significantly diluted and in lower concentrations compared to thicker, more concentrated oil in offshore areas closer to the spill source.

When considered overall, oil spills resulting from the proposed action could adversely affect physical and biological features of Gulf sturgeon critical habitat; however we do not anticipate the effects from oil spills will appreciably diminish the value of designated critical habitat for the conservation of the species.

12.3 Critical Habitat Integration and Synthesis Conclusions

Table 131 below summarizes conclusions for adverse modifications to the designated critical habitats for the Northwest Atlantic DPS of the loggerhead turtle, and for the Gulf sturgeon. NMFS found that while some physical and biological features would be adversely affected by the proposed action, the effects would not rise to the level to be considered adverse modification of critical habitat. We do not anticipate the effects will appreciably diminish the values of these species' designated critical habitat for the conservation of the species.

Table 131. Summary of Integration and Synthesis for Designated Critical Habitat based on review of effects to PBFs from oil spills and seismic surveys (loggerheads only).

Species Designated Critical Habitat	Adverse modification
NW Atlantic DPS Loggerhead Sea Turtle	No

Gulf Sturgeon	No

13 CONCLUSION

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of sperm whale, Northwest Atlantic loggerhead sea turtle, Kemp's ridley sea turtle, North Atlantic DPS and South Atlantic DPS green sea turtle, leatherback sea turtle, hawksbill sea turtle, Gulf sturgeon, giant manta ray, and oceanic whitetip shark. Additionally, it is NMFS' biological opinion that the proposed action is not likely to destroy or adversely modify loggerhead or Gulf sturgeon designated critical habitat. It is NMFS' biological opinion that the proposed action is likely to jeopardize the continued existence of the Gulf of Mexico Bryde's whale.

14 REASONABLE AND PRUDENT ALTERNATIVE

14.1 Proposed RPA

We have developed the following RPA to avoid the likelihood of jeopardizing the continued existence of the Gulf of Mexico Bryde's whale, which has very low population numbers (estimated at 44) and are highly vulnerable to vessel strike mortality, effects of sound, and the combination of other stressors from the proposed action.

The RPA for the programmatic opinion will be in effect for the timeframe of the opinion (50 years). NMFS will review the RPA every five years to evaluate whether and how the RPA may need to be modified to be consistent with any future MMPA rule. This review would be in addition to or in conjunction with any other review of the RPA or the opinion that is appropriate under the reinitiation triggers defined in Section 17 of the opinion.

During consultation, NMFS and BOEM/BSEE discussed different possibilities for mitigating Oil and Gas Program effects to the Bryde's whale. In general, for avoiding vessel strike in the area where Bryde's whales are primarily found, the proposed RPA, if adopted, implements a nighttime closure and 10 knot or less speed restriction during the day year-round to all oil and gas program related vessels for the program duration in the Bryde's whale area defined in section 8.1.2.1.

If BOEM and BSEE choose to implement the RPA, the following measures will be required for any vessel transiting through the Bryde's whale area, which is identified and defined in section 8.1.2.1 and displayed in Figure 96 below:

1. Visual observers monitoring the vessel strike avoidance zone (500 m) can be either third-party observers or crew members but crew members responsible for these duties must be provided sufficient training to distinguish aquatic protected species to broad

taxonomic groups. If transiting within the Bryde's whale area, operators must report their plans to BOEM or BSEE and include what port is used for mobilization and demobilization and specify if they will transit within the known Bryde's whale area. Other specifics to reporting will be followed as described below and in the preceding opinion.

2. All vessels, regardless of size, must observe a 10-knot, year-round speed restriction in the Bryde's whale area as specified in section 8.1.2.1 during daylight hours. The only exception to the 10-knot vessel speed restriction would be when the safety of the vessel or crew is in doubt or the safety of life at sea is in question.
3. All vessels must maintain a minimum separation distance of 500 m from Bryde's whales. If a whale is observed but cannot be confirmed as a species other than a Bryde's whale, the vessel operator must assume that it is a Bryde's whale and take appropriate action.
4. All vessels 65 feet or greater associated with oil and gas activity (e.g., source vessels, chase vessels, supply vessels) must have a functioning Automatic Identification System (AIS) onboard and operating at all times as required by US Coast Guard. If the vessel does not require AIS, it is strongly encouraged but at minimum, the reporting must include trackline (e.g., time and speed) data and visual marine mammal sightings. Vessel names and call signs must be provided to BSEE, and operators must notify BSEE when survey vessels are operating.
5. No transit at nighttime or at low visibility conditions except for emergencies when the safety of the vessel or crew is in doubt or the safety of life at sea is in question.
6. If an operator is in violation of these conditions/protocols, a record of said non-compliance must be generated beyond typical reporting in this area and presented to BSEE within 24 hours.
7. All other protected species measures described herein must be followed within the Bryde's whale vessel restriction area, to the extent it is more stringent than the measures specifically identified for the Bryde's whale vessel restriction.

Figure 96 displays the proposed mitigation area displayed as a magenta polygon. In this opinion, the Bryde's whale area is defined in section 8.1.2.1.

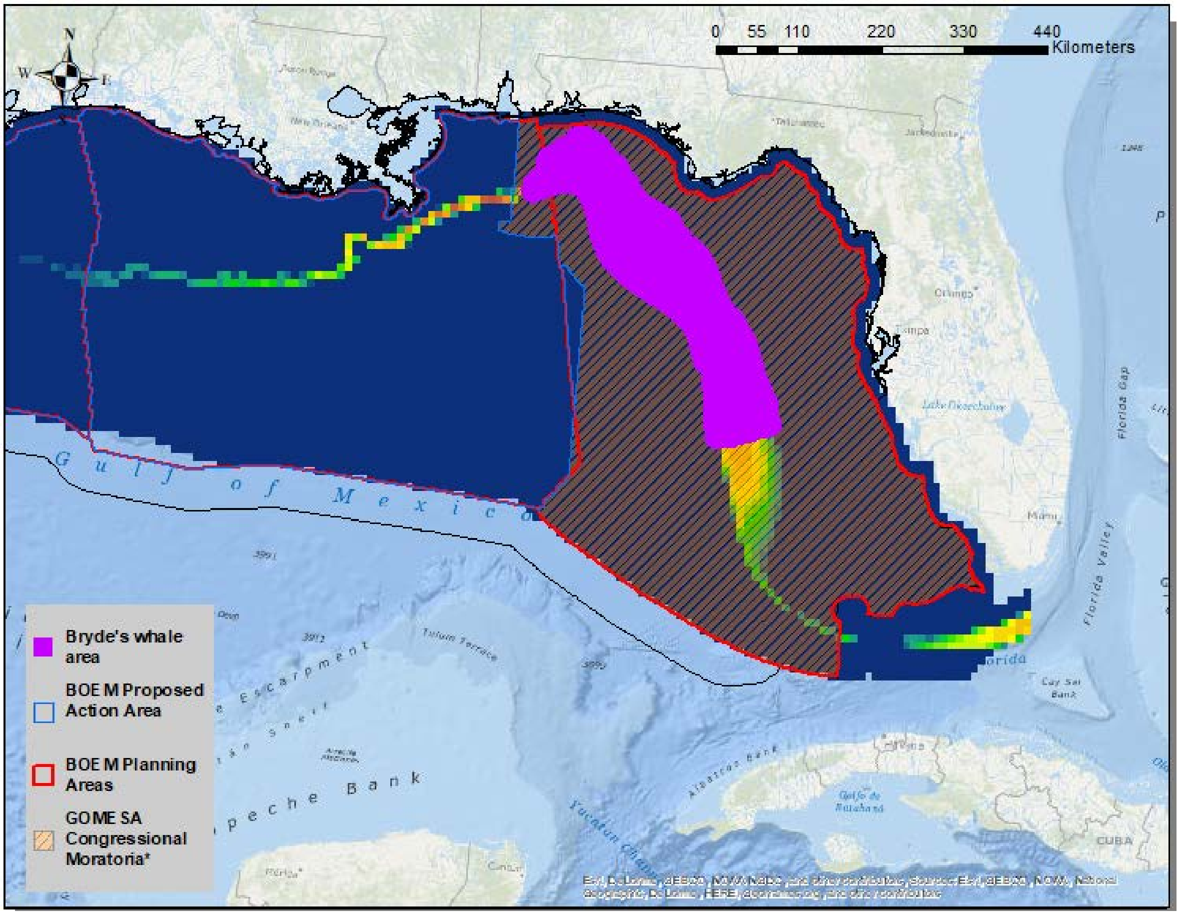


Figure 96. Image of the Bryde's whale area mitigation overlaying Roberts et al. (2016b) density model.

14.2 Compliance with RPA Criteria

Under ESA section 7(a)(2), the proposed action must not "jeopardize the continued existence of a species in the wild, by appreciably reducing the likelihood of a species' survival and recovery." A RPA to the proposed action is one that avoids jeopardy by ensuring that the action's effects do not appreciably increase the risks to the species' potential for survival or to the species' potential for recovery. The RPA must also be: (1) consistent with the intended purpose of the action; (2) within the scope of the federal agency's legal authority and jurisdiction; and (3) economically and technologically feasible. This RPA is consistent with the purpose of the programmatic action, as it will ensure the protection of the Gulf of Mexico Bryde's whale while allowing for continuance of the Oil and Gas Program in the Gulf of Mexico. BOEM and BSEE would implement and enforce this restriction through programmatic lease stipulations, conditions of approvals on permits and authorizations, NTLs (or comparable guidance), best management practices, and/or other appropriate authorities.

Implementation of the RPA may impose some additional costs because it requires vessel operators to slow down during the day in and avoid the Bryde's whale area at night. The RPA is economically and technologically feasible for the action agencies because it can be implemented through mechanisms routinely used to address other environmental impacts of the Oil and Gas Program, such as BOEM/BSEE NTLs or lease stipulations.

14.3 RPA Analysis of Effects

The RPA reduces or avoids risk of lethal vessel interaction and reduces sound effects within the area where Bryde's whales are primarily found. For vessel strike, where areas have an increase in vessel traffic there is a heightened strike risk. Therefore, minimizing traffic in the area where listed Bryde's whales are known to be concentrated would be reasonable and prudent. The Bryde's whale is at high risk of vessel strike and subsequent mortality, especially at night. The RPA, as proposed, prevents jeopardizing the Gulf of Mexico Bryde's whale by mitigating risk in two ways:

1. Avoid or reduce mortalities and serious injuries from oil and gas related vessel strikes from 10 knot daytime speed reduction and night time closure to traffic other than for emergency purposes; and

2. Reduction of vessel noise impacts (e.g., speed reduction or avoidance of transiting vessels in the Bryde's whale area).

Hence, this traffic reduction will avoid lethal vessel strikes and reduce adverse effects from vessel traffic sound to Bryde's whales.

14.4 RPA Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is our biological opinion that the proposed action as revised by this RPA would not likely jeopardize the continued existence of the Gulf of Mexico Bryde's whale.

15 Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as 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 by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species (includes all species other than marine mammals, for which we are using the MMPA definition of harass; see section 2.2) by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is further defined as an act that "creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering" (NMFSPD 02-110-19).

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Section 7(b)(4) and section 7(o)(2) provide that prohibited taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement, which is being provided based on section 7(b)(3)(4) and implementation of the RPA. The ITS covers take that is incidental to implementation of the RPA. It does not cover take that would occur incidental to the implementation of any action other than the RPA. This ITS only covers take that is incidental to the proposed action, as described in Section 3. Thus, it does not cover take incidental to potential future-planned activities in the GOMESA that are excluded from the proposed action.

15.1 Effects of the Take

During consultation and described in the opinion above, we determined that the amount or extent of anticipated take is not likely to jeopardize the continued existence of any ESA-listed species or result in the destruction or adverse modification of designated critical habitat, when the RPA is implemented.

15.2 Reasonable and Prudent Measures

The measures described below are nondiscretionary, and must be undertaken by BOEM, BSEE, and/or NMFS' Permits and Conservation Division so that they become binding conditions for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and terms and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR §402.02). NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

1. BOEM, BSEE, and NMFS' Permits and Conservation Division shall implement mitigation and monitoring measures to limit the potential for interactions with ESA-listed species.
2. BOEM and BSEE shall revise internal procedures and processes to assure that the measures identified in this opinion or through step-down reviews are implemented to protect ESA-listed species.

3. Action Agencies will report all activities as required by this opinion.
4. BOEM and BSEE must monitor the effectiveness of the mitigation measures described in the Terms and Conditions of this ITS.
5. BOEM and BSEE shall implement measures to reduce the impacts on ESA-listed species and habitats from oil exposure.
6. BOEM and BSEE shall implement measures to reduce the impacts from explosive severance and removal of offshore structures.
7. The action agencies shall participate in NMFS' annual activity reviews and adaptive management processes.

15.2.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions while the extent of take specifies the impact, i.e., the amount or extent, of such incidental taking on the species, which may be used if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (see 80 FR 26832).

We anticipate the Oil and Gas Program in the Gulf of Mexico and associated activities are likely to result in the incidental take of ESA-listed species by death, injury, and harassment. Table 132 shows the amounts of incidental take associated with all the activities analyzed in Effects of the Action on Species (Section 8). As described in Section 3 (Description of the Proposed Action) and Section 1.2 (Consultation History), BOEM recently changed the proposed action for purposes of this consultation to exclude activities within the GOMESA, which are mainly in the Eastern Planning Area and a small portion of the Central Planning Area. As a result, not all of the incidental take shown in Table 132 is actually going to occur as a result of the proposed action as now defined. As described further below, this Incidental Take Statement provides surrogate measures to monitor levels of incidental take and determine the need for reinitiation of consultation, and those surrogate levels are stated at the area level to reflect the exclusion of the GOMESA from the proposed action.

Section 7(b)(4)(C) of the ESA provides that take of ESA-listed marine mammals may be included in the ITS of a biological opinion only if the taking is authorized under §101(a)(5) of the MMPA.

The take listed in the table below do not account for all activities described in Section 3.4 for which adverse effects were identified to require step-down review processes because, for some of those activities, it may be determined during step-down review that the take resulting from such activities was not fully addressed in the programmatic opinion. Step-down review may also find in some cases that we cannot determine whether take will occur, or at what levels, from those activities until we know the site-specific details of those activities. However, we note that the step-down review process is designed to avoid or minimize adverse effects from all aspects of the proposed action. Additionally, there are several stressors that cause exposures/incidences as noted in the Integration and Synthesis section above, from which we would anticipate incidental take, but NMFS is not exempting for such take in this incidental take statement. The reasoning for these are:

- There are no exemptions for take for pile driving, vessel interaction, or marine debris effects to marine mammals because there is no authorization for those takes under section 101(a)(5) of the MMPA.
- While the opinion includes an estimate of the exposure scenarios and/or number of whales that are likely to experience effects from seismic surveys, this ITS does not exempt incidental take for Bryde's or sperm whales for seismic activities at this time because the incidental take of these ESA-listed whales has not been authorized under section 101(a)(5) of the MMPA. The terms of this incidental take statement and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization (i.e., five year regulations and LOA) to take the marine mammals identified here. Absent such authorization, this statement is inoperative for marine mammals.
- There are no exemptions for take of any ESA-listed species from oil spills because oil spills are not a lawful activity under the CWA[71].

Table 132. Estimated amount of annual incidental take (unless noted otherwise) by harassment of ESA-listed species authorized by this incidental take statement. Note that take associated with sound may not represent individuals, rather could represent repeat exposures to the same individuals. Take from seismic surveys (G&G activities) do not account for BOEM's revised action, which removed the area under the GOMESA moratorium. Refer to surrogate description below for how exceedance of take is addressed.

Stressor	Gulf Sturgeon*	Giant Manta Ray	Oceanic Whitetip Shark
Non-lethal vessel interaction	1	--	--

[71] The Clean Water Act (33 USC 1251 et seq.) as amended by the Oil Pollution Act of 1990 (33 USC 2701 et seq.) prohibits discharges of harmful quantities of oil, as defined at 40 CFR 110.3, into waters of the United States.

Stressor	Gulf Sturgeon*	Giant Manta Ray	Oceanic Whitetip Shark
Lethal vessel interaction	21	--	--
Disturbance from pile driving sound exposure (TTS/Behavioral)	--	--	--

** Take for Gulf sturgeon over 50 years, approximating no more than one per year.*

Stressor	Leatherback Sea Turtle	Loggerhead Sea Turtle	Kemps Ridley Sea Turtle	Green Sea Turtle**	Hawksbill Sea Turtle
G&G Activities					
Impairment (TTS) from Seismic survey sound	1,357	177,697	218,489	213,424	21,396
Harassment from seismic survey sound exposure (TTS/Behavioral)	9,767	1,279,296	1,572,966	1,536,496	154,033
Lethal entanglement in equipment	0	1	1	1	1
Offshore Infrastructure Activities					
Hearing injury (PTS) from pile driving sound exposure	1	152	202	102	7
Disturbance from pile driving sound exposure	0	23	28	32	1
Vessel strike					
Non-lethal vessel interaction	28		3,957	4,249	407
Lethal vessel interaction	10	959	2,100	8,452	11
Site Clearance Activities					
Non-lethal capture in trawl net	3	29	83	11	0
Marine Debris					
Sublethal effects	6	1,577	3,471	3,281	175
Lethal effects	2	268	590	558	30
Structure Severance Activities					
Harrassment from exposure to sound/impact from explosives	1	6	8	7	1
Injury/Lethal effects from exposure to sound/impact from explosives	1	3	4	3	1

**Four percent of total exposures are to South Atlantic DPS of green sea turtle.

No death is expected for any individual cetacean or sea turtle exposed to geophysical survey activities. As noted above, we will be exempting incidental take for cetaceans as we receive localized information for activities. For sea turtles, behavioral harassment is expected to occur if individuals are exposed to sound levels at or above 175 dB re: 1 µPa (rms), and TTS, which we also consider harassment, is expected to occur at or above those levels specified in Table 12. As noted in our exposure analysis, some sea turtle take estimates could not be determined to species, and instead were classified as being of hardshell turtles as a group. Based on the best available data, we expect that the majority of these unidentified hardshell turtles will be loggerhead turtles (Northwest Atlantic Ocean DPS), with the remainder representing green (North Atlantic DPS) and Kemp's ridley turtles.

Three-year Incidental Take Limits

We expect fluctuations in take to occur from year to year based on fluctuations in activity levels, and variations in overlap of listed species with program activities, thus the number in the take table (Table 132, above) is the number that should be used for a three year average. That is, the number each year may exceed the annual total take, as long as three years of take does not exceed the annual take multiplied by three. For Gulf sturgeon take over the 50-year period, that overall take must not be exceeded in the 50 year period with no more than three individuals taken in a three year period. In other words, if there is one annual incidental take authorized and an activity causes two takes one year and zero the next and one the following year, the average over those three years would still be one and take would have been met, but not exceeded. As part of the annual review process, we will be reviewing annual take to determine whether or not mitigations are effective.

Surrogate Measures to Monitor Levels of Incidental Take and Determine Need for Reinitiation of Consultation

The take expected to result from this proposed action has been quantified in terms of numbers of individuals expected to be taken per year (Table 132). For some of the stressors resulting in take of ESA-listed sea turtles it is possible to directly monitor takes using observers. Sea turtle take resulting from entanglement in G&G survey equipment and capture in trawl nets during site clearance activities will be directly monitored and reported by protected species observers. Pile driving activities will also be directly monitored for sea turtle take using protected species observers. Takes of sea turtles from pile driving sound will be categorized as either PTS or disturbance based on the estimated distances from the pile to the animal as recorded by observers. Because pile driving is a stationary sound source, most animals are expected to be observable. However, a correction factor, based on the reported direct observations and species specific ratios of observed to unobserved turtles, will be applied as needed to account for unobserved take. For structure explosive severance activities, NMFS' Platform Removal Observer Program will report ESA-listed sea turtle take through direct monitoring using helicopter and onboard observers for each structure removal project. Takes from explosives will be categorized as either injury/lethal take or harassment based on the estimated distances from the pile to the animal as recorded by observers. Similar to monitoring pile driving take, a correction factor will be applied, as necessary, to account for unobserved take due to explosives.

For other stressors resulting in take it is not practicable to directly monitor the take in terms of individuals. Feasible monitoring techniques for detecting and calculating actual take at the scale of the oil and gas activities described in this opinion do not exist. As such, we must rely on proxy indicators to determine when anticipated take levels have been exceeded. To provide a clear standard for determining when the level of anticipated take has been exceeded, we describe below the surrogate measures that will be used to monitor the predicted take and ensure it does not exceed the authorized take limits in Table 132.

G&G activities: We anticipate take of Bryde's whales, sperm whales and sea turtles from seismic survey sound associated with G&G activities. There is no practicable way to detect and calculate actual take of these species from sound sources because we do not have information about where a specific survey may occur. Therefore, we instead use seismic survey activity level as an indicator of take. Our surrogate measure of take of these species will be the location and extent of seismic survey tracklines. The location and extent of seismic survey tracklines is causally linked to the take of the listed species because we can estimate using density information for a specific project location. BOEM will provide an annual report summarizing G&G survey activities in terms of the amounts and locations of tracklines. Our standard for determining when the level of anticipated take is exceeded is the amounts and locations of tracklines shown in Table 3. For the Eastern Planning Area that is part of the proposed action, activity levels shall not exceed one percent[72] of the annual tracklines in Table 3 under the section for the Eastern Planning Area. For the Central Planning Area that is part of the proposed action, activity levels shall not exceed 97.1 percent[73] of the annual tracklines in Table 3 under the section for the Central Planning Area. If the amount or location of predicted tracklines change, or the acoustic characteristics of the airgun arrays are larger than those predicted in this opinion, then step-down review with NMFS is required to determine whether those changes will result in an exceedance of take for ESA-listed species.

Vessel Strikes: We anticipate take of Gulf sturgeon and sea turtles resulting from vessel strike. Feasible monitoring techniques for detecting and calculating actual take (either lethal or nonlethal) of these species from ship strike do not exist. Monitoring and tracking the actual number of vessel strikes is not practicable since many incidents go unreported or unnoticed. It is not practical to require direct monitoring and reporting of such incidents because it would under represent the actual number of incidents that may be occurring. While strandings reports may provide a minimum estimate of animals killed (or injured) from vessel strike, the large majority of animals struck by vessels do not strand. Therefore, we will use information on vessel activity level as a proxy indicator to determine when anticipated ship strike take levels may have been

[72] The portion of the EPA included as part of the proposed action is 657,905 acres divided by 64.56 million acres total area of the EPA as described in Section 4.

[73] The CPA moratorium area covers approximately 1.942 million acres divided by 66.45 million acres total area of the CPA as described in Section 4 is 2.92 percent. Therfore, the area remaining in the CPA proposed action represents 97.1 percent.

exceeded. Our surrogate measure of take of these species from vessel strike will be the level of vessel activity, expressed as reported vessel track kilometers. Vessel level activity is causally linked to the take of listed species because an animal may be located within the trackline of a vessel and at risk of vessel strike. BOEM will collect vessel track data (e.g., AIS data) for all vessels associated with the proposed action (see Section 8.4 Effects of Vessel Strikes for vessels included) and report to NMFS annually on vessel activity. Other sources of information, including direct reports of ship strikes and strandings data, will also be used as appropriate to evaluate potential exceedance of anticipated levels of ship strike take.

Marine Debris: We anticipate take of sea turtles resulting from ingestion or entanglement in marine debris. There is no practicable way to detect and calculate actual take of these species from marine debris because of the lack of observable animals that are affected. For the proposed action, we assume that vessels associated with the oil and gas program represent the greatest source of marine debris discharged into the Gulf of Mexico as a result of the proposed action. Our surrogate measure of take of these species from vessel strike will be the level of vessel activity, expressed in reported vessel track kilometers. Therefore, we use vessel activity level as a surrogate of take from marine debris. Similar to ship strike take monitoring, BOEM will collect vessel track data for all vessels associated with the proposed action and report to NMFS annually on vessel activity.

15.3 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the BOEM, BSEE, and NMFS' Permits and Conservation Division must comply with the following terms and conditions, which implement the *Reasonable and Prudent Measures* (repeated in italics below) described above and outlines the mitigation, monitoring and reporting measures required by the section 7 regulations (50 CFR §402.14(i)). These terms and conditions are non-discretionary. If BOEM, BSEE, and NMFS's Permits and Conservation Division fail to ensure compliance with these terms and conditions and their implementing reasonable and prudent measures, the protective coverage of section 7(o)(2) may lapse.

15.3.1 Term and Condition #1

The following terms and conditions implement reasonable and prudent measure 1: BOEM, BSEE, and NMFS' Permits and Conservation Division shall implement mitigation and monitoring measures to limit the potential for interactions with ESA-listed species.

A. For mitigation and monitoring measures implementation:
   i. BOEM and BSEE shall implement all mitigation and monitoring measures as proposed in the action described in section 3.1.6 of this opinion for all ESA-listed species, and the mitigation and conservation measures relevant to the Bryde's whale and sperm whale as specified herein as measures adopted for the extent of the time period under this opinion. BOEM and BSEE shall ensure the implementation of the

procedures described in section 3.4 of this opinion for step-down review and in section 3.5 for annual activity reviews (see also section 15.3.7, below).

ii. BOEM and BSEE shall implement mitigation protocols in **Appendix A** (seismic survey mitigation), **Appendix B** (marine debris), and **Appendix C** (vessel strike mitigation).

iii. NMFS Permits and Conservation Division shall ensure the mitigation and conservation measures as specified in the final MMPA rule, which will be available through the Federal Register and posted at [https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-oil-and-gas], may be imposed through subsequent individual LOA(s); and the implementation of the procedures described in section 3.4 of this opinion for step-down review and in section 3.5 for annual activity reviews (see also section 15.3.7, below).

B. BOEM and BSEE will work together with the NMFS ESA section 7 Consulting Biologist to consider or identify any needs for additional measures beyond those in the current opinion, and consider means of having those implemented, programmatically or to site-specific projects, as necessary, to ensure the protection of ESA-listed species through the annual review process, which includes adaptive management as needed.

C. To reduce the risk of stressors to listed species (e.g., entanglement, marine debris, sound from oil and gas related activities):

i. BOEM and BSEE shall ensure that all Oil and Gas Program equipment shall be properly conditioned to reduce the risk of entanglement or entrainment of ESA-listed species. Underwater lines (rope, chain, cable, etc.) must be stiff, taut, and non-looping. Flexible lines such as nylon or polypropelene that could loop or tangle must be enclosed in a sleeve to add rigidity and prevent looping or tangling. No excess underwater line shall be allowed. All equipment, especially towed apparatuses, shall be designed in a way as to prevent entrainment of sea turtles or other ESA-listed species.

15.3.2 Term and Condition #2

The following terms and conditions implement reasonable and prudent measure 2: BOEM and BSEE shall revise internal procedures and processes to assure that the measures identified in this opinion or through step-down reviews are implemented to protect ESA-listed species:

A. BOEM, in conjunction with BSEE, for activities that have the potential to affect ESA-listed species, especially those that have sound sources within hearing ranges of ESA-listed species, such as: dynamically positioned vessels, High Resolution Geophysical (non-airgun) survey equipment (sub-bottom profilers or echosounders), airgun surveys, emergent technologies, or others (e.g., incorporation of biological reviews for seismic survey permit applications) shall require a level of reporting detail from industry such that the information is sufficient to conduct internal reviews and to create summary reports as necessary for NMFS in annual activity reviews, (section 1.1.7 below).

B. BOEM, in conjunction with BSEE, shall update their regulatory guidance documents or other documents (e.g., Notice to Lessee's, protected species stipulation, conditions of approval), as necessary, to reflect requirements imposed by this ESA section 7 programmatic biological opinion including those requirements for ESA listed marine mammals adopted from the MMPA rule.
    i. BOEM, in coordination with BSEE, shall develop guidance or other documents on the required use of protected species observers for site clearance trawling activities completed within a year of opinion implementation.

15.3.3 Term and Condition #3

The following terms and conditions implement reasonable and prudent measure 3: Action Agencies will report all activities as required by this opinion.

15.3.3.1 Bureau of Ocean Energy Management Reporting

A. BOEM, in conjunction with BSEE, shall compile and summarize annual monitoring and activity reports, and describe interactions with marine mammals, as specified in this opinion. The same monitoring reports shall be compiled for all ESA-listed species as those being reported for marine mammals under the MMPA rule (from the Federal Register). BOEM shall report to NMFS ESA section 7 Consulting Biologist all interactions with any ESA-listed species resulting from the proposed actions that are observed during the course of implementing monitoring requirements in this opinion. See section 3.5.4 for example summary review tables that will be submitted each year at the meetings.
B. BOEM, in conjunction with BSEE, shall monitor and coordinate with marine mammal stranding networks to help determine any potential relationship of any stranding with Oil and Gas Program associated activities. If a dead or injured marine mammal is observed during oil and gas associated activities, BOEM and BSEE shall immediately contact NMFS ESA section 7 Consulting Biologist and the appropriate stranding networks to report stranding details.
C. BOEM, in conjunction with BSEE, shall report to NMFS ESA section 7 Consulting Biologist any observations of stranded or dead ESA-listed marine mammals that are not attributable to oil and gas-associated activities but are observed during those activities and while implementing monitoring requirements required by this opinion and the MMPA LOA within 24 hours of the observation.
D. BOEM, in conjunction with BSEE, shall report to NMFS any possible exceedance of activity levels (e.g. seismic survey line miles/kilometers and the type and numbers of explosives used) or planned activities specified in the preceding opinion before the exceedance occurs if operational security considerations allow, or as soon as operational security considerations allow after the relevant activity is conducted. This includes reporting/tracking activity levels to NMFS summary information each time actions that

require step down review are performed. If NMFS determines that the aggregate number of such actions may lead to effects that are more extensive or spatially or temporally intensive than was anticipated under the programmatic analysis, NMFS may require subsequent review of such actions.

E. BOEM, in conjunction with BSEE, shall submit annual summary monitoring reports that identify the general location, timing, number of G&G survey hours, line kilometers and other aspects of the activities analyzed in this opinion to help assess the actual amount or extent of take incidental to oil and gas activities.

F. BOEM, in conjunction with BSEE, shall annually report to NMFS summarized vessel and aircraft traffic data associated with all oil and gas activities. Reporting shall include: vessel/aircraft type (fixed-wing, helicopter, barge, tow, tanker, supply, etc.), vessel tracks vessel size/draft, vessel type/purpose, port name, number of annual port calls for that vessel, outgoing vessel offshore destination (e.g., block area name and water depth), highest travelling vessel speed capability, and other relevant information as identified through annual review process. Vessel captains typically keep vessel logs and know the specifications of their vessels, and therefore this information should be readily available to oil and gas companies.

G. As part of the annual review process (see section 15.3.7 below) that becomes effective upon completion of this consultation, BOEM, in conjunction with BSEE, shall include annual summary reporting of all G&G survey activities and for all ESA-listed species monitored:

   i. At a minimum for required PAM (section 3.3), operators shall provide BSEE with a description of the passive acoustic system, the software used, and the monitoring plan prior to its use with any towed seismic survey activities as part of permit applications submitted under a G&G permit or revised exploration plan.

   ii. All procedures described in this opinion for ramp-up, PSO training, observer monitoring, and reporting (section 3.3, and as part of the terms and conditions of this opinion) shall be followed and shall be required for all ESA-listed species for the entirety of the 50 year time period covered under this opinion unless modified through the annual review process.

   iii. A standardized reporting form shall be used for all G&G surveys requiring PSOs in the Gulf of Mexico. Use of the new form shall be fully implemented in time for the first annual review cycle. Only through standardized data collection protocols can the number of takes, the magnitude of observed takes, and the effectiveness of mitigation measures be monitored. Information on observer effort and seismic operations are as important as animal sighting and behavior data.

   iv. Within a year of the implementation of this opinion, create requirements for observer experience level reporting consistent with Baker et al. (2013) for observer training, effort reporting, survey reporting, and sighting reporting.

H. BOEM, in conjunction with BSEE shall compile, summarize and annually report unauthorized releases associated with Gulf of Mexico Oil and Gas Program to NMFS. Details should include volume of the release, date, location, and any mitigation or enforcement measures taken.

I. BOEM must include biological review for ESA-listed species of planned Oil and Gas Program activities for the use of Dynamically Positioned (DP) vessels as drilling platforms for deeper water, an activity that already occurs and has been noted as a dominating sound source in support vessels as noted in BOEM's 2012 quieting technologies workshop report (https://www.boem.gov/ESPIS/5/5377.pdf). Sound source information for DP vessels, will be required for submission to the annual review process.

15.3.3.2 Bureau of Safety and Environmental Enforcement Reporting

A. BSEE, in conjunction with BOEM, must report to NMFS any possible exceedance of activity levels (e.g. numbers of explosives used) or planned activities specified in the preceding before the exceedance occurs if operational security considerations allow, or as soon as operational security considerations allow after the relevant activity is conducted.

B. BSEE, in conjunction with BOEM, shall provide annual reporting of:
   i. Pipeline installations or decommissioning including locations
   ii. Safety enforcement measures of changes to safety regulations
   iii. Loss of well control events
   iv. New developments or changes in environmental regulations
   v. Generalized reporting for APD authorizations (grouped by how many in water depths and in what planning area; was there a NUT used; etc.)
   vi. Incident of Non-compliance events (activity; reason for INC; penalty ensued)
   vii. Non-compliance that did not receive INCs (e.g., instance of entanglement in gear)

C. Summary report of Oil and Gas Program pile driving activity including potential interactions with ESA-listed species.

D. See also Term and Condition #6 for decommissioning reporting details.

E. See also Term and Condition #3 reporting requirements for BOEM, in conjunction with BSEE, including but not limited to parts G and H.

15.3.3.3 NMFS Permits and Conservation Division Reporting

A. NMFS' Permits and Conservation Division, in conjunction with BOEM and BSEE, shall compile and summarize annual monitoring and activity reports and describe interactions with ESA-listed species, as specified in the final MMPA rule and LOA.

B. NMFS' Permits and Conservation Division shall submit reports that identify the general location, timing, number of G&G survey hours and other aspects of the activities, and any potential to exceed activity G&G levels analyzed in this opinion to help assess the actual amount or extent of take incidental to oil and gas G&G activities.

15.3.4 Term and Condition #4

The following terms and conditions implement reasonable and prudent measure 4: BOEM and BSEE must monitor the effectiveness of the mitigation measures described in the Terms and Conditions of this ITS.

A. As means to standardize data collection methods are available, BOEM, in conjunction with BSEE, will insure that data it collects or requires operators to collect comply with those standards (e.g., see National Standards for a Protected Species Observer and Data Management Program: A Model for Seismic Surveys (Baker et al. 2013) or Passive Acoustic Monitoring standards) to allow for complete and concise reporting of observer data.
B. BOEM and BSEE, in coordination with NMFS, shall create a standard form for company reporting of vessel information and activity. Use of the new form shall be fully implemented in time for the first annual review cycle. Details shall include those described in Term and Condition #3, BOEM reporting part E, above.

15.3.5 Term and Condition #5

The following terms and conditions implement reasonable and prudent measure 5: BSEE shall implement measures to reduce the impacts on ESA-listed species and habitats from oil exposure.

A. The next time BSEE amends or updates NTL No. 2012-N06, "Guidance to Owners and Operators of offshore Facilities Seaward of the Coast Line Concerning Regional Oil Spill Response Plans", or issues similar guidance on OSRPs, the amendment or new guidance will include a reminder to owners and operators that in preparing OSRPs, such plans should be consistent with the provisions of applicable Area Contingency Plans (ACPs) and the Region 6 Regional Contingency Plan (RCP), including the sensitive species and habitats annexes of the ACPs and RCP. See 40 C.F.R. 40 C.F.R. § 300.210(c)(4)(i) (requiring each ACP to include "a detailed annex containing a Fish and Wildlife and Sensitive Environments Plan" that "provide[s] the necessary information and procedures to immediately and effectively respond to discharges that may adversely affect" the environment). Until this change to guidance is made, BSEE will provide these reminders on their website where they post public information on OSRPs (currently https://www.bsee.gov/what-we-do/oil-spill-preparedness/preparedness-activities/oil-spill-response-plans).

B. On the BSEE website where information is provided to the public about OSRPs (currently https://www.bsee.gov/what-we-do/oil-spill-preparedness/preparedness-activities/oil-spill-response-plans), BSEE will provide a link to the NRT Region map (currently at https://www.nrt.org/Site/Regionmap.aspx), which allows selection of the desired Regional website that provides the applicable ACPs, RCPs, and associated annexes of such plans.

C. In conferral with NMFS, BSEE will evaluate its existing guidance on review of OSRP's, including NTL No. 2012-N06, to determine whether any other revisions to such guidance are needed in light of the requirements in 30 C.F.R. §§ 254.23(g)(4) and (7), and/or the provisions of existing ACPs and the Region 6 RCP.

D. **Appendix H** to this Opinion provides NMFS guidance with respect to cetacean and sea turtle response during an oil spill release event in the Gulf of Mexico. These are NMFS recommendations, and not additional requirements for OSRP approval. BSEE will post a link to the NMFS webpage where this guidance is posted on BSEE's public website where information about OSRPs is provided.

E. BSEE will notify NMFS whenever it proposes revision to the portions of its guidance or regulations pertaining to the wildlife and habitat provisions of OSRPs, and provide NMFS with an opportunity to review such revisions prior to issuing them to the public.

15.3.6 Term and Condition #6

The following terms and conditions implement reasonable and prudent measure 6: BOEM and BSEE shall implement measures to reduce the impacts from explosive severance and removal of offshore structures.

A. BOEM and BSEE must ensure explosive-severance contractors or operators comply with all of the appropriate measures based on the Net Explosive Weight, charge placement or configuration, and water depth. These measures are included in **Appendix I** of this opinion.
B. If a sea turtle is stunned or injured as part of explosive-severance activities, then BOEM shall ensure that the operator will perform sea turtle resuscitation procedures provided in **Appendix J** of this opinion.

15.3.7 Term and Condition #7

Adaptive management is a systematic approach for improving resource management by learning from management outcomes. An adaptive approach involves exploring alternative ways to meet management objectives, predicting the outcomes of alternatives based on the current state of knowledge, implementing one or more of these alternatives, monitoring to learn about the impacts of management actions, and then using the results to update knowledge and adjust management actions. Adaptive management promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from actions and other events become better understood (e.g., making minor changes to protocols). A list of implementable objectives should reflect that flexibility going forward.

Within six months of the opinion being signed BOEM/BSEE will develop an outline for an adaptive management plan that lays out a framework for summarizing activity levels and evaluation of mitigation and monitoring for review by NMFS. Within nine months, BOEM/BSEE will provide a draft adaptive management plan, with final approval of that plan by NMFS within a year of opinion implementation. This process allows for BOEM, BSEE, and NMFS to collaboratively implement in a reasonable timeframe (e.g., phased implementation) new data source identification and methods of data collection, compilation and reporting detailed within this opinion and summarized here, to include, but is not limited to the following:

- Reporting required under this opinion, including results from BOEM or BSEE monitoring from the previous year(s).
- Review and use of data coming from monitoring vessel movement/speed in the Bryde's whale area.
- Additional data on the location of ESA-listed species in and outside of the Bryde's whale area.
- Results from other ESA-listed species and/or sound (acoustics) research or studies; or any information that reveals ESA-listed species may have been taken in a manner, extent, or number; or damage to designated critical habitat, not authorized under this opinion.
- Possible sources of data that could contribute to the decision to modify the mitigation, monitoring, and reporting measures in this opinion:
- Changes under MMPA processes that would not align with the conclusions of this opinion.
- Unforeseeable changes to activities or actions.
- Emergencies. If NMFS determines that an emergency exists with appropriate BOEM and BSEE notification that poses a significant risk to the well-being of an ESA-listed species this opinion may be amended immediately.

The review under the adaptive management process on an approximate yearly basis will be used by BOEM/BSEE/NMFS to determine if no changes are needed; minor operational amendments are needed; or full reinitiation is needed to the current opinion.

If, through adaptive management, the modifications to the mitigation, monitoring, or reporting measures are substantial, NMFS would discuss with the action agencies at the appropriate time, likely during the annual review process, but could also be more immediate, if necessary, to determine the best course of action.

16 CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

We make the following conservation recommendations, which would provide information for future consultations involving the proposed programmatic action that may affect ESA-listed species as well as reduce injury or harassment related to the authorized activities:

1. We recommend that BOEM and BSEE create a reporting/auditing process for BOEM/BSEE permitting. Consider creation of online reporting system that industry, BOEM/BSEE, NMFS and the public can use simultaneously for closer-to real-time information and ease of annual reporting.
    a. BOEM uses a process to deem an application complete and, part of that process helps BOEM determine whether further review is necessary. To improve and streamline the intake process the following items could be used:
        i. Consideration of NUTs use
        ii. ESA-listed species and designated critical habitats that could be present and determination of effects to those species
        iii. NTLs being followed are noted within the plan
        iv. Worst Case Discharge scenario associated with the plan does not exceed the WCD outlined in the applicant's (BOEM/BSEE-approved) Regional Oil Spill Response Plan
        v. Verification that the Regional Oil Spill Response Plan has been approved by BOEM/BSEE and is up to date
        vi. Environmental Impact Assessment is included describing expected impacts to species and environment
        vii. Sound source information for DP vessels
        viii. Information on pile driving activities (number of piles, number of strikes per pile, water depth and associated sound source estimates)
        ix. Any post-lease G&G activities
    b. We recommend BOEM/BSEE work with NMFS to ensure the checklist that BOEM's receiving department uses for determining plan sufficiency includes information necessary for BOEM/BSEE to verify that implementation of the plans will not result in actions exceeding the types and levels of effects anticipated in this programmatic opinion individually or in aggregate.
2. We recommend that BOEM consider making the voluntary turtle pause and the turtle guards mentioned below in bullets a and b, respectively, requirements for all permits. These simple measures, which many G&G companies appear to already take, further reduce the likelihood of adverse effects to ESA-listed sea turtles and do not appear to affect the quality of seismic data obtained.

a. If at any time an ESA-listed sea turtle is observed within or near the exclusion zone of a seismic array, a shutdown is not required, but BOEM notes that most G&G companies in the Gulf of Mexico employ a "turtle pause", a voluntary practice during which the visual PSO requests that the operator pause the airgun array for six shots to let the turtle float past the array while it is inactive (BOEM 2017a). According to BOEM (2017a), this six shot pause is not considered to produce a loss of data/production, and as a result, operators would not have to re-survey the area.

b. Towed or derelict gear has the potential to entangle or entrap sea turtles. Turtle guards are described in section 8.6.2, and the comprehensive use of turtle guards on towed gear will prevent entanglement or entrapment occurrence.

3. We recommend that BOEM and the NMFS Permits and Conservation Division work with the G&G companies to coordinate their seismic surveys such that across companies the overall impact of the seismic activity on ESA-listed species is minimized. Based on the available data, the greatest impact is expected to occur if animals are more frequently disturbed and have little time for recovery between disturbances. As such, staggering the permitting of surveys, if allowable given the G&G companies' timelines, may reduce the overall additive impacts associated with the proposed action.

4. We recommend BOEM and BSEE continue to work with the oil and gas industry to minimize the effects of sound resulting from the Oil and Gas Program activities and report any progress during annual activity reviews.

5. We recommend that BOEM, BSEE and the NMFS Permits and Conservation Division work to make the data collected as part of the required monitoring and reporting available to the public and scientific community in an easily accessible online database that can be queried to aggregate data across required reports. Access to such data will not only help us better understand the biology of ESA-listed species (e.g., their range), it will also inform future consultations and authorizations by providing information on the effectiveness of the conservation measures and the impact of Oil and Gas Program activity on ESA-listed species.

6. We recommend that BOEM and the Permits and Conservation Division encourage the G&G companies to utilize real-time cetacean sighting services such as an Early Warning System (WhaleAlert App available at http://www.whalealert.org/), especially for baleen whales. We recognize that in many cases, the companies may not have reliable internet access during operations far offshore, but nearshore, where some of the cetaceans considered in this opinion are likely found in greater numbers, we anticipate internet access would be better. Monitoring such systems would help the companies plan their surveys to avoid locations with recent ESA-listed cetacean sightings, and may also be valuable during operations to alert survey operators of cetaceans within the area, which they can then avoid.

7. We recommend BOEM and BSEE work with the U.S. Coast Guard to implement a 10 knot [voluntary] speed reduction in 100-400 meter water depths across the northern Gulf of Mexico to further reduce the chance of vessel strike to Bryde's whales. There may be co-benefits between reducing speed with reduction of noise and increasing fuel efficiency. The speed reduction would reduce risk of lethal vessel strike to Gulf of Mexico Bryde's whales, specifically in the area off Louisiana where vessel traffic is highest and risk of strike may be most likely for occurrences of animals outside the Bryde's whale area. This would reduce potential for strike risk similar to the voluntary speed reduction that has been implemented in Harauki Gulf, New Zealand for that localized population of Bryde's whales (Ebdon et al. 2020).

8. We recommend USEPA, BOEM and BSEE conduct research to aid in the further understanding of effluents, as part of their action, and their potential to affect ESA-listed species. BOEM and BSEE are in the best position to understand the full effects of the oil and gas program including the effects regulated under other agencies. This could include improving knowledge on how well each species used for toxicity testing may represent ESA-listed species.

    a. We recommend BOEM/BSEE monitor all Gulf of Mexico NPDES general permit oil and gas discharges monitoring data to NMFS ESA section 7 Consulting Biologist.
    b. We recommend BOEM/BSEE work with USEPA compile, summarize and annually report to NMFS all Oil and Gas Program NPDES general permit non-compliance events that result in enforcement action.

9. We recommend BOEM and BSEE continue to reduce the uncertainty related to the effects of oil and gas emissions and discharges on ESA-listed species and their habitats. This includes working with other federal agencies (e.g., USCG and USEPA) to better understand aggregate effects to ESA-listed species from emissions/discharges and improve standards for prevention of unlawful events or impacts to ESA-listed species and their designated critical habitats. We recommend BOEM continue to model air emissions and use those estimates to feed into an updated atmospheric fate and transport model to estimate concentrations of pollutants, and better evaluate risk to air breathing ESA-listed marine species and their designated critical habitats.

10. We recommend USEPA work with BOEM and BSEE to improve knowledge on effects of air emissions on ESA-listed species, especially offshore.

11. We recommend USEPA aid in the conservation of the imperiled Bryde's whale in the Eastern portion of the Gulf of Mexico by implementing non-exceedance of the NAAQS near the area where Bryde's whales are primarily found.

12. We recommend BOEM/BSEE consider the recommendations in Murawski (2020) regarding minimizing risk of spills from ultra-deep wellsite locations. Additionally, we

recommend consideration of the recommendations in Frasier (2020) discussing preparation strategies for future spills in at-risk regions based on lessons learned from the DWH event.

In order for us to be kept informed of actions minimizing or avoiding adverse effects on or benefiting ESA-listed species or their critical habitat, BOEM, BSEE, and the Permits Division should notify us of any conservation recommendations they implement in their final action.

17 REINITIATION NOTICE

This concludes formal consultation on the Oil and Gas Program in the Gulf of Mexico with proposed activities from BOEM, BSEE, and NMFS' Permits and Conservation Division. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

(1) The amount or extent of taking specified in the incidental take statement is exceeded.
(2) New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
(3) The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered in this opinion. This includes creation of new regulations or revisions to existing regulations that modify the proposed action.
(4) A new species is listed or critical habitat designated under the ESA that may be affected by the action.

In accordance with the above, reinitiation may be needed if:

(1) Activities are planned in the area under GOMESA moratorium, which expires in 2022 and is not renewed.
(2) Change or cessation of the MMPA rule and LOA requirements that have been adopted for the time period covered under this programmatic biological and conference opinion.
(3) Exceedance of any projected programmatic activity level or annual take. If the amount of tracklines, location of tracklines, acoustic characteristics of the airgun arrays, or any other aspect of the proposed action or action area changes in such a way that the incidental take for ESA-listed species could be greater than estimated in the incidental take statement of this opinion, then (3) above may be met and reinitiation of consultation may be necessary.
(4) Identification during step-down reviews of an activity under the Oil and Gas Program that causes a program-level change, may affect ESA-listed species, and determined during review to require re-initiation. This includes if an activity in the Description of the Proposed Action is carried out in a manner different than described by an action agency in their respective BA and/or supplemental information then that could change how the action affects an ESA-listed species.

(5) New scientific information becomes available about the Gulf of Mexico Bryde's whale, which could include information about population trends or distribution, significant changes to the known distribution area, distribution outside the Bryde's whale area or publication of new density models or abundance estimates. This information may be relevant to inform our vessel strike analysis, which involved uncertainty regarding Bryde's whales outside the area where they are usually observed.

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