

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT
GULF OF AMERICA REGION
NEW ORLEANS, LOUISIANA

SITE-SPECIFIC ENVIRONMENTAL ASSESSMENT

OF

GEOLOGICAL & GEOPHYSICAL
SURVEY APPLICATION T26-004

FOR

TGS

June 25, 2026

RELATED ENVIRONMENTAL DOCUMENTS

Gulf of Mexico OCS Proposed Geological and Geophysical Activities
Western, Central, and Eastern Planning Areas, Final Programmatic Environmental Impact Statement
(OCS EIS/EA BOEM 2017-051)

Biological Opinion Oil and Gas Leasing, Exploration, Development, Production, Decommissioning, and All
Related Activities in the Gulf of Mexico Outer Continental Shelf
(FWS April 20, 2018)

Biological Environmental Background Report for the Gulf of Mexico OCS Region (OCS Report 2021-015)

Biological and Conference Opinion on Bureau of Ocean Energy Management and Bureau of Safety and
Environmental Enforcement's Oil and Gas Program Activities in the Gulf of America
(NMFS May 20, 2025)

Gulf of America Regional OCS Oil and Gas Lease Sales and Post-Lease Activities
Final Programmatic Environmental Impact Statement
(OCS EIS/EA BOEM 2025-042)

FINDING OF NO SIGNIFICANT IMPACT (FONSI)

The Bureau of Ocean Energy Management (BOEM) has prepared a Site-Specific Environmental Assessment (SEA) for application T26-004 complying with the National Environmental Policy Act (NEPA) at 42 United States Code (U.S.C.) §§ 4321 et seq. The United States Department of the Interior (DOI) NEPA implementing regulations at 43 Code of Federal Regulations (CFR) Part 46, DOI NEPA Handbook §1.5, and BOEM policy require an evaluation of proposed major Federal actions, which under BOEM jurisdiction includes oil and gas exploration or development activity on the Outer Continental Shelf (OCS).

The potential effects or impacts caused by similar actions to those proposed were examined at a basin-wide scale on the OCS in the following documents, from which this SEA is tiered:

- GOM G&G PEIS – Gulf of Mexico OCS Proposed Geological and Geophysical Activities Western, Central, and Eastern Planning Areas Final Programmatic Environmental Impact Statement (OCS EIS/EA BOEM 2017-051).
- 2025 PEIS – Gulf of America Regional OCS Oil and Gas Lease Sales and Post-Lease Activities Final Programmatic Environmental Impact Statement (OCS EIS/EA BOEM 2025-042).

This SEA also considers the impacts of the proposed action and incorporates by reference the evaluations below:

- 2018 FWS BO – Biological Opinion Oil and Gas Leasing, Exploration, Development, Production, Decommissioning, and All Related Activities in the Gulf of Mexico Outer Continental Shelf, United States Fish and Wildlife Service (FWS) April 20, 2018.
- 2021 BEBR – Biological Environmental Background Report for the Gulf of Mexico OCS Region (OCS Report 2021-015).
- 2025 NMFS BiOp – Biological and Conference Opinion on Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement's Oil and Gas Program Activities in the Gulf of America, National Marine Fisheries Service (NMFS) May 20, 2025.

Secretary of the Interior Doug Burgum issued Secretary's Order 3423, which directed the renaming of the Gulf of Mexico (GOM) to the Gulf of America. As a result, BOEM updated existing content while legacy content such as previously published reports, studies, and NEPA documents remain unchanged.

Proposed Action: TGS proposes to conduct an active acoustic seismic survey utilizing airgun arrays with ocean bottom nodes (OBNs) and pressure inverted echo sounders (PIES). The OBNs will be placed on the seafloor and recovered using a remote operational vehicle (ROV). Four vessels will be utilized for survey activities with one for towing the airgun array (*Sanco Swift*), two for the deployment and retrieval of OBNs and PIES from the seafloor (*Olympic Artemis*, *Armada 8603* or *Armada 8604*), and one support/chase vessel (*Koft Levi*). The proposed activities are located south of Texas in the East Breaks, Garden Banks, Alaminos Canyon, and Keathley Canyon protraction areas of the Western Planning Area. The proposed survey covers 650 OCS blocks centered on Alaminos Canyon 421.

The area of the proposed action is approximately 87 miles (140 kilometers) from the nearest shoreline and in water depths ranging from approximately 2,954 to 9,185 feet (ft) (900 to 2,800 meters [m]). Site-specific analysis was completed using TGS's description of the proposed operations; however, specific technical information regarding the geological and geophysical (G&G) activities described in the permit application is proprietary and therefore is not included in

this document. The proposed survey is expected to take approximately 365 days to complete and will begin in September 2026.

Factors Considered in this Determination: The impacts from the proposed action are further analyzed at the site-specific level in this Environmental Assessment. The impact analysis for the proposed activity focused on the geological and geophysical activities and the resources that may be potentially impacted. The impact producing factors (IPF) include: (1) active acoustic sound sources, (2) seafloor disturbance, (3) vessel noise, (4) vessel traffic, and (5) marine trash and debris.

In this SEA, BOEM has considered three alternatives: (1) No Action, (2) Proposed Action as Submitted, and (3) Proposed Action with Conditions of Approval (COAs). BOEM has assessed the impacts of the proposed action on the following resources:

- marine mammals
- sea turtles
- fish
- benthic communities
- archaeological resources.
- other users (i.e., military).

The use of an active acoustic sound source (airgun) is potentially the most disruptive impact for a free-swimming individual or groups of marine mammals, turtles, and fish in proximity to the airgun in operation. The effect of an active acoustic sound source is weighted most heavily out of all other potential impacting factors. Individual animals are vulnerable to injury if hit by the survey vessel from the proposed action. COAs include the monitoring of an exclusion zone by trained protected species observers and activation of survey shutdown requirements when mammals are observed (1) within the exclusion zone or in proximity to an active acoustic sound source, or (2) near the vessel. The application of passive acoustic monitoring, a visually / acoustically monitored exclusion zone, shutdown criteria, and vessel avoidance are designed to remove the possibility that animals and an operating airgun are located in the same place at the same time; therefore, groups or individuals are not unduly affected by underwater noise or exposed to being hit by the survey vessel. The impacts of the proposed activities from active acoustic sound sources have been mitigated to **nominal** to **minor** for marine mammals and **nominal** for sea turtles and fish. The impacts of the proposed activity from vessel strike have been mitigated to **nominal** to **moderate** for marine mammals, **nominal** to **minor** for sea turtles, and **nominal** for fish. The impacts of the proposed activity from vessel noises or marine trash and debris to marine mammals, sea turtles, fish, and other users have been mitigated to **nominal**. Impact significance levels are explained in **Chapter 3.1** of this SEA.

Our evaluation in this SEA has selected Alternative 3 and serves as the basis for approving the proposed action. BOEM concludes that no significant impacts are expected to occur to any affected resources by allowing the proposed activities to proceed, provided that the specific COAs and monitoring measures identified below are met by the operator.

- **PROJECT CRITERIA:** The applicant will adhere to the following Project Criteria. A full description of the Project Criteria can be found on the [BOEM Project Criteria](#) website.
 - **GEOPHYSICAL SURVEY PROJECT CRITERIA**
 - **MARINE DEBRIS PROJECT CRITERIA**
 - **VESSEL STRIKE AVOIDANCE AND INJURED AND/OR DEAD AQUATIC PROTECTED SPECIES REPORTING PROJECT CRITERIA**
 - **VESSEL TRANSIT WITHIN THE RICE'S WHALE AREA**
 - **IN-WATER LINE PRECAUTION PROJECT CRITERIA**
 - **MOON POOL MONITORING PROJECT CRITERIA**

○ **SEA TURTLE RESUSCITATION GUIDELINES PROJECT CRITERIA**

- **ARCHAEOLOGICAL RESOURCES:** This review indicates that there may be significant archaeological sites existing within the area of proposed ROV, 3D seismic, OBN, and PIES operations within the Federal waters of the OCS. Significant portions of the project area within the OCS have received either limited or no previous archaeological survey. These areas could contain additional archaeological materials that may be impacted by the proposed operations. All ROV operations must avoid impacting archaeological resources with the tether. One option is to use a ROV Tether Management System (TMS) to minimize entanglement risk and mitigate unnecessary seafloor contact. A second option would be to manually reduce slack in the tether during dive operations. Other options can be used if they are sufficient to actively avoid impacting archaeological sites, but they will need prior review and approval with BOEM archaeology. If you choose to develop your own tether management solution, email archaeology@boem.gov noting your application number in the subject line of the email.

If the applicant discovers human-made debris that appears to indicate the presence of a shipwreck, aircraft, or other human-made structure (e.g., a sonar image or visual confirmation of an iron, steel or wooden hull, wooden timbers, anchors, concentrations of human-made objects such as lithics, bottles, ceramics, piles of ballast rock, or aircraft wreckage or remains) within or adjacent to the area during the proposed survey operations, the applicant will be required to immediately halt operations, take steps to ensure that the site is not disturbed in any way, and contact the BOEM Regional Supervisor of the Office of Environment within 48-hours of its discovery. The applicant must cease all operations within 1,000 feet (305 meters) of the site until the Regional Supervisor instructs them on what steps must be taken to assess the site's potential historic significance and what steps must be taken to protect it. The applicant must report coordinates of the impact (to DGPS accuracy), a description of the submerged object, any damage that may have resulted from the operations, and provide copies of any photographic and/or video imagery that is collected. The applicant must also submit a copy of any data collected as a result of these investigations.

If remote-sensing survey data is collected for any reason during the course of this project (i.e., side-scan sonar, sector-scan sonar, multi-beam bathymetry, or magnetometer), the applicant must submit copies of these data to BOEM.

Please direct any questions or correspondence pertaining to these requirements to Ms. Melanie Damour at (504) 736-2783 or by emailing archaeology@boem.gov.

- **NON-RECURRING MITIGATION BENTHIC COMMUNITIES:** BOEM review of geophysical activities proposed in T26-004 identified potential sensitive sessile benthic resources within the proposed node area. According to NTL 2009-G40, the minimum separation distance for bottom disturbing activities is 76 m (250 ft) from any sensitive sessile benthic community (e.g., deepwater coral, chemosynthetic tube worms). Based on the methods described in the application, BOEM authorizes the applicant to deploy nodes with less than 76 m (250 ft) avoidance of deepwater benthic communities contingent upon the applicant adhering to the mitigations described below:
 1. All seafloor disturbances, including nodes, cables, and ROV, must remain a minimum of 5 m (16 ft) from **all sensitive sessile benthic communities**.
 2. The operator must photograph the seabed within a 10 m (33 ft) radius of any node placed within 76 m (250 ft) of **sensitive sessile benthic communities** or a **BOEM anomaly** (June 2019 dataset, see link below). Photographs of each such location shall be taken pre-node deployment, post-node deployment, and post-node retrieval. The photos shall clearly show the geographic location of each node.
 3. If any sessile benthic communities are present at a proposed node location, a new site that allows compliance with the above requirements shall be selected.
 4. The operator must provide an as-placed GIS shapefile of actual OBN locations to demonstrate compliance. Submit the required photographs and shapefile to the BOEM

Regional Supervisor, Office of Resource Evaluation, Data Acquisition and Special Projects Unit, within 90 calendar days after you complete the G&G activity.

Refer to the following BOEM site for GIS data layers of known 3D seismic water bottom anomalies: <https://www.boem.gov/Seismic-Water-Bottom-Anomalies-Map-Gallery/>

The following feature classes have a high probability of supporting sensitive sessile benthic organisms and shall be avoided unless visual inspection and photographic data confirm an absence of high-density deepwater benthic communities:

1. Anomaly_patchreefs (Shallow Water)
2. Anomaly_confirmed_patchreefs (Shallow Water)
3. Seep_anomaly_positives
4. Seep_anomaly_positives_possible_oil
5. Seep_anomaly_positives_confirmed_oil
6. Seep_anomaly_positives_confirmed_gas
7. Seep_anomaly_confirmed_corals
8. Seep_anomaly_confirmed_organisms
9. Seep_anomaly_confirmed_hydrate
10. Seep_anomaly_confirmed_carbonate
11. Anomaly_Cretaceous
12. Anomaly_Cretaceous_talus

If you have any question regarding this mitigation, please contact Dr. Alicia Caporaso – Benthic Ecology Lead at Alicia.Caporaso@BOEM.gov.

- **MILITARY WARNING AREA COORDINATION:** Our review indicates that the routes to be taken by boats in support of your proposed activities are within Military Warning Areas W-147D, W-147E and W-602, W-147E, W-228B, W-228C, and W-602 shown at: [MWA map](#). You shall contact the appropriate individual military command headquarters concerning the control of electromagnetic emissions and use of boats in each of the areas before commencing your operations. A list of contacts can be found at: [MWA contacts](#).

Conclusion: BOEM has evaluated the potential environmental impacts of the proposed action. Based on the SEA for application T26-004, BOEM has determined that the proposed action with COAs would have no significant impact on the marine, coastal, or human environment provided that the avoidance and mitigation measures required through conditions of approval are met by the operator. Therefore, an Environmental Impact Statement will not be required.

PERRY
BOUDREAUX

Digitally signed by PERRY BOUDREAUX
DN: c=US, o=U.S. Government,
ou=Department of the Interior,
ou=Bureau of Ocean Energy
Management, cn=PERRY BOUDREAUX,
0.9.2342.19200300.100.1.1=1400100131
8382
Date: 2026.06.29 07:01:04 -05'00'

June 29, 2026

Perry Boudreaux
Environmental Assessment Unit 2
Office of Environment, GOA OCS Region
Bureau of Ocean Energy Management

Date

CERTIFICATION OF ENVIRONMENTAL ASSESSMENT COMPLIANCE

This letter certifies the attached site-specific environmental assessment (SEA) for Geological and Geophysical (G&G) application T26-004, submitted by TGS, complies with the requirements outlined in Section 1.5 of the United States Department of the Interior (DOI) Handbook of National Environmental Policy Act (NEPA) Implementing Procedures (516 DM 1).

Page Limit Certification

The SEA, not including citations and appendices, does not exceed the 75-page limit. This document has been prepared in accordance with the specified formatting criteria outlined in Section 1.5(e) of 516 DM 1. As the responsible official, I certify that the breadth and depth of the analysis have been tailored to meet this page limit. This SEA represents the Bureau of Ocean Energy Management's (BOEM's) good-faith effort to prioritize the most important considerations required by NEPA within the mandated page limits. Our prioritization reflects the bureau's expert judgment, and any considerations addressed briefly or left unaddressed were, in our judgment, not of a substantive nature that would have meaningfully informed the environmental effects or the resulting decision.

Deadline Certification

This SEA has been completed within the required statutory deadline described in Section 1.5(f) of 516 DM 1. The completion date of this document is within one year of June 4, 2026, which is when the T26-004 application was deemed submitted as per 30 Code of Federal Regulations (CFR) § 550.231. I certify that this document represents the bureau's good-faith effort to fulfill NEPA's requirements within the congressional timeline. In our expert opinion, the analysis is thorough and adequate to inform and reasonably explain the bureau's decision regarding the proposed action.

**PERRY
BOUDREAUX**

Digitally signed by PERRY BOUDREAUX
DN: c=US, o=U.S. Government,
ou=Department of the Interior,
ou=Bureau of Ocean Energy
Management, cn=PERRY BOUDREAUX,
0.9.2342.19200300.100.1.1=140010013
18382
Date: 2026.06.29 07:01:33 -05'00'

June 29, 2026

Perry Boudreaux
Environmental Assessment Unit 2
Office of Environment, GOA OCS Region
Bureau of Ocean Energy Management

Date

Table of Contents

Page

FINDING OF NO SIGNIFICANT IMPACT (FONSI)	i
CERTIFICATION OF ENVIRONMENTAL ASSESSMENT COMPLIANCE	v
1. INTRODUCTION	1
1.1. Background.....	2
1.2. Purpose of and Need for the Proposed Action	3
1.3. Description of the Proposed Action	3
2. ALTERNATIVES CONSIDERED	4
2.1. No Action Alternative	4
2.2. Proposed Action as Submitted	4
2.3. Proposed Action with Conditions of Approval.....	4
2.4. Summary and Comparison of the Alternatives	4
2.5. Alternatives Considered but Not Analyzed in Detail	7
3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS.....	8
3.1. Introduction	8
3.2. Marine Mammals	10
3.2.1. Description.....	10
3.2.2. Impact Analysis	11
3.2.3. Cumulative Impact Analysis	15
3.3. Sea Turtles	15
3.3.1. Description.....	15
3.3.2. Impact Analysis	16
3.3.3. Cumulative Impact Analysis	19
3.4. Fish Resources and Essential Fish Habitat	20
3.4.1. Description.....	20
3.4.2. Impact Analysis	21
3.4.3. Cumulative Impact Analysis	24
3.5. Benthic Communities.....	25
3.5.1. Description.....	25
3.5.2. Impact Analysis	26
3.5.3. Cumulative Impact Analysis	27
3.6. Archaeological Resources	28
3.6.1. Description.....	28
3.6.2. Impact Analysis	28
3.6.3. Cumulative Impact Analysis	30
3.7. Other Users of the OCS.....	31
3.8. Other Considerations.....	31
4. CONSULTATION AND COORDINATION	31
5. BIBLIOGRAPHY	32
6. PREPARERS	41
7. REVIEWERS	41

**SITE-SPECIFIC ENVIRONMENTAL ASSESSMENT (SEA)
PREPARED FOR TGS
GEOLOGICAL AND GEOPHYSICAL SURVEY APPLICATION
T26-004**

1. INTRODUCTION

TGS has submitted a permit application (T26-004) to conduct a geological and geophysical (G&G) survey on the Outer Continental Shelf (OCS). This Site-Specific Environmental Assessment (SEA) evaluates the specific impacts associated with TGS's proposed G&G survey activities. **Chapter 1.3** of this SEA provides specific details on the G&G activities proposed in TGS's application.

The potential effects or impacts caused by similar actions to those proposed were examined at a basin-wide scale on the OCS in the following documents, from which this SEA is tiered:

- GOM G&G PEIS – Gulf of Mexico OCS Proposed Geological and Geophysical Activities Western, Central, and Eastern Planning Areas Final Programmatic Environmental Impact Statement (OCS EIS/EA BOEM 2017-051) (BOEM, 2017)
- 2025 PEIS – Gulf of America Regional OCS Oil and Gas Lease Sales and Post-Lease Activities Final Programmatic Environmental Impact Statement (OCS EIS/EA BOEM 2025-042) (BOEM, 2025)

“Tiering” is designed to reduce and simplify the size of environmental assessments by eliminating repetitive discussions of impacts considered in prior National Environmental Policy Act (NEPA) compliance documents, allowing analyses to focus on those site-specific concerns and effects related to the action proposed. Tiering is subject to additional guidance under the United States Department of the Interior (DOI) regulations at 43 Code of Federal Regulations (CFR) § 46.140 and the DOI NEPA Handbook §3.2(c), wherein the site-specific analysis must note which conditions and effects addressed in the programmatic document remain valid and which conditions and effects require additional review.

This SEA also incorporates by reference the evaluations from the relevant environmental documents listed below:

- 2018 FWS BO – Biological Opinion Oil and Gas Leasing, Exploration, Development, Production, Decommissioning, and All Related Activities in the Gulf of Mexico Outer Continental Shelf, United States Fish and Wildlife Service (FWS) April 20, 2018 (FWS, 2018)
- 2021 BEBR – Biological Environmental Background Report for the Gulf of Mexico OCS Region (OCS Report 2021-015) (BOEM, 2021)
- 2025 NMFS BiOp – Biological and Conference Opinion on Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement's Oil and Gas Program Activities in the Gulf of America, National Marine Fisheries Service (NMFS) May 20, 2025 (NMFS, 2025a) and Appendices and Attachments (NMFS, 2025b)

Secretary of the Interior Doug Burgum issued Secretary's Order 3423, which directed the renaming of the Gulf of Mexico (GOM) to the Gulf of America. As a result, the Bureau of Ocean Energy Management (BOEM) updated existing content while legacy content such as previously published reports, studies, and NEPA documents remain unchanged.

For this SEA, all of the analyses prepared in the GOM G&G PEIS, 2018 FWS BO, 2021 BEBR, 2025 NMFS BiOp, and 2025 PEIS (referenced hereafter as relevant NEPA compliance documents) are sufficiently comprehensive and adequate to support decision making for TGS's proposed activities, with the following exceptions:

- **Active Acoustic Sound Sources and Vessel Noise and Traffic Impacts on Marine Mammals** – the environmental baseline since completion of the programmatic analyses may have experienced slight changes and/or new information has become available
- **Active Acoustic Sound Sources and Vessel Noise and Traffic Impacts on Sea Turtles** – the environmental baseline since completion of the programmatic analyses may have experienced slight changes and/or new information has become available
- **Active Acoustic Sound Source Impacts on Fish and Fisheries** – the environmental baseline since completion of the programmatic analyses may have experienced slight changes and/or new information has become available
- **Space-Use conflicts with other Users of the OCS** – survey operations have the potential to interfere with ongoing military operations in the area of the proposed action
- **Seafloor Disturbance** – site specific analysis is required to assess the impacts on biological features and archaeological resources that were not known during the preparation of the programmatic analyses.

Marine mammals, sea turtles, fish, benthic resources, archaeology, other uses (military), and commercial and recreational fisheries, as indicated in the GOM G&G PEIS, are susceptible to impacts from geophysical activities that may be considered adverse, but not significant. Impacts to fishes and commercial and recreational fisheries from the proposed activities are not expected due to the temporary nature of the operations. Impacts to other uses (military) are not expected because the proposed activities are not located within military warning or Eglin water test areas. This SEA considers the potential for change in the status of resources and the potential for increased sensitivity of those resources to impacts from G&G activities.

Chapter 3 of this SEA will focus on new information relative to the cumulative environmental effects of this action. Where applicable, affected environment discussions and impact analyses from relevant NEPA compliance documents are summarized and utilized for this site-specific analysis and are incorporated by reference into this SEA. Appropriate conditions of approval (COAs) and monitoring measures identified in the relevant NEPA compliance documents have been considered in the evaluation of the proposed action.

1.1. BACKGROUND

BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) are mandated to manage the development of OCS oil, gas, mineral resources, and renewable energy resources while ensuring safe operations and the protection of the human, marine, and coastal environments. One purpose of BOEM's regulatory program is to ensure that the G&G data is obtained in an environmentally safe manner. BOEM and BSEE regulate leasing, exploration, development, production, and decommissioning, and they perform environmental analyses during each of these phases. BOEM's Resource Evaluation Program oversees "speculative" G&G data acquisition and permitting activities pursuant to 30 CFR Parts 551 and 580. Specifically, 30 CFR Part 551 regulates prelease G&G exploratory operations for oil, gas, and sulfur resources, and 30 CFR Part 580 regulates prelease prospecting activities. BOEM's Office of Leasing and Plans oversees "on-lease" or "ancillary" G&G data acquisition pursuant to 30 CFR Part 550, which applies to post-lease G&G exploratory operations.

The G&G surveys provide information used by industry and government to evaluate the potential for offshore oil and gas resources, renewable energy development, mineral resources exploration and development, and geologic hazards in a particular area. Industry needs accurate data to determine the location, extent, and properties of hydrocarbon resources. Information on shallow geologic hazards and seafloor geotechnical properties assists in the safe and economical exploration, development, production, and transportation of hydrocarbons. Additionally, the results of G&G surveys characterize sea bottom conditions before installing a renewable energy facility or to verify the completion of decommissioning activities.

The scope of the effects on resources from activities proposed in TGS's G&G survey permit application, T26-004, were fully discussed and analyzed in the GOM G&G PEIS. Neither the

specific location, equipment, nor the duration of this proposal will result in impacts different from those discussed in the relevant NEPA compliance documents. Existing peer-reviewed literature and environmental monitoring suggests the proposed activity will not result in a different cumulative impact conclusion from what was made in the relevant NEPA compliance documents. This information was not available or considered during the preparation of the GOM G&G PEIS. Therefore, this SEA was prepared by BOEM to evaluate the operator's proposed G&G activities in light of any new changes in the baseline and/or new information.

1.2. PURPOSE OF AND NEED FOR THE PROPOSED ACTION

TGS has submitted a permit application T26-004 to conduct a G&G activity on the OCS. The permit application proposes to conduct a seismic survey using airguns with ocean bottom nodes (OBNs) and pressure inverted echo sounders (PIES). The data collected can be utilized to evaluate the potential for, and develop plans for, the development and production of hydrocarbons or mineral resources on the OCS, which would help satisfy the Nation's need for energy or coastal restoration resources. Additional information regarding other survey activities can be found in the GOM G&G PEIS.

The need for this action is established by BOEM's responsibility under the Outer Continental Shelf Lands Act (OCSLA) to make OCS lands available for expeditious and orderly development, subject to environmental safeguards, in a manner that is consistent with the maintenance of competition and other national needs. Section 11 of the OCSLA at 43 United States Code (U.S.C.) 1340 requires anyone seeking to conduct such activities to first obtain approval from BOEM. The Secretary of the Interior oversees the OCS oil and gas program, and BOEM and BSEE are the agencies charged with this oversight and regulated management of the permitted or otherwise authorized oil and gas activities. The Secretary is required to balance orderly resource development with protection of the human, marine, and coastal environments while ensuring that the U.S. public receives a fair return for resources discovered on and produced from public lands (43 U.S.C. 1332[3]).

In response to the proposed activities in TGS's application, BOEM has regulatory responsibility, consistent with the OCSLA and other applicable laws, to approve, approve with modifications or COAs, or deny the application. BOEM's regulations provide criteria that BOEM will apply in reaching a decision and providing for any applicable COAs.

1.3. DESCRIPTION OF THE PROPOSED ACTION

TGS proposes to conduct an active acoustic seismic survey utilizing airgun arrays with OBNs and PIES. The OBNs will be placed on the seafloor and recovered using a remote operational vehicle (ROV). Four vessels will be utilized for survey activities with one for towing the airgun array (*Sanco Swift*), two for the deployment and retrieval of OBNs and PIES from the seafloor (*Olympic Artemis*, *Armada 8603* or *Armada 8604*), and one support/chase vessel (*Koft Levi*). The proposed activities are located south of Texas in the East Breaks, Garden Banks, Alaminos Canyon, and Keathley Canyon protraction areas of the Western Planning Area (WPA). The proposed survey covers 650 OCS blocks centered on Alaminos Canyon 421.

The area of the proposed action is approximately 87 miles (140 kilometers [km]) from the nearest shoreline and in water depths ranging from approximately 2,954 to 9,185 feet (ft) (900 to 2,800 meters [m]). Site-specific analysis was completed using TGS's description of the proposed operations; however, specific technical information regarding the geological and geophysical (G&G) activities described in the permit application is proprietary and therefore is not included in this document. The proposed survey is expected to take approximately 365 days to complete and will begin in September 2026 (TGS, 2026).

3D Seismic Survey Using Ocean Bottom Nodes and Pressure Inverted Echosounders

Seismic surveys using OBNs as receivers involve the placement of OBNs on the seafloor. The OBNs are typically placed using a ROV from a node handling vessel. After deployment, a source vessel towing an airgun array passes along the receivers. The OBNs may remain deployed for a

couple of days to several weeks, depending on the survey's design. After a survey is completed, the sensors are retrieved by an ROV. Each node placement would temporarily affect a small area of the seafloor.

PIES are used for measuring the average speed of sound in the water column. PIES use an up chirp to accurately measure two-way travel-time in the water column. It simultaneously measures pressure at the seafloor. Pressure measurements are converted to depth to find the acoustic distance traveled from the seafloor to the surface and back again. By combining the depth and travel time, the average speed of sound in the water column is calculated (Sonardyne, 2022).

The sound source typically used in most seismic surveys is an airgun array. An airgun array consists of pneumatic devices that produce acoustic output through the rapid release of a volume of compressed air. The airgun array is designed to direct the high energy bursts of low-frequency sound (termed a "shot") downward toward the seafloor. Reflected sounds from below the seafloor are received by an array of sensitive hydrophones on cables (collectively termed "streamers") that are either towed behind a survey vessel, attached to cables/nodes placed on or anchored to the seafloor, or placed within the wellbore during vertical seismic profile surveys. A typical full-scale array produces a source level of 248 to 255 dB re 1 μ Pa-m (decibels referenced to 1 microPascal at a distance of 1 meter), zero-to-peak (referring to the waveform of the sound pulse). Typical seismic arrays being used in the Gulf produce source levels (sound pressure levels) of approximately 240 dB re 1 μ Pa-m. While the seismic array pulses are directed toward the ocean bottom, sound can propagate horizontally for several kilometers (Richardson et al., 1995). Measurements of sources at sea (Goold and Fish, 1998; Sodal, 1999) have demonstrated that, although airgun arrays are primarily a source of low-frequency energy, there is also some transmission of energy at higher frequencies. These energies encompass the entire audio frequency range of 20 hertz (Hz) to 20 kilohertz (kHz) (Goold and Fish, 1998) and may extend well into the ultrasonic range up to 50 kHz (Sodal, 1999).

2. ALTERNATIVES CONSIDERED

2.1. NO ACTION ALTERNATIVE

Alternative 1 –If this alternative is selected the applicant would not undertake the proposed activity. This alternative might prevent the exploration and development of hydrocarbons or mineral resources, resulting in the potential loss of royalty income and energy resources for the United States.

2.2. PROPOSED ACTION AS SUBMITTED

Alternative 2 – If this alternative is selected the applicant would undertake the proposed activity as requested in the application. No COAs would be required by BOEM.

2.3. PROPOSED ACTION WITH CONDITIONS OF APPROVAL

Alternative 3 – This is BOEM's *Preferred Alternative*. If this alternative is selected the applicant would undertake the proposed activity as requested in the application, but with the COAs identified by BOEM to fully address the site- and project-specific impacts of the proposed action.

2.4. SUMMARY AND COMPARISON OF THE ALTERNATIVES

If selected, Alternative 1, the No Action Alternative, would prevent the applicant from acquiring the proper permits and the subsequent collection of seismic data on the OCS. The information would not be available to industry and government to assist in their evaluation of offshore oil and gas resources, geologic hazards, or potential renewable energy sites in a particular area. Alternative 1 would not result in any impacts to the environmental resources analyzed in **Chapter 3**; however, it does not meet the underlying purpose and need.

If selected, Alternative 2 would allow for the collection of seismic data, as requested in the application, but would not include any additional COAs or monitoring measures applied by BOEM. Alternative 2 meets the underlying purpose and need of the proposed action but could cause

unacceptable impacts to the environmental resources analyzed, as described in **Chapter 3** (e.g., hearing loss in marine mammals, injuries to marine mammals and sea turtles from vessel strikes, potential damages to unknown cultural resources and benthic resources on the seafloor). Alternative 2 would not require the implementation of COAs and monitoring measures developed by BOEM to limit the potential for lethal and sublethal impacts to marine mammals and sea turtles.

Alternative 3 is the Preferred Alternative, based on the analysis of potential impacts to resources described in **Chapter 3**, because it meets the underlying purpose and need, and also implements COAs and monitoring measures that adequately limit or negate potential impacts.. The COAs and monitoring measures were identified and will need to be imposed to provide further protection for marine mammals per the 2024 NMFS ITR (NMFS, 2024a). The G&G activities proposed will provide TGS with sufficiently accurate data to determine the location, extent, and properties of potential hydrocarbon or mineral resources. Additionally, the collected data supports BOEM's regulatory and oversight responsibilities while promoting the development of hydrocarbon resources, potentially resulting in increased royalty income as well as energy or mineral resources for the United States.

Other alternatives regarding Agency oversight of the G&G permitting program, identified in the GOM G&G PEIS, were reviewed with the alternatives listed above chosen as reasonable for the current proposed action.

Conditions of Approval Required under the Preferred Alternative

The need for and utility of the COAs and monitoring measures are discussed in the relevant impact analysis sections of this SEA. The following COAs and reporting requirements were identified to ensure adequate environmental protection and post-activity compliance:

- **PROJECT CRITERIA:** The applicant will adhere to the following Project Criteria. A full description of the Project Criteria can be found on the [BOEM Project Criteria](#) website.
 - **GEOPHYSICAL SURVEY PROJECT CRITERIA**
 - **MARINE DEBRIS PROJECT CRITERIA**
 - **VESSEL STRIKE AVOIDANCE AND INJURED AND/OR DEAD AQUATIC PROTECTED SPECIES REPORTING PROJECT CRITERIA**
 - **VESSEL TRANSIT WITHIN THE RICE'S WHALE AREA**
 - **IN-WATER LINE PRECAUTION PROJECT CRITERIA**
 - **MOON POOL MONITORING PROJECT CRITERIA**
 - **SEA TURTLE RESUSCITATION GUIDELINES PROJECT CRITERIA**
- **ARCHAEOLOGICAL RESOURCES:** This review indicates that there may be significant archaeological sites existing within the area of proposed ROV, 3D seismic, OBN, and PIES operations within the Federal waters of the OCS. Significant portions of the project area within the OCS have received either limited or no previous archaeological survey. These areas could contain additional archaeological materials that may be impacted by the proposed operations. All ROV operations must avoid impacting archaeological resources with the tether. One option is to use a ROV Tether Management System (TMS) to minimize entanglement risk and mitigate unnecessary seafloor contact. A second option would be to manually reduce slack in the tether during dive operations. Other options can be used if they are sufficient to actively avoid impacting archaeological sites, but they will need prior review and approval with BOEM archaeology. If you choose to develop your own tether management solution, email archaeology@boem.gov noting your application number in the subject line of the email.

If the applicant discovers human-made debris that appears to indicate the presence of a shipwreck, aircraft, or other human-made structure (e.g., a sonar image or visual confirmation of an iron, steel or wooden hull, wooden timbers, anchors, concentrations of human-made objects such as lithics, bottles, ceramics, piles of ballast rock, or aircraft wreckage or remains)

within or adjacent to the area during the proposed survey operations, the applicant will be required to immediately halt operations, take steps to ensure that the site is not disturbed in any way, and contact the BOEM Regional Supervisor of the Office of Environment within 48-hours of its discovery. The applicant must cease all operations within 1,000 feet (305 meters) of the site until the Regional Supervisor instructs them on what steps must be taken to assess the site's potential historic significance and what steps must be taken to protect it. The applicant must report coordinates of the impact (to DGPS accuracy), a description of the submerged object, any damage that may have resulted from the operations, and provide copies of any photographic and/or video imagery that is collected. The applicant must also submit a copy of any data collected as a result of these investigations.

If remote-sensing survey data is collected for any reason during the course of this project (i.e., side-scan sonar, sector-scan sonar, multi-beam bathymetry, or magnetometer), the applicant must submit copies of these data to BOEM.

Please direct any questions or correspondence pertaining to these requirements to Ms. Melanie Damour at (504) 736-2783 or by emailing archaeology@boem.gov.

- **NON-RECURRING MITIGATION BENTHIC COMMUNITIES:** BOEM review of geophysical activities proposed in T26-004 identified potential sensitive sessile benthic resources within the proposed node area. According to NTL 2009-G40, the minimum separation distance for bottom disturbing activities is 76 m (250 ft) from any sensitive sessile benthic community (e.g., deepwater coral, chemosynthetic tube worms). Based on the methods described in the application, BOEM authorizes the applicant to deploy nodes with less than 76 m (250 ft) avoidance of deepwater benthic communities contingent upon the applicant adhering to the mitigations described below:
 1. All seafloor disturbances, including nodes, cables, and ROV, must remain a minimum of 5 m (16 ft) from **all sensitive sessile benthic communities**.
 2. The operator must photograph the seabed within a 10 m (33 ft) radius of any node placed within 76 m (250 ft) of **sensitive sessile benthic communities** or a **BOEM anomaly** (June 2019 dataset, see link below). Photographs of each such location shall be taken pre-node deployment, post-node deployment, and post-node retrieval. The photos shall clearly show the geographic location of each node.
 3. If any sessile benthic communities are present at a proposed node location, a new site that allows compliance with the above requirements shall be selected.
 4. The operator must provide an as-placed GIS shapefile of actual OBN locations to demonstrate compliance. Submit the required photographs and shapefile to the BOEM Regional Supervisor, Office of Resource Evaluation, Data Acquisition and Special Projects Unit, within 90 calendar days after you complete the G&G activity.

Refer to the following BOEM site for GIS data layers of known 3D seismic water bottom anomalies: <https://www.boem.gov/Seismic-Water-Bottom-Anomalies-Map-Gallery/>

The following feature classes have a high probability of supporting sensitive sessile benthic organisms and shall be avoided unless visual inspection and photographic data confirm an absence of high-density deepwater benthic communities:

1. Anomaly_patchreefs (Shallow Water)
2. Anomaly_confirmed_patchreefs (Shallow Water)
3. Seep_anomaly_positives
4. Seep_anomaly_positives_possible_oil
5. Seep_anomaly_positives_confirmed_oil
6. Seep_anomaly_positives_confirmed_gas
7. Seep_anomaly_confirmed_corals
8. Seep_anomaly_confirmed_organisms
9. Seep_anomaly_confirmed_hydrate

10. Seep_anomaly_confirmed_carbonate
11. Anomaly_Cretaceous
12. Anomaly_Cretaceous_talus

If you have any question regarding this mitigation, please contact Dr. Alicia Caporaso – Benthic Ecology Lead at Alicia.Caporaso@BOEM.gov.

- **MILITARY WARNING AREA COORDINATION:** Our review indicates that the routes to be taken by boats in support of your proposed activities are within Military Warning Areas W-147D, W-147E and W-602, W-147E, W-228B, W-228C, and W-602 shown at: [MWA map](#). You shall contact the appropriate individual military command headquarters concerning the control of electromagnetic emissions and use of boats in each of the areas before commencing your operations. A list of contacts can be found at: [MWA contacts](#).

2.5. ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

A viable alternative is required to be a logical option for carrying out the proposed action, ensure that the purpose of and need can be met, and be feasible under the regulatory directives of the OCSLA and all other applicable guidance. As such, other alternatives regarding Agency oversight of the G&G permitting program, identified in the GOM G&G PEIS, were reviewed with the alternatives listed above chosen as reasonable for the current proposed action. Several other alternatives were considered and reviewed during the coordination of the resource reviews, but they were ultimately dismissed and not analyzed further since they did not meet the aforementioned requirements. The following alternative was considered and given review; however, it was not accepted for the reasons discussed below.

Alternative Requiring Shut-Down Conditions for Delphinids

This analysis also considered whether to apply the shutdown conditions to delphinids. From a biological standpoint, the best available information suggests that delphinids are considered high-frequency specialists (i.e., auditory bandwidth of 150 Hz to 160 kHz) (Southall et al., 2007; 2019; 2021; NMFS, 2024b). Low frequency seismic arrays, such as the one considered for use under this proposed action, generally operate in the frequency range of 20 Hz to 20 kHz (Goold and Fish, 1998) and may extend well into the ultrasonic range up to 50 kHz (Sodal, 1999). Therefore, while the majority of the seismic noise occurs at frequencies below that of delphinids, there are some components that may enter into the hearing range of delphinids (Goold and Fish, 1998). These higher frequency components would be at lower intensity levels (i.e., not as loud). It is unclear, though, from a scientific standpoint whether any of the seismic noise that might be heard by delphinids is in fact disruptive.

Delphinids are known to bow ride on operating seismic vessels. BOEM funded data synthesis studies on the effectiveness of seismic survey mitigation measures and marine mammal observer reports (Barkaszi et al., 2012; Barkaszi and Kelly, 2019) that analyzed protected species observer (PSO) data collected from 2002 to 2008 and 2009 to 2015 in the Gulf. From 2002 to 2008, approximately 58% of all dolphin sightings occurred within the 500 m exclusion zone (now referred to as “shutdown zone”), and of these, 33% were exhibiting bow-riding behavior (Barkaszi et al., 2012). To note, prior to 2014, operators were not requested to specify bow-riding behavior (Barkaszi and Kelly, 2019). Barkaszi and Kelly (2019) found that approximately 67% of dolphin sightings occurred in the 500 m exclusion zone and 68% of all dolphin sightings were recorded as positive for bow-riding. Dolphins’ proclivity for bow-riding likely increases the number of sightings within the 500 m exclusion zone (Barkaszi and Kelly, 2019).

Looking at these records for a typical year (2009), approximately 400 (~27%) were delphinids within the 500 m exclusion zone with operating airguns. In that same year, there were 55 records of shutdowns for whales within the 500 m exclusion zone. If sources had also been shut down for the 400 sightings of delphinids, this would have resulted in a 7-fold increase in the number of shutdowns. There is little doubt then that a shutdown provision for delphinids within the shutdown zone would have a significant impact on seismic operations, such as those under the proposed action.

BOEM next considered whether a provision could be applied to allow for a reasonable exception for bow riding delphinids. For example, a provision could be considered that would allow PSOs to call for a power down (versus immediate shutdown) of the seismic source to the smallest airgun should any delphinid enter, or come close to entering, the 500 m shutdown zone referenced under the Geophysical Survey Project Criteria. If the delphinids leave the shutdown zone or engage in bow riding behavior, then the PSO could call for the immediate return of the array to full power. This would allow for an opportunity for the PSO to determine if the behavior of the animal(s) warranted a shutdown and if not would allow the applicant to return to full power more quickly (versus a shutdown followed by a 30 minute clearance of the zone and a no less than 20 minute ramp up procedure).

Based on the PSO sighting records, it is clear that shutdowns for delphinids would result in an impact to industry activities. Unlike other sound producing activities (e.g., sonar), seismic surveys occur on specified tracklines that need to be followed in order to meet the data quality objectives of the survey. In other words, seismic vessels in operation cannot simply divert away from nearby marine mammals without a loss in data quality. As stated above, an analysis of 2009 PSO data (Barkaszi et al., 2012) indicates that if shutdowns for delphinids within the shutdown zone were employed, there would have been a 7-fold increase in shutdowns of seismic arrays that year. Shutdowns of 30 minutes or longer would have required an additional 30 minute observation period to ensure animals have left the exclusion area followed by a no less than 20 minute ramp up procedure. In all likelihood, these shutdowns would then have required the applicants to return to an earlier point in the track line and resurvey the area again. This not only results in substantially more expense in downtime and repositioning of seismic arrays and streamers but would also likely increase the duration of and amount of total seismic noise for each affected survey area.

Conclusion

Based on the analysis above, BOEM believes it is essential to more fully investigate and vet the application of shutdown conditions to delphinids before requiring it as a COA (under Alternative 3) or considering it as an additional alternative to the proposed action. It is BOEM's intention, therefore, to fully analyze the application of this COA.

3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS

3.1. INTRODUCTION

The discussion below will: (1) describe/summarize the pertinent potentially affected resources; (2) determine whether the proposed G&G activities and their impact-producing factors (IPF) will have significant impacts on the marine, coastal, or human environments; and (3) identify significant impacts, if any, that may require further NEPA analysis in an EIS. The description of the affected environment and impact analysis are presented together in this section for each resource.

For each potentially affected resource, BOEM staff reviewed and analyzed all currently available peer-reviewed literature and integrated these data and findings into the analyses below. The analyses cite the best available, relevant scientific literature. BOEM performed this analysis to determine whether TGS's proposed survey activities will significantly impact the marine, coastal, or human environments. For the impact analysis, resource-specific significance criteria were developed for each category of the affected environment. The criteria for impacts to environmental resources are generally classified into one of the three following levels:

- ***Significant Adverse Impact*** (including those that could be mitigated to nonsignificance)
- ***Adverse but Not Significant Impact***
- ***Negligible Impact.***

Preliminary screening for this assessment was based on a review of previous SEAs, relevant NEPA compliance documents, and relevant literature pertinent to historic and projected activities. BOEM initially considered the following resources for impact analysis:

- marine mammals, including Endangered Species Act (ESA) listed species and strategic stocks
- sea turtles (all are ESA listed species)
- fishes, including listed species and ichthyoplankton
- commercial and recreational fisheries
- coastal and marine birds, including ESA listed species
- benthic communities
- archaeological resources
- military uses
- recreational and commercial diving
- marine transportation
- geology/sediments
- air and water quality.

In the GOM G&G PEIS, the impact analysis focused on a broad group of G&G activities (including other survey types) and resources with the potential for non-negligible impacts. First, a matrix identifies impact agents associated with each type of G&G activity. The IPFs include: (1) active acoustic sound sources, (2) vessel and equipment noise, (3) vessel traffic, (4) aircraft traffic and noise, (5) stand-off distance, (6) vessel discharges, (7) trash and debris, (8) seafloor disturbance, (9) drilling discharges, (10) entanglement, and (11) accidental fuel spills. The preliminary analysis in the GOM G&G PEIS considers surveys of the type proposed by TGS as well as impacts to resources by type of activity. To assist with subsequent coordination, the GOM G&G PEIS' analysis further defines the level of impact associated with each interaction as follows:

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

The GOM G&G PEIS notes that G&G surveys have historically covered a large area of the region each year and, when unmitigated, have the greatest potential for "significant" impacts to protected and other sensitive marine species in comparison with other OCSLA-approved activities, including, but not limited to, exploration and development drilling. Further, it acknowledges increasing concerns in the regulatory and scientific communities regarding acoustic impacts on marine life, including marine mammals, turtles, and fishes. Species of particular concern are those whose hearing capabilities (based on vocalization characteristics) fall within the low frequencies introduced into the marine environment by G&G activities. The GOM G&G PEIS provides a comprehensive characterization of biological resources that may be adversely affected by G&G activities. This information is summarized in the various resource-specific descriptions of the affected environment and impact analyses in the chapters that follow.

However, for the purposes of this SEA, BOEM has not included analyses on resource areas that were evaluated and considered under the GOM G&G PEIS as having nominal impacts or determined the resource would not be impacted by the proposed action. Such a procedure is consistent with the NEPA concept of tiering. Additionally, since no expansion or modification of support bases or related vessel construction work are proposed as a result of this activity, socioeconomic effects were not analyzed due to the type, the temporary nature, and employment size of the survey activity. The most recent evaluation of the best available peer-reviewed scientific literature continues to support this conclusion for the following resource categories:

- commercial and recreational fisheries
- coastal and marine birds, including ESA listed species

- recreational and commercial diving
- marine transportation
- geology/sediments
- air and water quality

For this SEA, BOEM evaluated the potential impacts from the applicant's proposed G&G activities on the following resource categories:

- marine mammals, including threatened/endangered and non-ESA listed species
- sea turtles (all are ESA listed species)
- fish and fisheries, including listed species and ichthyoplankton
- benthic communities
- archaeological resources
- other users of the OCS (space-use conflicts with military uses)

3.2. MARINE MAMMALS

3.2.1. Description

The marine mammal community is diverse and distributed throughout the northern Gulf waters. The marine mammals are represented by members of the taxonomic order Cetacea, including suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales), as well as the order Sirenia (i.e., manatee). Twenty-one species of cetaceans and one species of Sirenia regularly occur in the region and are identified in the NMFS Gulf of Mexico Stock Assessment Reports (Hayes et al., 2024). A complete description of marine mammals can be found in the relevant NEPA compliance documents and is incorporated by reference.

Threatened or Endangered Marine Mammal Species

Only two cetaceans, the sperm whale (*Physeter macrocephalus*) and the Rice's whale (*Balaenoptera ricei*) (previously named the GOM Bryde's whale [*Balaenoptera edeni*]), regularly occur in the region and are listed as endangered under the ESA. The Florida manatee (*Trichechus manatus latirostris*), a subspecies of the West Indian manatee (*Trichechus manatus*), has been documented all along the Gulf in nearshore waters, typically less than 4 m (13 ft) deep and within 1,000 m (328 ft) of the shore (Slone et al., 2022). West Indian manatees are currently listed as threatened. However, the Florida manatee subspecies is proposed to be listed as threatened, and the Antillean manatee (*Trichechus manatus manatus*) subspecies as endangered, which would replace the listing of the West Indian manatee (FWS, 2025). The sperm whale was listed as endangered throughout its range on December 2, 1970. The GOM Bryde's (now Rice's) whale was listed as endangered on May 15, 2019 (NMFS, 2019). The Rice's whale critical habitat is currently proposed by NMFS in the northern Gulf from the 100 to 400 m (328 to 1,312 ft) isobath (NMFS, 2023c).

The only commonly occurring baleen whale in the northern Gulf is the Rice's whale. The majority of Rice's whale detections are limited to the northeastern Gulf along the continental shelf between roughly 100 and 400 m depths (Garrison et al., 2024; NOAA Fisheries, 2026), though there have been some detections outside of this area in the northwestern and northcentral Gulf (Soldevilla et al., 2022; Rappucci et al., 2023; Soldevilla et al., 2024; NOAA Fisheries, 2024). Predicted densities and occurrence of Rice's whales remain highest in their northeastern Gulf habitat (Farmer et al., 2022; Garrison et al., 2024). Sperm whales in the Gulf are not evenly distributed, showing greater densities in areas associated with oceanic features that provide the best foraging opportunities (Garrison et al., 2018).

Non-ESA-Listed Marine Mammal Species

Nineteen toothed cetaceans (including beaked whales and dolphins) regularly occur in the region but are not ESA-listed. Despite being non-listed, the Marine Mammal Protection Act (MMPA) of 1972 protects all marine mammals.

Unusual Mortality Events (UME)

An UME is defined under the MMPA as a “stranding that is unexpected, involves a significant die-off of any marine mammal population, and demands immediate response.” A list of active and closed UMEs with updated information can be found at: [Unusual Mortality Events](#). There are currently no active UMEs in the Gulf.

Marine Mammal Hearing

Marine mammals are highly dependent on acoustic cues as a primary means of communicating and assessing their environment. For example, toothed whales use echolocation clicks to navigate their surroundings and locate prey, demonstrating the sophisticated use of sound in their ecological interactions (Madsen and Surlykke, 2013). An animal's auditory sensitivity to a sound depends on the spectral, temporal, and amplitude characteristics of the sound (Richardson et al., 1995). Baleen whales (i.e., Rice's whales) are classified within the low-frequency cetacean (LFC) hearing group (7 Hz to 36 kHz); dolphins, beaked whales, and toothed whales (e.g., sperm whales) are classified within the high-frequency cetacean (HFC) hearing group (150 Hz to 160 kHz); and *Kogia* are classified within the very high-frequency (VHF) cetacean hearing group (200 Hz to 165 kHz) (NMFS, 2024b).

3.2.2. Impact Analysis

The IPFs associated with the proposed action that could affect marine mammals are primarily active acoustic sound sources and vessel noise from survey activities, collisions with survey vessels, and marine trash and debris. The GOM G&G PEIS contains a discussion of the potential impacts from survey operations on marine mammal resources. Additional information about routine impacts from oil and gas activity on marine mammals is addressed in the relevant NEPA compliance documents. The discussions are summarized below and are incorporated by reference into this SEA.

3.2.2.1. Alternative 1

If Alternative 1, the No Action Alternative, is selected the applicant would not undertake the proposed activities; therefore, the IPFs to marine mammals would not occur. For example, there would be no vessel noise or seismic airgun noise that would result in behavioral change, masking, or non-auditory effects to marine mammals, no long-term or permanent displacement of the animals from preferred habitats, and no destruction or adverse modification of any habitats. In addition, there would be no survey related debris that could result in endangerment to marine mammals and no additional vessel traffic related to the survey activities, so there would be no risk of collisions with marine mammals.

3.2.2.2. Alternative 2

If Alternative 2, the Proposed Action as Submitted, is selected the applicant would undertake the proposed activities as requested and conditioned in the application. Examples of potential impacts to marine mammals without implementation of the COAs include, but are not limited to, injury from vessel strikes, hearing loss from seismic noise, disruption of feeding and other behaviors from seismic noise and vessel presence, and exposure to marine trash and debris. This Alternative would not adequately limit or negate potential impacts to marine mammals.

3.2.2.3. Alternative 3

If Alternative 3, the Proposed Action with COAs, is selected the applicant would undertake the proposed activities as requested and conditioned in the application; however, the applicant would be required to undertake COAs as identified by BOEM. For the reasons set forth below, inclusion of these measures under Alternative 3 limits or minimizes potential impacts to marine mammals.

Potential Impacts to Marine Mammals from Active Acoustic Sound Sources

In 2018, BOEM and NMFS began collaborating to improve efficiency and consistency in joint ESA Section 7 consultations, MMPA authorizations, and BOEM permits related to the oil and gas program and other program areas. The effort was designed to specifically address actions for

which the two agencies have regulatory authority, and those that would have the greatest long-term impact to increase efficiency, resolve regulatory issues, and complete actions. From this effort, a peer-reviewed technical paper analyzing active acoustic sources and ascribing them to tiers based on potential level of impact to marine mammals was developed and published (Ruppel et al., 2022). An encyclopedic-like resource describing the sound sources and how they are typically used by different industries was also published (BOEM, 2023). Jointly developed standard operational protocols which already incorporated tiers for mitigating and monitoring the effects of geophysical surveys, including those from seismic airguns and HRG equipment, are found in the Geophysical Survey Project Criteria, with *de minimis* (i.e., unlikely to result in incidental take) activity characterized (Tier 4).

The potential for noise impacts from anthropogenic sound sources on marine mammals is highly variable and depends on the specific circumstances of a given situation (Nowacek et al., 2007; Southall et al., 2007; 2019; 2021; Erbe et al., 2025). The potential effects of underwater sound from an active acoustic source could result in auditory injury, permanent threshold shift (PTS), temporary threshold shift (TTS), behavioral disturbance, stress, masking, and nonauditory physical or physiological effects (Nowacek et al., 2007; Southall et al., 2007; 2019; 2021; Erbe et al., 2025). The degree of the potential impact depends on the species' hearing frequency, sound characteristics, received level, distance of the animal from the sound source, and duration of the sound exposure.

Because most of the energy from airguns is radiated at frequencies below 200 Hz, low-frequency cetaceans (e.g., Rice's whales) would most likely hear the acoustic source since it falls within their hearing range. High-frequency cetaceans (e.g., sperm whales and beaked whales) have auditory bandwidths that partially overlap with the frequencies of maximum airgun output. Further, because mysticetes (e.g., Rice's whales) produce calls that span a low-frequency range (20 Hz to 30 kHz) with their best hearing abilities presumably falling into this range as well, they would be most likely to experience impacts from the low-frequency sounds produced by seismic surveys (Richardson et al., 1995). In contrast, odontocetes produce calls and hear best at mid to high frequencies (Richardson et al., 1995) and appear less vulnerable to low-frequency sound sources than mysticetes. There is evidence that some whales' closest points of approach to airgun arrays during seismic operations are substantially farther during full-power operations than during silence, indicating that there may be some avoidance response to the full-power operations (Barkaszi and Kelly, 2019).

BOEM applies the Geophysical Survey Project Criteria to mitigate effects of noises less than 180 kHz and requires PSOs. Under this criteria, airguns are categorized as Tier 1 or 2, depending on total volume. Sources having transmission frequencies higher than 180 kHz are deemed inaudible by marine mammals and therefore their effects are considered *de minimis* (Ruppel et al., 2022). With the application of protocols requiring vessels to maintain distances from marine mammals if within a specific Tier (when applicable) or shutdown of airgun source, the potential for impacts to marine mammals from G&G surveys is reduced or eliminated. The primary impacts expected are behavioral and short-term due to the transient nature of the sound source, and the wide-ranging distributions and movements of marine mammals in the Gulf.

By selecting Alternative 3, the operator is required to follow the Geophysical Survey Project Criteria and 2024 NMFS ITR. With these criteria in place, the impacts to marine mammals are determined to be **nominal to minor**.

Potential Impacts to Marine Mammals from Vessel Noise

Vessel noise from the proposed action will produce low levels of noise, generally in the 150 to 170 dB re 1 μ Pa-m at frequencies below 1,000 Hz. Vessel and equipment noises are transitory and generally do not propagate at great distances from the vessel. The intensity of noise from service vessels is roughly related to ship size and speed (Erbe et al., 2019). For a given vessel, relative noise tends to increase with increasing speed. Seismic operations with towed gear generally are conducted at relatively slow speeds of 4 to 6 knots, with a maximum speed of less than 8 knots. A comprehensive review of the literature on marine mammals and vessel noise (Erbe et al., 2019; 2025) revealed that changes in behavior vary widely across species and are

heavily dependent on context. Vessel noise could interfere with marine mammal communication either by masking important sounds from conspecifics (a member of the same species), masking sounds from predators, or it may trigger animals to alter their vocalizations (Tyack, 2008). There is the possibility of short-term disruption of movement patterns and/or behavior caused by vessel noise and disturbance. The behavioral disruptions potentially caused by noise and the presence of vessel traffic will therefore have **nominal** effects on cetacean populations in the northern Gulf.

Potential Impacts to Marine Mammals from Vessel Traffic

All marine mammals are vulnerable to accidental vessel strike. However, some marine mammal species may be more vulnerable than others to possible vessel strike with all vessels operating at speed, including primarily slow-moving species (e.g., manatees) or those that spend extended periods of time at the surface (e.g., Rice's whales), and deep-diving species (e.g., sperm whales) while on the surface (Vanderlaan and Taggart, 2007). For example, Rice's whales may spend up to 88 percent of their time at night, and 70 percent of their time overall, within 15 m (39 ft) of the ocean surface (Soldevilla et al., 2017), making them vulnerable to collisions with large vessels (Stevens et al., 2024).

Accidental vessel strike on a marine mammal can result in injury, mortality, or no apparent injury (Laist et al., 2001; Van Waerebeek et al., 2007; Vanderlaan and Taggart, 2007; Pace, 2011). Three fundamental components are essential to understanding and assessing vessel strike risk to any marine mammal population: 1) distribution, occurrence, and habitat selection of the population; 2) dive and surface behavior of individuals; and 3) vessel characteristics, activity, and mitigation measures (Stevens et al., 2024). Further, several factors affect the risk and severity of vessel strike to marine mammals, including species type, speed, health, and behavior of the animal and the path, speed, size, and number of vessels (Laist et al., 2001; Vanderlaan and Taggart, 2007; Martin et al., 2016). Vessel speed and vessel size are of note when assessing strike risk (Stevens et al., 2024; Garrison et al., 2025). Most global reports of vessels striking marine mammals involve large whales, though strikes with smaller species also occur (Van Waerebeek et al., 2007). Most severe and lethal whale injuries involve large ships (>80 m [262 ft]) at higher speeds. Eighty-nine percent of ship strike records show that vessels were moving at greater than 14 knots, most strikes occurred over or near the continental shelf, and the whales were usually not seen beforehand or were seen too late to be avoided (Laist et al., 2001; Van Waerebeek et al., 2007). Seismic operations with towed gear generally are conducted at relatively slow speeds of 4 to 6 knots, with a maximum speed of less than 8 knots.

The proposed activities are located outside of the area where the Rice's whale is likely to be present. The operator has not proposed any service vessels or vessel traffic within the Rice's whale area. Under Alternative 3, the operator is required to provide notification and concurrence to fulfill the Rice's Whale reporting requirements to BOEM and BSEE prior to any vessel transit changes, per the Vessel Transit within the Rice's Whale Area as identified in the 2020 RWA. The operator is also required to follow the Vessel Strike Avoidance and Injured and/or Dead Aquatic Protected Species Reporting Project Criteria, which would prevent or substantially reduce marine mammal interactions with vessels by requiring separation distances, speed restrictions, and the use of onboard observers for monitoring during certain activities. NMFS also provides all boat operators with whale watching guidelines, which are derived from the MMPA. These guidelines suggest safe navigational practices based on speed and distance limitations when encountering marine mammals. With these project criteria in place and considering the wide range of marine mammals in the Gulf, the impacts to marine mammals are determined to be **nominal to moderate**¹.

Potential Impacts to Marine Mammals from Marine Trash and Debris

Marine debris, such as plastics, can affect marine mammals through entanglement and/or ingestion (e.g., choking or intestinal blockage) (Gall and Thompson, 2015). Entanglement in marine debris could lead to injury, infection, reduced mobility, increased susceptibility to

¹ In the unlikely (i.e., not reasonably foreseeable) event of a strike on an ESA-listed whale that results in mortality, the determination could be major.

predation, decreased feeding ability, fitness consequences, and mortality (e.g., drowning) (Gall and Thompson, 2015). In addition, marine debris ingestion could lead to intestinal blockage, which can impact feeding ability and lead to injury or death (Senko et al., 2020). The discharge of marine debris by the offshore oil and gas industry and supporting activities is subject to several laws and treaties. By selecting Alternative 3, the operator is required to follow the Marine Debris Project Criteria, which is designed to prevent or minimize accidental marine debris. With this criteria in place, the impacts to marine mammals are determined to be **nominal**.

Conclusion

Seismic noise has the potential, individually or cumulatively, to result in impacts to marine mammal species commonly found in the proposed action area. However, BOEM finds that the potential for such effects from the proposed action is unlikely to rise to significant levels for the following reasons:

- Mysticetes, as low-frequency hearing specialists, are the species group most likely to be susceptible to impacts from non-pulse sound (intermittent or continuous) given that their hearing ranges overlap most closely with the noise frequencies produced from G&G survey-related noise (Richardson et al., 1995; Southall et al., 2007; 2019; 2021). However, most mysticeti species that may occur in the Gulf (i.e., North Atlantic right, blue, fin, sei, humpback, and minke) are considered either extralimital, rare, or uncommon within the region (Hayes et al., 2024). The only commonly occurring baleen whale in the northern Gulf is the Rice's whale, which is mostly found in the northeastern Gulf. Given the small geographic scope of the proposed action, as well as the operator proposing no survey activity or service vessels through the Rice's whale area, the presence of these species within the action area is unlikely. The potential for significant impacts is prevented or minimized given the implementation of the Geophysical Survey Project Criteria under Alternative 3.
- Manatees are typically uncommon in the proposed action area, though some deepwater sightings have occurred. As they predominantly inhabit only coastal marine, brackish, and freshwater areas, they are not expected to occur regularly in the area of the proposed action.
- The remaining marine mammal species in the Gulf are considered either HFC hearing specialists (e.g., sperm whales, beaked whales, and dolphins) with hearing ranges that partially overlap with the frequencies of maximum airgun output (Richardson et al., 1995; Southall et al., 2007; 2019; 2021) or VHF hearing specialists (e.g., *Kogia* spp.). Therefore, the potential for seismic noise produced from this proposed action to cause auditory and non-auditory effects, PTS, TTS, behavioral changes, or masking on these species is further limited.
- BOEM requires Project Criteria under Alternative 3 and the 2024 NMFS ITR. The protocols are expected to prevent or minimize duration of exposure to G&G survey-related noise when implemented in accordance with NMFS Incidental Take Authorizations (ITA) under the MMPA.

Given the scope, timing, and transitory nature of the proposed action and adherence to the COAs, the noise related to the proposed seismic survey is not expected to result in PTS, TTS, behavioral change, masking, or non-auditory effects to marine mammals that would rise to the level of significance. The geographic scope of the proposed action is small in relation to the ranges of marine mammals. The proposed survey activities are not expected to cause long-term or permanent displacement of the animals from preferred habitats, nor will they result in the destruction or adverse modification of any habitats. The operator is required to follow the Geophysical Survey Project Criteria, which will prevent or minimize/negate potential acoustic impacts to marine mammals. Survey activities will involve limited slow-moving vessel traffic related to the towing of the airgun array that carries some risk of collisions; however, animals may avoid the moving vessels, reducing the likelihood of collision. BOEM has adopted requirements to prevent or minimize/negate the chance of vessel strike to marine mammals with the Vessel Strike Avoidance and Injured and/or Dead Aquatic Protected Species Reporting Project Criteria. Also, BOEM has adopted requirements to prevent or minimize/negate the chance of marine trash and debris impacts to marine mammals with the Marine Debris Project Criteria.

3.2.3. Cumulative Impact Analysis

The relevant NEPA compliance documents address the cumulative impacts on marine mammals as a result of oil and gas leasing, exploration, development and production activities, including G&G activities.

Activities considered under the cumulative scenario which include the oil and gas program and other anthropogenic and natural activities, including the proposed action, may affect protected marine mammals or critical habitat. Marine mammals could be impacted by the degradation of water quality resulting from operational discharges; vessel traffic; noise generated by platforms, drilling rigs, helicopters, vessels, and G&G surveys; explosive structure removals; oil spills; oil-spill-response activities; loss of debris from service vessels and OCS structures; commercial fishing; capture and removal; and pathogens. The cumulative impact on marine mammals is expected to result in a number of chronic and sporadic sublethal effects (i.e., behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) that may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources.

Few deaths may occur from chance vessel collisions, ingestion of plastic material, commercial fishing, and pathogens. Disturbance (noise from vessel traffic and survey operations, etc.) and/or exposure to sublethal levels of toxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. The net result of any disturbance will depend upon the size and percentage of the population likely to be affected, the ecological importance of the disturbed area, the environmental and biological parameters that influence an animal's sensitivity to disturbance and stress, or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Natural phenomena such as tropical storms and hurricanes do occur in the region, though impacts remain difficult to quantify.

Incremental effects from the proposed action on marine mammals are expected to be **nominal** for vessel noise and marine trash and debris and **nominal** to **minor** for active acoustic sound sources. Incremental effects from the proposed action on marine mammals are expected to be **nominal** to **moderate** for vessel strike, though not rise to the level of significance because of the limited scope, duration, and geographic area of the proposed action, the wide-ranging movements of marine mammals in the Gulf, and adherence to the Project Criteria.

Conclusion

The effects of the proposed action, when viewed in light of the effects associated with other relevant activities, may impact marine mammals. With the implementation of the required COAs for seismic survey and vessel operations under Alternative 3, as well as the limited scope, timing, and geographic location of the proposed action, and considering the wide range of marine mammals in the Gulf, effects from the proposed survey activities on marine mammals will be **nominal** for vessel noise, marine trash and debris, **nominal** to **minor** for active acoustic sound sources, and **nominal** to **moderate** for vessel strike. For animals that may be continuing to experience stress/sublethal impacts from natural or anthropogenic stressors, adherence to the Project Criteria should act to further reduce impacts and provide an abundance of precaution.

3.3. SEA TURTLES

3.3.1. Description

The life history, population dynamics, status, distribution, behavior, and habitat use of sea turtles can be found in the relevant NEPA compliance documents and are incorporated by reference into this SEA. Of the extant species of sea turtles, five are known to inhabit the waters of the region (Pritchard, 1997): the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), and loggerhead (*Caretta caretta*). These five species are all highly migratory, and individual animals will migrate into nearshore waters as well as other areas of the North Atlantic Ocean, Gulf, and Caribbean Sea. Garrison et al. (2020) found that spatial and seasonal variation in loggerheads in the northern Gulf represents

the shift in habitats and behavioral modes across seasons, with animals moving into deeper waters and spending progressively less time at the surface during cooler months. Further, Lamont and Hart (2023) found that time at the surface was greater for loggerhead, Kemp's ridley, and green turtles in summer, though did not differ between BOEM's Eastern Planning Area (EPA) and Central Planning Area (CPA), except for Kemp's ridleys, which spent more time at the surface in the WPA than the EPA.

All five species of sea turtles found in the Gulf have been federally listed as endangered or threatened since the 1970s. The North Atlantic Distinct Population Segment (DPS) of green turtle is ESA-listed as threatened. Hawksbill turtles, Kemp's ridley turtles, leatherback turtles, and the Northwest Atlantic Ocean DPS of loggerhead turtle are ESA-listed as endangered. Floating *Sargassum* patches are federally designated under the ESA as critical habitat for loggerhead turtles (NMFS, 2014) and proposed for green turtles (NMFS, 2023b).

Sea Turtle Hearing

There is limited data available on sea turtle hearing abilities. While the general importance of sound to sea turtles is not well understood, there is a growing body of knowledge suggesting that sea turtles use sound in a multitude of ways. Sea turtles may use sound for navigation, locating prey or preferred habitat, predator avoidance, and environmental awareness (Piniak et al., 2016). There are few studies reporting sound production in sea turtles, despite their ability to hear sounds in both air and water. In general, sea turtles hear best in water at levels between 100 to 750 Hz, do not hear well above 1 kHz, and are generally less sensitive to sound than marine mammals (Papale et al., 2020; Reese et al., 2023).

3.3.2. Impact Analysis

The diversity of a sea turtle's life history leaves it susceptible to many natural and human impacts, including impacts while it is on land, in the benthic environment, and in the pelagic environment. The IPFs associated with the proposed action that could affect sea turtles include (1) active acoustic sound sources, (2) vessel noise, (3) vessel traffic, and (4) marine trash and debris. The GOM G&G PEIS contains a discussion of the potential impacts from survey operations on sea turtles (BOEM, 2017). Additional information about routine impacts from oil and gas activity on sea turtles is addressed in the relevant NEPA compliance documents. The discussions are summarized below and are incorporated by reference into this SEA.

3.3.2.1. Alternative 1

If Alternative 1, the No Action Alternative, is selected the applicant would not undertake the proposed activities; therefore, the IPFs to sea turtles would not occur. For example, there would be no vessel noise or seismic airgun noise that would result in behavioral change, masking, or non-auditory effects to sea turtles, no long-term or permanent displacement of the animals from preferred habitats, and no destruction or adverse modification of any habitats. Since there would be no vessel traffic related to the towing of the airgun array, there would be no risk of collisions with sea turtles.

3.3.2.2. Alternative 2

If Alternative 2, the Proposed Action as Submitted, is selected the applicant would undertake the proposed activities as requested and conditioned in the application. Examples of potential impacts to sea turtles without implementation of the COAs include, but are not limited to, exposure to marine trash and debris, potential hearing impacts from active acoustic sound sources, injury from vessel traffic, and disruption of feeding and other behaviors from vessel presence. This Alternative would not adequately limit or negate potential impacts to sea turtles.

3.3.2.3. Alternative 3

If Alternative 3, the Proposed Action with COAs, is selected the applicant would undertake the proposed activities as requested and conditioned in the application; however, the applicant would be required to undertake COAs identified by BOEM. For the reasons set forth below, inclusion of these measures under Alternative 3 limits or negates potential impacts to sea turtles.

Potential Impacts to Sea Turtles from Active Acoustic Sound Sources

Noise associated with G&G activities may result in behavioral effects (e.g., changes in direction or swimming speed) or auditory masking in sea turtles. The most likely impacts on sea turtles are expected to be short-term behavioral responses. Studies have demonstrated avoidance behavior of sea turtles to seismic surveys (O'Hara and Wilcox, 1990; Lenhardt, 1994; McCauley et al., 2000a; Piniak, 2012). Sea turtles may alter their behaviors when a seismic vessel approaches, and thereby suspend feeding, resting, or interacting with conspecifics. Such disruptions are expected to be temporary, however, and are not expected to impact the overall survival and reproduction of individual turtles. Seismic operations have the potential to permanently injure sea turtles in close proximity to active airgun arrays (Popper et al., 2014). Subadult and adult turtles may be more likely to be affected by seismic airgun noise than post-hatchling turtles because of the time that they remain submerged at depth. Post-hatchling turtles generally reside at or near the sea surface and may be less likely to be injured by the sound field produced by an airgun array projecting directionally downward. Sea turtles have been observed to dive immediately following airgun shots, suggesting an avoidance response. Few data are recorded about the potential direct physical injury to turtles from seismic surveys (Nelms et al., 2016).

Airguns are categorized as Tier 1 or 2 (per the Geophysical Survey Project Criteria) depending on total volume. Tier 1 sound sources are high energy surveys that would likely require mitigation and monitoring. Tier 2 sound sources are low to intermediate energy sources. Tier 2 sources are expected to have significantly fewer effects than Tier 1 sources. BOEM applies the Geophysical Survey Project Criteria to mitigate effects of noises less than 180 kHz and requires PSOs. The application of project criteria requiring vessels to maintain distances from sea turtles when applicable or mandatory pause of airgun sources would prevent or reduce the potential for impacts. Therefore, potential impacts to sea turtles from seismic surveys are unlikely if sufficiently distanced from the sound source. Given the scope, timing, and transitory nature of the proposed action, the wide-ranging movements of sea turtles in the Gulf, the implementation of the Geophysical Survey Project Criteria, and that the best available information indicates that sea turtles do not appear to use environmental sound heavily to meet daily needs for survival, the effects to sea turtles from seismic noise are expected to be **nominal to minor**.

Potential Impacts to Sea Turtles from Vessel Noise

The dominant source of noise from vessels is propeller operation, and the intensity of this noise is largely related to ship size and speed. Seismic operations with towed gear generally are conducted at relatively slow speeds of 4 to 6 knots, with a maximum speed of less than 8 knots. Vessel noise from the proposed action would produce low levels of noise, generally in the 150 to 170 dB re 1 μ Pa-m at frequencies below 1,000 Hz. Vessel and equipment noises are transitory and generally does not propagate at great distances from the vessel. There is no information regarding the long-term consequences that vessel noise may have on sea turtles. Hazel et al. (2007) demonstrated that sea turtles appear to respond behaviorally only to vessels at approximately 33 ft (10 m) or closer. Noise from service vessel activity may elicit a startle response from sea turtles, and there is the possibility of short-term disruption of activity patterns and temporary sublethal stress (National Research Council, 1990). It is conservative to assume that noise associated with survey vessels may elicit behavioral changes, such as evasive maneuvers, in individual sea turtles. The most likely effects of vessel noise on sea turtles could include short-term behavioral changes and possibly auditory masking. Based on the best available information, vessel noise is not expected to significantly disrupt normal behavior patterns in sea turtles that include, but are not limited to, breeding, feeding, or sheltering. Further, vessel noises generated by the proposed action will be localized and short term. It is not expected that vessel noise will have any detectable effect on biologically important behaviors of sea turtles. The effects to sea turtles from vessel noise are therefore expected to be **nominal**.

Potential Impacts to Sea Turtles from Vessel Traffic

Sea turtles are vulnerable to vessel strikes due to the time they spend at the ocean surface. Limited data are available concerning potential sea turtle impacts from vessel strikes due to a lack of studies and the challenges with detecting such impacts (Nelms et al., 2016). Nonetheless,

strikes from all types of vessels are known to result in sea turtle injury and mortality in the Gulf (Lutcavage et al., 1997; Work et al., 2010; Nelms et al., 2016). If a sea turtle is struck by a vessel, no apparent injury, minor non-lethal injury, serious injury, or mortality can occur with the associated effects varying based on the size and speed of the vessel. Seismic operations with towed gear generally are conducted at relatively slow speeds of 4 to 6 knots, with a maximum speed of less than 8 knots.

To prevent or minimize the potential for vessel strikes, BOEM requires operators to implement the Vessel Strike Avoidance and Injured and/or Dead Aquatic Protected Species Reporting Project Criteria, which contains vessel strike avoidance measures for sea turtles and other protected species. As per the required reporting under the Vessel Strike Avoidance and Injured and/or Dead Aquatic Protected Species Reporting Project Criteria, BOEM requires that any operator immediately report the striking of any animal. To date, there have been no reported strikes of sea turtles by G&G survey vessels; however, collisions with small or submerged sea turtles may go undetected. Given the scope, timing, and transitory nature of the proposed action, the wide-ranging movements of sea turtles in the Gulf, and adherence to the COAs, effects to sea turtles from vessel collisions are expected to be **nominal to minor**.

Potential Impacts to Sea Turtles from Marine Trash and Debris

Marine debris affects sea turtles primarily through entanglement and/or ingestion (e.g., choking or intestinal blockage) (Gall and Thompson, 2015). Entanglement in marine debris could lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and/or mortality (e.g., drowning) of sea turtles (Gall and Thompson, 2015). Marine debris ingestion could lead to intestinal blockage, which can impact feeding ability and lead to injury or death (Senko et al., 2020). The discharge of marine debris by the offshore oil and gas industry and supporting activities is subject to several laws and treaties. By selecting Alternative 3, the operator is required to follow the Marine Debris Project Criteria, which is designed to prevent or minimize accidental marine debris. With this COA in place, the impacts to sea turtles are determined to be **nominal**.

Conclusion

The sections above discuss sea turtle hearing in general and the potential range of effects to sea turtles from the proposed action, including (1) active acoustic sound sources, (2) vessel noise, (3) vessel traffic, and (4) marine trash and debris.

Effects of seismic noise on sea turtles will not rise to the level of significance for the following reasons:

- The best available scientific information indicates that sea turtles do not greatly use sound in the environment for survival; therefore, disruptions in environmental sound would have little effect.
- BOEM instituted the Geophysical Survey Project Criteria. The project criteria are expected to prevent or minimize duration of exposure to sounds above threshold.
- The scope, timing, and transitory nature of the proposed action will produce limited amounts of seismic noise in the environment.

Effects of vessel noise on sea turtles are considered discountable. The risk of impacts from marine trash and debris would not rise to the level of significance given that BOEM requires compliance with Marine Debris Project Criteria. The risk of collisions between sea turtles and vessels associated with the proposed action exists but would not rise to the level of significance given:

- BOEM requires compliance with the Vessel Strike Avoidance and Injured and/or Dead Aquatic Protected Species Reporting Project Criteria, which provides guidelines on monitoring programs to prevent or minimize the risk of vessel strikes to sea turtles and other protected species and the reporting of any observations of injured or dead protected species.

- The scope, timing, and transitory nature of the proposed action and the wide-ranging movements of sea turtles in the Gulf will result in limited opportunity for vessel strikes on sea turtles.

3.3.3. Cumulative Impact Analysis

The relevant NEPA compliance documents address the cumulative impacts on sea turtles as a result of oil and gas leasing, exploration, development and production activities, including G&G activities. The information from these documents is incorporated by reference in this SEA.

Activities considered under the cumulative scenario which include the oil and gas program and other anthropogenic and natural activities, including the proposed action, may affect protected sea turtles or critical habitat. Sea turtles may be impacted by the degradation of water quality resulting from operational discharges, vessel traffic, noise generated by platforms, drilling rigs, helicopters and vessels, G&G surveys, explosive structure removals, oil spills, oil-spill-response activities, loss of debris from service vessels and OCS structures, commercial fishing, capture and removal, and pathogens. The cumulative impact of these ongoing OCS activities on sea turtles is expected to result in a number of chronic and sporadic sublethal effects (i.e., behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) that may stress and/or weaken individuals of a local group or population and that may predispose them to infection from natural or anthropogenic sources. Through a systematic review, policy comparison, and stakeholder analysis, Nelms et al. (2016) found that potential impacts of seismic surveys on sea turtles vary (i.e., hearing damage, entanglement, and critical habitat exclusion) and can be obscure due to the lack of research. Thus, understanding the impacts on individuals and populations can be challenging, and additional research is needed (Nelms et al., 2016).

Few deaths may occur from chance collisions with vessels, ingestion of plastic material, commercial fishing, and pathogens. Disturbance (noise from vessel traffic and survey equipment) and/or exposure to sublethal levels of toxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. The net result of any disturbance depends upon the size and percentage of the population likely to be affected, the ecological importance of the disturbed area, the environmental and biological parameters that influence an animal's sensitivity to disturbance and stress, or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980).

Natural disturbances such as hurricanes can cause significant destruction of nests and topography of nesting beaches (Pritchard, 1980; Ross and Barwani, 1982; Witherington, 1986). Tropical storms and hurricanes are a normal occurrence in the Gulf and along the Gulf Coast. Some impacts of the hurricanes, such as loss of beach habitat, continue to impact sea turtles that would have otherwise used those areas as nesting beaches. Increases or decreases in beach armoring and other structures may impact all nesting sea turtles in the areas affected. Hurricanes and tropical activity may temporarily remove some of these barriers to suitable nesting habitat.

Incremental effects from the proposed action on sea turtles are expected to be **nominal** for vessel noise and marine trash and debris. Incremental effects from the proposed action on sea turtles are expected to be **nominal to minor** for active acoustic sound sources and vessel strike, though not rise to the level of significance because of the limited scope, duration, and geographic area of the proposed action, the wide-ranging movements of sea turtles in the Gulf, and adherence to the Project Criteria.

Conclusion

The effects of the proposed action, when viewed in light of the effects associated with other relevant activities, may affect sea turtles in the region. With the implementation of the required COAs for seismic survey and vessel operations, wide range of sea turtles in the Gulf, and the scope of the proposed action, incremental effects from the proposed seismic activities on sea turtles will be **nominal** for vessel noise and marine trash and debris and **nominal to minor** for active acoustic sound sources and vessel strikes.

3.4. FISH RESOURCES AND ESSENTIAL FISH HABITAT

3.4.1. Description

The life history, population dynamics, status, distribution, behavior, and habitat use of fish and essential fish habitat can be found in the relevant NEPA compliance documents and are incorporated by reference into this SEA.

Threatened or Endangered Species

Three fish species and one elasmobranch species found in the region are protected under the ESA: Gulf sturgeon, smalltooth sawfish, and giant manta ray and the ocean whitetip shark. The Gulf sturgeon (*Acipenser oxyrinchus*) was listed as threatened, effective October 30, 1991, under the ESA in the Federal Register (FR) at 56 FR 49653. The smalltooth sawfish DPS (*Pristis pectinata*) was listed as endangered, effective May 1, 2003, under the ESA at 68 FR 15674. The giant manta ray (*Manta birostris*) was listed as threatened, effective February 21, 2018, under the ESA at 83 FR 2916. The oceanic whitetip shark (*Carcharhinus longimanus*) was listed as threatened, effective March 1, 2018, under the ESA at 83 FR 4153. A detailed description of the Gulf sturgeon and critical habitat, smalltooth sawfish, giant manta ray, and oceanic white tip shark may be found in the 2025 NMFS BiOp.

Gulf sturgeon is predominantly distributed in the nearshore waters of the northeastern Gulf, from Lake Pontchartrain in Louisiana to the Suwannee River in Florida. Currently, the smalltooth sawfish is predominantly distributed in the nearshore waters of south Florida (FWS and Gulf States Marine Fisheries Commission, 1995; NMFS, 2009). The essential fish habitat (EFH) for the oceanic whitetip shark in the project area includes localized areas in the central Gulf and Florida Keys. Although no EFH or critical habitat has been designated, the giant manta rays are widespread in the region. Giant manta rays occupy tropical, subtropical, and temperate oceanic waters and productive coastlines and are commonly found offshore in oceanic waters but are sometimes found feeding in shallow waters (less than 10 m) during the day (Miller and Klimovich, 2016).

Non-ESA-Listed Species

Approximately 1,540 species of fishes are recorded in the region and Florida Keys (McEachran, 2009). NOAA, working with the South Atlantic and Gulf of Mexico Fishery Management Councils, manage 71 and 40 fish and crustacean species, respectively, within the Federal waters of the Gulf. Distinctive fish assemblages are recognized within broad habitat classes including demersal (soft bottom and hard bottom), coastal pelagic, and oceanic pelagic (epipelagic and midwater) species. Fish are also classified by their movement patterns. Billfishes (marlins and sailfish), swordfish, tuna, and many shark species are considered highly migratory as they are widely distributed geographically and occur from coastal waters seaward into the open ocean. Highly migratory species move vertically in the water column to feed, usually on a daily basis, and move great geographic distances for feeding or reproduction (NMFS, 2006). An example is the Atlantic bluefin tuna, which are known to use the Gulf in the spring for spawning grounds (Teo et al., 2007a and 2007b; Teo and Block, 2010).

Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MFCMA), as amended in 1996 by the Sustainable Fisheries Act, mandates that the regional Fishery Management Councils, through Fishery Management Plans, describe and identify EFH for each federally managed species, minimize adverse effects on such habitat caused by fishing, and identify other actions that encourage the conservation and enhancement of such habitats. Almost the entire Gulf is within a designated EFH. Further, the regional Fishery Management Council amended their plans (referred to as Generic Amendment Number 3, 2005) to more specifically designate that habitats less than 100 fathoms (600 ft) are identified and described as EFH.

Fish Hearing

All fish species have hearing and skin-based mechanosensory systems (inner ear and lateral line) used to detect sound in their environment (Fay and Popper, 2000; Popper, 2003). These sounds may be produced by other fish, other organisms (e.g., snapping shrimp, marine mammals), or other naturally occurring sounds such as waves breaking on the shore, rain on the water surface, etc. Many Gulf fish species are known to actively use sound to mediate specific behaviors (e.g., spawning). Anthropogenic (human-generated) sounds may affect fishes through auditory masking, behavioral modification, temporary hearing loss, or physiological injury. Masking of important environmental sounds or social signals could potentially reduce foraging success, increase predation, or disrupt reproduction. Studies suggest responses to anthropogenic sound can vary, even among members of a species. However, startle responses generally include avoidance behaviors away from adverse conditions. Responses may also vary with duration and frequency of exposure to a given signal. Fishes in close proximity to intense sound sources may experience temporarily reduced hearing sensitivity or TTS. These effects depend upon the type of sound, duration of sound, distance of sound, and fish species (Popper and Hastings, 2009). Injury to fishes as a result of rapid changes in pressure (barotrauma) may occur in close proximity to an intense sound source.

Hearing mechanisms in fishes have been studied extensively (Fay and Popper, 2000; Ladich and Popper, 2004; Webb et al., 2008), but the specific capabilities of species and the received-sound levels where potentially adverse impacts may occur are not well known. Furthermore, Popper and Fay (2011) suggest the broad designation of fishes as “hearing specialists” and “hearing generalists” is not sufficient to classify the hearing abilities of fishes. They recommend that the range of hearing capabilities across species is more like a continuum that includes the relative contributions of hydrostatic pressure to the overall hearing capabilities of a species. Although studies have investigated physiological impacts (McCauley et al., 2000a; McCauley et al., 2003) and behavioral response (Skalski et al., 1992; Engås et al., 1996; Slotte et al., 2004; Løkkeborg et al., 2012; Fewtrell and McCauley, 2012) in several species, results are generally inconclusive and cannot be applied at the population level (National Science Foundation, 2011). However, information gaps are widely recognized (Hawkins et al., 2014; Popper et al., 2014) and broad guidance has been developed to minimize potential impacts to fishes and sea turtles resulting from anthropogenic sound exposure. The sections below provide a synopsis of the available information relevant to the effects on fish from exposure to seismic and other anthropogenic sound.

3.4.2. Impact Analysis

Distinctive fish assemblages can be found within a broad range of habitats in continental shelf and oceanic waters. The IPFs associated with the proposed action that could affect fish include (1) active acoustic sound sources, (2) vessel noise, and (3) vessel traffic. The GOM G&G PEIS contains a discussion of the potential impacts from survey operations on fish resources. Additional information about routine impacts from oil and gas activity on fish is addressed in the relevant NEPA compliance documents. The discussions are summarized below and are incorporated by reference into this SEA.

3.4.2.1. Alternative 1

If Alternative 1, the No Action Alternative, is selected the applicant would not undertake the proposed activities; therefore, the IPFs to fish would not occur. For example, there would be no seismic airgun noise that would result in behavioral change, masking, or non-auditory effects to the animals, no long-term or permanent displacement of the animals from preferred habitats, and no destruction or adverse modification of any habitats.

3.4.2.2. Alternative 2

If Alternative 2, the Proposed Action as Submitted, is selected the applicant would undertake the proposed activities as requested and conditioned in the application. As described in the analyses below, impacts to fish from the proposed action (e.g., hearing loss or behavioral disruption from seismic noise), are expected to be short-term, localized and not lead to significant impacts.

Although the COAs outlined in **Chapter 2.4** and discussed in the marine mammal and sea turtle sections are requisite for permit approval, their implementation will not increase or decrease the potential for effects to fish from the proposed action.

3.4.2.3. Alternative 3

If Alternative 3, the Proposed Action with COAs, is selected the applicant would undertake the proposed activities as requested and conditioned in the application; however, the applicant would be required to undertake COAs identified by BOEM. As described in the analyses below, impacts to fish from the proposed action (e.g., hearing loss or behavioral disruption from seismic noise), are expected to be short-term, localized and not lead to significant impacts. Although the COAs outlined in **Chapter 2.4** would be included, their implementation would not increase or decrease the potential for effects to fish from the proposed action.

Potential Impacts to Fish from Active Acoustic Sound Sources

Fish ears respond to changes in pressure and particle motions (van Bergeijk, 1967; Schuijf, 1981; Kalmijn, 1988 and 1989; Schellert and Popper, 1992; Hawkins, 1993; Fay, 2005). Fish exposed to natural or manmade sound may experience physical and behavioral effects, ranging in magnitude from negligible to severe. The four areas of primary concern for fish exposed to elevated noise levels include: (1) hearing loss, (2) behavioral response, (3) masking, and (4) non-auditory effects.

Hearing Loss

To result in hearing loss, a sound must exceed the specific hearing threshold of that fish for a certain period of time (Popper, 2005). The consequences of temporary or permanent hearing loss in individual fish or a fish population is largely unknown. However, it likely depends upon the number of individuals affected and whether critical behaviors involving sound (e.g., predator avoidance, prey capture, orientation and navigation, and reproduction) are adversely affected.

McCauley et al. (2003) found that caged pink snapper exposed to airgun sounds (600 pulses with peak-to-peak source levels of approximately 223 dB re 1 $\mu\text{Pa}\cdot\text{m}$) experienced observable anatomical damage to the auditory structures and that this damage did not repair 58 days after exposure. The damage as quantified by missing hair cells was relatively low, but the potential for impaired function in the remaining cells and the wider implications of potentially reduced fitness were not tested. Popper et al. (2005) documented TTS of northern pike and lake chub in the Mackenzie River Delta but found that broad whitefish receiving a source level of 177 dB re 1 $\mu\text{Pa}^2\cdot\text{s}$ (decibels referenced to 1 microPascal squared, times seconds) showed no TTS. In both cases, the repetitive exposure to sound was greater than is expected in a typical seismic survey. Fishes involved in the study by Popper et al. (2005) were examined for damage to the sensory cells of the inner ear as a result of exposure to seismic sound, and no damage was observed (Song et al., 2008).

Behavioral Response

Behavioral effects from seismic noise on fishes can include changes in distribution, migration, mating, and ability to be caught. In general, any adverse effects on fish behavior or fisheries due to G&G surveys may depend on the species in question and the nature of the fishery (i.e., season, duration, and fishing method). Responses may also depend on the age of the fish, motivational state, size, and numerous unknown factors that are difficult, if not impossible, to quantify. Studies investigating the effects of sound (including seismic survey sound) on fish behavior were conducted on both uncaged and caged individuals (Chapman and Hawkins, 1969; Pearson et al., 1992; Santulli et al., 1999; Wardle et al., 2001; Hassel et al., 2003; Boeger et al., 2006) noted that fish typically exhibited a sharp “startle” response at the onset of a sound, followed by a return to normal behavior after the sound ceased. Investigation by Jorgenson and Gyselman (2009) indicated that behavioral characteristics of Arctic riverine fishes were generally unchanged by exposure to airgun sound.

Disturbance to fish population structures and distributions could result in reduced catch. An example would be temporary displacement of fish from traditional fishing grounds. Hirsh and

Rodhouse (2000) reviewed studies investigating the hypothesis that seismic survey sounds have a deleterious effect on (usually commercial) fishing success. In most cases, these studies (e.g., Skalski et al., 1992; Engås et al., 1996) found that fishing catch of one or more target species declined with the onset of seismic survey operations and remained depressed throughout this activity and for days after. These effects, as reviewed in Boertmann et al. (2010), depend on species, fishing gear, and other environmental parameters. Further, reduced catch rates have been reported in some marine fisheries during seismic surveys; in several cases the findings are confounded by other sources of disturbance (Dalen and Raknes, 1985; Dalen and Knutsen, 1986; Løkkeborg, 1991; Skalski et al., 1992; Engås et al., 1996). No change was determined in catch-per-unit-effort of fish when airgun pulses were emitted, particularly in the immediate vicinity of the seismic survey (Pickett et al., 1994; La Bella et al., 1996; Wardle et al., 2001). For certain species, reductions in catch may have resulted from a change in behavior of the fish, such as a change in vertical or horizontal distribution (Slotte et al., 2004) and simply coincided with the seismic work.

Masking

Masking is defined as the effect of an acoustic source interfering with the reception and detection of an acoustic signal or other sound of biological importance to a receiver. Any sound within an animal's hearing range can mask relevant sounds. Theoretically, the airguns or airgun arrays and vessel sound could contribute minimally to localized, short-term, and transitory masking of sound detection by some marine fishes, at least those species whose sound detection capacities are in the frequency range of the seismic survey sound source(s). However, there have been no documented studies concluding that seismic surveys resulted in the masking of any biologically relevant sounds for any fish species. This is most likely due to the roving nature of the G&G surveys or the limited exposure area where survey-related energy can be found. For example, some surveying technologies (e.g., vibroseis) may have operational frequencies or cycles that present an increased potential for locally masking biologically relevant sounds. For a discussion of the biological relevance of ambient and signal sounds to fish, see Fay and Popper (2000).

Non-Auditory Effects

Existing research suggests there is a potential for non-auditory injury or mortality of fish in the immediate vicinity of a high-energy acoustic source. Airguns and airgun arrays may potentially injure or kill fishes within several meters at the time of discharge (Kostyvchenko, 1973; Dalen and Knutsen, 1986; Booman et al., 1996; Dalen et al., 1996). The potential for injury is greater among fishes with trapped gas pockets or swim bladders that expand and contract with the ambient pressure changes. There are few studies that specifically investigate the effects of airgun sound on fish larvae and eggs, but existing research suggests these life stages are no more vulnerable to intense sound than adult fishes. Other studies document no egg, larvae, or fish mortality resulting from exposure to seismic sources (Falk and Lawrence, 1973; Holliday et al., 1987; La Bella et al., 1996; Santulli et al., 1999; McCauley et al., 2000a and 2000b; Thomsen, 2002; Hassel et al., 2003; McCauley et al., 2003; Popper, 2005; Payne et al., 2009).

Physiological effects may also include cellular and/or biochemical responses by fish to acoustic stress. Such stress potentially affects fish by increasing mortality or reducing reproductive success. However, primary and secondary stress responses of fish after exposure to seismic survey sound appear temporary (Sverdrup et al., 1994; McCauley et al., 2000a and 2000b). The periods necessary for these biochemical changes to return to normal are variable and depend on numerous aspects of the biology of the species and of the sound stimulus. The effects to fish from acoustic sound sources are expected to be **nominal**.

Potential Impacts to Fish from Vessel Noise

Within the area of the proposed action, the Gulf sturgeon may be exposed to vessel noise when support vessels transit across their habitat. While the Gulf sturgeon may be able to detect passing vessels, they are not expected to be affected by the sound. Therefore, the effects to fish from vessel noise are expected to be **nominal**.

Potential Impacts to Fish from Vessel Traffic

In the last five-year NMFS species review, vessel strikes were identified as an emerging threat for Gulf sturgeon. The operator is required to adhere with the mitigation and monitoring measures provided in the Vessel Strike Avoidance and Injured and/or Dead Aquatic Protected Species Reporting Project Criteria. Compliance with the Project Criteria should reduce or avoid impacts from vessel strikes under this alternative. With these COAs in place, the impacts to the Gulf sturgeon and other fish species are expected to be **nominal**.

Conclusion

Noise from the proposed action could potentially result in acute injury and mortality of a minimal number of individuals of some species of fish, their larvae, and/or eggs when in very close proximity to a high-energy acoustic source. The proposed action may result in short-term, localized behavioral reactions. Highly migratory species like the bluefin tuna are found in the proposed action area at certain times of the year. However, given the small area and timeframe exposed to seismic noise under the proposed action, the transience of the moving seismic source relative to the region, and the small number of fish potentially within this localized area, the chance of non-auditory injury or mortality would be limited to an insignificant number of individuals. Seismic effects on such a small number of individuals would be insignificant at the population scale and considerably smaller than the natural mortality rate. Therefore, based on the limited best available science, seismic surveys are not expected to result in significant auditory or non-auditory injury or mortality on marine fish at the population scale. Finally, the frequency range of some G&G survey equipment (e.g., airguns) overlaps with the likely hearing range of the ESA-listed fish species; however, these species are not routinely found beyond state waters. Therefore, impacts to fish resources from the proposed activity would be **nominal**.

3.4.3. Cumulative Impact Analysis

Cumulative impacts on fish and EFH that result from oil and gas leasing, exploration, development, and production activity including G&G activities are discussed in the relevant NEPA compliance documents. The information from these documents is incorporated by reference in this SEA.

Activities considered under the cumulative scenario include the oil and gas program and other anthropogenic and natural activities, including the proposed action, may affect fish and fisheries. Degradation of water quality from multiple human activities as described in the relevant NEPA compliance documents will continually affect fish and fisheries species. The cumulative impact of these ongoing OCS activities on fish and fisheries is expected to result in a number of chronic and sporadic lethal and sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) effects that may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources. Finally, non-anthropogenic sources such as red tides and tropical storms may add to the cumulative impacts on fish resources in the northern Gulf. The proposed action is a short-term event in a portion of the region; therefore, the effects from the proposed action will be slight in relation to these ongoing impacts.

The net result of any disturbance depends upon the size and percentage of the population likely to be affected, the ecological importance of the disturbed area, the environmental and biological parameters that influence an animal's sensitivity to disturbance and stress, and the accommodation time in response to prolonged stress.

Conclusion

The effects of the proposed action, when viewed in light of the effects associated with other relevant activities, may impact fish and fisheries in the Gulf. However, given the scope of the proposed action, incremental effects from the proposed seismic activities on fish and fisheries will be **nominal**.

3.5. BENTHIC COMMUNITIES

3.5.1. Description

For purposes of OCS activity impact analyses, BOEM defines “deepwater benthic communities,” to include chemosynthetic and deepwater coral communities as those typically found in water depths of 984 ft (300 m) and greater (BOEM, 2017).

A description of chemosynthetic and deepwater coral communities in the region can be found in the relevant NEPA compliance documents. The following information is a summary of the descriptions in the EISs, and it is incorporated by reference into this SEA.

The continental slope in the Gulf extends from the edge of the continental shelf at a depth of about 656 ft (200 m); benthic communities have been found in water depths ranging from 656 ft to 11,483 ft (200 to 3,500 m) (BOEM, 2017). The vast majority of the region has a soft, muddy bottom in which burrowing infauna are the most abundant invertebrates. The proposed survey area generally falls into this category as the water depth of the proposed activity ranges from 2,954 to 9,185 ft (900 to 2,800 m).

A remarkable assemblage of invertebrates is found in association with hydrocarbon seeps in the Gulf. Chemosynthetic communities can occur at or near hydrocarbon seeps and are defined as persistent, largely sessile assemblages of marine organisms dependent upon symbiotic chemosynthetic bacteria as their primary food source (MacDonald, 1992). Invertebrate taxa in these communities include tube worms and bivalves, among others. Symbiotic chemosynthetic bacteria live within specialized cells in the invertebrate organisms and are supplied with oxygen and chemosynthetic compounds (methane and sulfides) by the host via specialized blood chemistry (Fisher, 1990). Chemosynthetic bacteria, which live on mats, in sediment, and in symbiosis with chemosynthetic invertebrates, use a carbon source independent of photosynthesis to make sugars and amino acids. The host, in turn, lives off the organic products subsequently released by the chemosynthetic bacteria and may even feed on the bacteria themselves. Chemosynthetic communities can become established when a hard substrate is available for colonization at or near a seep. Depending on the situation, sessile benthic invertebrates can settle on and colonize carbonate substrate. These organisms form additional structure upon the seafloor, increasing the complexity of the habitat that may provide support to a variety of deepwater corals, invertebrates and fishes.

Some deepwater corals form communities occurring at or near hydrocarbon seeps, or on exposed outcrops, and may be found in association with chemosynthetic communities. Deepwater coral communities are also found on shipwrecks, and deepwater oil and gas infrastructure. These coral communities are distinctive and provide three-dimensional habitat for a range of fishes and invertebrates. Hard-bottom habitats in deep water include communities dominated by *Lophelia pertusa*, with other corals such as the bamboo coral (*Keratoisis flexibilis*) and zigzag coral (*Madrepora oculata*). Numerous other invertebrates are also associated with these benthic habitats (Sulak et al., 2008; Cordes et al., 2008; Fisher et al., 2007; Schroeder et al., 2005).

Hydrocarbon seep communities in the Gulf have been reported to occur at water depths greater than 300 m (984 ft) (BOEM, 2017). To date, there are over 300 deepwater benthic communities comprised of chemosynthetic organisms and/or deepwater corals. Once thought rare, research suggests that deepwater faunal communities are regularly associated with seafloor features commonly found in the vicinity of the primary geophysical signatures of the seabed for hydrocarbon migration to the seafloor. These areas include those where hydrocarbons percolate through sediments or where hydrocarbons move along faults that reach the seafloor. More than 23,000 positive anomalies have been identified from seismic survey data and each may represent a habitat where a hard substrate and a deepwater community may be found. However, until an anomaly has been visited and confirmed, it is unknown if hard substrates are exposed and capable of supporting deepwater benthic communities.

To map areas of probable habitat for deepwater benthic communities, scientists at BOEM analyzed decades of three-dimensional seismic data to classify seafloor returns exhibiting anomalously high or low reflectivity. The areas of high reflectivity represent patches of anomalous

seafloor returns that likely indicate patches of hard seafloor that would provide substrate for deepwater benthic communities. Most confirmed hard bottoms in the deepwater Gulf were created by the precipitation of calcium carbonate substrate by chemosynthetic bacterial activity and are capable of supporting deepwater benthic communities. However, non-biogenic hard bottoms are also found at escarpments, seafloor-reaching faults, or where salt formations reach the surface. Investigations of the seafloor at patches of high reflectivity indicate that chemosynthetic and coral communities are much more common in the deepwater than previously known. Also, areas of low reflectivity (negative anomalies) can be indicative of gassy sediments and mud volcanoes with a high flux of hydrocarbons from the seafloor. Although uncommon, chemosynthetic bivalves may be found in areas with a high flux of hydrocarbons.

3.5.2. Impact Analysis

A detailed impact analysis of the routine, accidental, and cumulative impacts of the proposed activities on chemosynthetic communities and deepwater coral communities can be found in the relevant NEPA compliance documents and are incorporated by reference into this SEA.

Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities resulting in bottom disturbances and increased turbidity. Such impacts to these habitats could permanently prevent recolonization by similar organisms requiring hard substrate. The IPF associated with the proposed activities that could affect deepwater benthic communities include physical impacts from placement and recovery of OBNs and PIES.

3.5.2.1. Alternative 1

If Alternative 1, the No Action Alternative, is selected the applicant would not undertake the proposed activities. Therefore, the IPF to deepwater benthic communities would not occur. For example, there would be no bottom impacts that could result in physical damage to the deepwater benthic communities or their substrates.

3.5.2.2. Alternative 2

If Alternative 2, the Proposed Action as Submitted, is selected the applicant would undertake the proposed activities as requested and conditioned in the application. An example of potential impacts to deepwater benthic communities without implementation of the COAs and monitoring measures noted in **Chapter 2.4** and the following analysis includes, but is not limited to, physical damage to deepwater benthic communities or their substrates from the proposed survey activities. The operator proposes seismic survey activities with OBNs as receivers at sites that are located near potential and/or confirmed deepwater benthic communities which, without additional measures, may lead to potential impacts to those sites.

3.5.2.3. Alternative 3

If Alternative 3, the Proposed Action with COAs, is selected the applicant would undertake the proposed activities as requested and conditioned in the application; however, the applicant would be required to undertake COAs and monitoring measures as identified by BOEM. The measures outlined in **Chapter 2.4** are expected to decrease or negate the potential for impact to deepwater benthic communities from the proposed action. For the reasons set forth below, inclusion of these measures under Alternative 3 further limits or negates potential impacts to deepwater benthic communities.

Potential Impacts on Deepwater Benthic Communities from Bottom Disturbances

As described in **Chapter 2** of this SEA, the applicant proposes to conduct seismic survey activities that will involve the placement of OBNs and PIES, disturbing the seafloor in the area of the proposed action. If the OBNs or PIES are deployed near or atop a confirmed or potential deepwater benthic community, impacts to these sensitive habitats could permanently prevent recolonization by similar organisms.

If a high-density deepwater benthic community is subjected to impacts by bottom-disturbing activities, potentially severe or catastrophic impacts could occur due to direct impingement by a

receiver or partial to complete burial due to resuspension of sediments. The severity of such an impact could be immediate loss of the community or incremental losses of productivity, reproduction, community relationships, leading to degradation of the overall ecological functions of the community and incremental damage to surrounding communities.

However, the offsets to OBN and PIES positioning proposed by BOEM will allow for deployment of the required OBNs and PIES within the demonstrated capability of the operator and provides for buffering of the seafloor disturbances caused by deployment. This COA ensures the potential for impacts resulting from the proposed survey activities are minimal. The effects to benthic communities from bottom disturbances are expected to be **nominal**.

Conclusion

Features capable of supporting deepwater benthic communities are located within the survey area. If the proposed bottom positioned receivers were to contact one of the sites, it would have the potential to destroy any sessile organisms that may be present or cause destruction of underlying carbonate structures on which organisms rely for substrate as well as dispersion of hydrocarbon sources. These impacts could be severe in the immediate area; with recovery times as long as 200 years for mature tube-worm communities and with some corals aged at over 2,000 years (Prouty et al., 2011), there is the possibility a community may never recover. The same geophysical conditions associated with the potential presence of chemosynthetic communities can also result in hard carbonate substrate upon which deepwater corals can attach. The proposed activities may impact the ecological function, biological productivity, or distribution of hard-bottom deepwater benthic (both chemosynthetic and deepwater coral) communities. Burial or disruption of the organisms from redistribution of bottom sediment or increased turbidity from resuspended sediment may foul or otherwise interfere with filter-feeding organs.

Recruitment of new organisms from nearby communities and settlement of organisms in areas with exposed hard ground may take years to decades to become established, if ever. With this in mind, BOEM uses COAs applied to permits to preserve such undisturbed areas. The COAs outlined in **Chapter 2.4** would help assure sources for colonizing larvae and protect existing habitat. Impacts to hard-bottom communities are expected to be avoided as a consequence of compliance with existing BOEM regulations and adherence by the operator to the COAs.

Sensitive sessile benthic resources could occur in the vicinity of the proposed activities; with operator adherence to the measures in **Chapter 2.4**, the proposed activities are not expected to impact either known or probable areas of deepwater benthic communities.

3.5.3. Cumulative Impact Analysis

Considering the location of these habitats, the operator's proposed activities would constitute the primary effect on the resources that may exist in the area of the proposed action. As such, the potential cumulative impacts from all other activities would be identical to the effects described above. Given the negligible impacts on deepwater benthic communities, because of the application of BOEM avoidance criteria as described in NTL No. 2009-G40, the cumulative impacts are also **nominal**.

Conclusion

The effects of the proposed action, when viewed in light of the effects associated with other relevant activities, may impact deepwater benthic communities. However, given the scope of the proposed action and conservative nature of the applied conditions of approval, incremental effects from the proposed survey activities on deepwater benthic communities will be **nominal**.

The proposed activities are expected to have negligible impacts on the ecological function, abundance, productivity, and/or distribution of deepwater benthic communities given adherence to distancing requirements found in NTL No. 2009-G40. The operator's plan proposes compliance with the regulations as clarified by NTL No. 2009-G40. Bottom disturbances from nodal placement would be sited away from any sensitive deepwater benthic communities. Any sediments or fluids that could come in contact with the organisms would be diluted to a concentration where the impact to the deepwater benthic community would be **nominal**.

3.6. ARCHAEOLOGICAL RESOURCES

3.6.1. Description

Archaeological resources are defined in 30 CFR § 550.105 as, "...the material remains of human life or activities that are at least 50 years of age and that are of archaeological interest, including any historic property described by the National Historic Preservation Act, as defined in 36 CFR § 800.16(l)." Archaeological interest means that it is capable of providing scientific or humanistic understanding of past human behavior, cultural adaptation, and related topics through the application of scientific or scholarly techniques, such as controlled observation, contextual measurement, controlled collection, analysis, interpretation, and explanation.

As obligated under OCSLA regulations at 30 CFR § 551.6(a)(5), applicants are not allowed to disturb archaeological resources while conducting their survey activities. The description of archaeological resources (pre-contact and historic) can be found in the relevant NEPA compliance documents. The following information is a summary of these descriptions and is incorporated by reference into this SEA.

Pre-contact

Pre-contact Native American sites may exist on the OCS dating from the time at the end of the last Ice Age (~20,000 to 22,000 years ago), when sea levels were about 427 ft (130 m) lower than they are today. Based on our current understanding of the archaeological and geological evidence, BOEM has adjusted, over time, its understanding of when and where people may have lived on the OCS when it was a terrestrial landform. Based on this evidence, consultations with Native American Tribes, advances in remote sensing technology, and new coring methodologies to locate submerged ancient landforms, BOEM has updated the depth within the Gulf where remote sensing surveys for ancient landforms are required (from the previous depth of 60 to 130 m [200 to 427 ft]).

Historic

Submerged historic archaeological resources in the OCS and along the Gulf Coast consist mostly of historic shipwrecks and historic aircraft. A historic shipwreck is defined as a submerged or buried vessel or its associated components, at least 50 years old, that has foundered, stranded, or wrecked, and that is currently lying on or embedded in the seafloor. A proprietary database of shipwrecks maintained by BOEM currently lists over 1,300 named shipwrecks in the Gulf. Many of these reported shipwrecks may qualify for listing on the National Register of Historic Places. Although a number of shipwrecks have been identified based on historical documents, there are many others that have yet to be located and many more still for which no record of their loss survives and whose identity and location remains unknown. Currently a high-resolution remote sensing survey is the most reliable method for identifying and avoiding historic archaeological resources.

At present, high-resolution geophysical, ROV, and/or diver survey is required for all new bottom disturbing activities by the oil and gas industry. Historic shipwrecks have, with the exception of three significant vessels found by treasure salvors, been primarily discovered through oil industry sonar surveys in water depths up to 11,000 ft (3,353 m). The preservation of historic wrecks found in deep water has been outstanding because of a combination of environmental conditions and limited human access.

3.6.2. Impact Analysis

The IPF associated with the proposed action that could affect archaeological resources is seafloor disturbance from the placement and recovery of OBNs and PIES. Available literature is not sufficient to identify historic shipwreck losses in the area of the proposed action as historic records of losses occurring this far offshore are not location-specific (Pearson et al., 2003; Krivor et al., 2011; Rawls and Bowker-Lee, 2011). However, if a historic resource exists in the survey area, direct physical contact with a shipwreck site could destroy fragile materials, such as hull remains or artifacts, and could disturb the site context (Atauz et al., 2006; Church and Warren, 2008).

The IPF that could be associated with accidental events include seafloor disturbances from jettisoned/lost debris. Similar to routine impacts, discarded/lost material that falls to the seabed has the potential to damage and/or disturb archaeological resources.

The GOM G&G PEIS contains a discussion of the potential impacts from survey operations on archaeological resources (BOEM, 2017). Additional information about routine impacts from oil and gas activity on archaeological resources is addressed in the relevant NEPA compliance documents. The following information is a summary of the impact analyses and is incorporated by reference into this SEA.

3.6.2.1. *Alternative 1*

If Alternative 1, the No Action Alternative, is selected the applicant would not undertake the proposed activities; therefore, the impacts to archaeological resources would not occur. For example, there would be no bottom impacts from OBN or PIES placement that could result in potential loss of any known or unknown historic archaeological resource.

3.6.2.2. *Alternative 2*

If Alternative 2, the Proposed Action as Submitted, is selected the applicant would undertake the proposed activities as requested and conditioned in the application. An example of potential impacts to archaeological resources would include, but is not limited to, damage to potential archaeological resources from the proposed survey activities. The operator proposes seismic survey activities with OBNs as receivers and PIES at sites that are located near potential and/or confirmed archaeological resources which, without additional COAs and monitoring measures, may lead to potential impacts to those sites.

3.6.2.3. *Alternative 3*

If Alternative 3, the Proposed Action with COAs, is selected the applicant would undertake the proposed activities as requested and conditioned in the application; however, the applicant would be required to undertake COAs and monitoring measures as identified by BOEM. The COAs and monitoring measures outlined in **Chapter 2.4** are expected to decrease or negate the potential for impact to archaeological resources from the proposed action. For the reasons set forth below, inclusion of these measures under Alternative 3 further limits or negates potential impacts to archaeological resources.

Routine Activities

Historic modeling assumes that shipwrecks would be found closest to shore along the Federal/State boundary or within 10 mi (16 km) of their reported loss location. However, high-resolution geophysical data acquired by oil and gas industry remote sensing surveys now indicate that this model is too limited. For example, several vessel casualties from World War II with historically reported coordinates were later discovered well over 10 mi (16 km) outside the 9-square mile area assumed to be their location by the model (Irion, 2002). An early nineteenth century steamship lost off the Texas coast was found by treasure salvors over 120 mi (193 km) from the area of its presumed loss in the Minerals Management Service model (Irion, Official Communication, 2011). These situations, coupled with the fact that no confirmed historic shipwreck sites had been found in any of the designated historic high probability area in 20 years, led to a study released in 2003 (Pearson et al., 2003) to reassess the high-probability model. Some of the recommendations of this study were implemented in September 2024 with the revision of 30 CFR § 550.194 and 195. The current requirement is that all new bottom disturbing activity by the oil and gas industry be cleared by high-resolution geophysical, ROV, and/or diver survey.

Impacts to a historic site could result from direct physical contact with an OBN or PIES causing irreversible damage. The undisturbed provenience of archaeological data (i.e., the 3-dimensional location of archaeological artifacts) allows archaeologists to accumulate a record of where every item is found, and to develop a snapshot as to how artifacts relate to other items or the site as a whole. The analysis of artifacts and their provenience is one critical element used to make a determination of eligibility to the National Register of Historic Places under 30 CFR § 60.4 and is

essential in understanding past human behavior and ways of life. Impacts from the proposed operations could alter the provenience and destroy fragile remains, such as the hull, wood, glass, ceramic artifacts and possibly even human remains, or information related to the operation or purpose of the vessel. The destruction and loss of this data eliminates the ability of the archaeologist to fully and accurately detail activity areas found at the site, variation and technological advances lost to history, the age, function, and cultural affiliation of the vessel, and its overall contribution to understanding and documenting the maritime heritage and culture of the region. Under Alternative 3, the operator is required to avoid known archaeological resources and cease operations should the operator discover an unknown, potential archaeological resource. With the conditions of approval and monitoring measures in place under Alternative 3, the effects to archaeological resources are expected to be **nominal**.

Accidental Events

An IPF that could result from an accidental event is from the loss of debris from the survey and support vessels during survey operations. Debris such as structural components (i.e., grating, wire, tubing, etc.), boxes, pallets, and other loose items can become dislodged during heavy seas or storm events and fall to the seabed. Similar to the impacts noted under Routine Activities, if debris were to fall onto an unknown archaeological resource, damage could destroy fragile materials, such as hull remains and artifacts, and could disturb the site's context and associated artifact assemblage. Additionally, lost material could result in the masking of actual archaeological resources or the introduction of false targets that could be mistaken in the remote sensing record as historic resources.

3.6.3. Cumulative Impact Analysis

Cumulative impacts on unknown archaeological resources that may be present in the area of the proposed action could result from other OCS activities such as commercial fishing, marine transportation, and adjacent oil and gas exploration, development, and production operations.

During adjacent oil and gas operations, commercial fishing, and maritime transportation activities, there is associated loss or discard of debris that could result in the masking of archaeological resources or the introduction of false targets that could be mistaken in the remote sensing record as historic resources. Future exploration, development, and production operations and/or any related infrastructure support could lead to bottom disturbances in the area of the proposed action; however, no additional activities have been proposed or are under review at this time.

Any known or unknown archaeological resources that may be present in the proposed survey area could be impacted by contact with oil from a blowout or spill from adjacent oil and gas operations. Similarly, cumulative impacts from accidental oil spills and remediation efforts for adjacent oil and gas operations are not expected because of the water depth at the proposed site and the historically low probability of a loss of well control/blowout.

Considering the potential cumulative impacts from all other activities, the operator's proposed activities would constitute the primary effect, if any, on any known or unknown archaeological resource that may exist in the area of the proposed action.

Conclusion

Based on the previous information, study conclusions, and the number of confirmed wrecks recently found in similar water depths, there is reason to believe that archaeological resources could be present in the area of the proposed action. Impacts may include damage and/or disturbance to the potential resources from OBN and PIES placement. Impacts from accidental events related to the proposed action such as debris lost from the survey and support vessels could lead to impacts similar to those expected from routine impacts. If the operator's seabed disturbing activities make contact with these targets, it might have a significant impact on the resources. Based on the review findings, it is likely that submerged archaeological resources could exist in the area of the proposed action as targets have been identified in pre-existing survey data. Without necessary avoidance COAs and monitoring measures, selecting Alternative 3

should not result in significant impacts to archaeological resources; the effects are expected to be **nominal**.

3.7. OTHER USERS OF THE OCS

BOEM is required to consider the impact of the proposed action on other users of the OCS; one of the most prevalent users is the U.S. military. All military activities on the OCS occur within MWAs or Eglin Water Test Areas (EWTAs) designated by the Federal Aviation Administration in coordination with the U.S. Department of Defense. Space-use conflicts related to military activities were addressed in the GOM G&G PEIS; potential impacts related to MWAs were determined to be **nominal**. Lessees and permittees conducting G&G operations within these warning areas are required to coordinate with the appropriate military command.

The survey operations and routes to be taken by vessels in support of TGS's proposed survey will operate within MWAs W-147D, W-147E and W-602, W-147E, W-228B, W-228C, and W-602 shown at: [MWA map](#). TGS shall contact the appropriate individual military command headquarters concerning the control of electromagnetic emissions and use of boats in each of the areas before commencing your operations. A list of contacts can be found at: [MWA contacts](#).

Using this information, the coordination COA has proven effective over many years to reduce the risk of interrupting planned military or geophysical activities.

3.8. OTHER CONSIDERATIONS

A discussion of the other resources considered but not analyzed under this SEA is found in the relevant NEPA compliance documents.

4. CONSULTATION AND COORDINATION

On March 31, 2026, the Endangered Species Committee convened in Washington, D.C. to consider the Secretary of Defense's determination that an exemption from the ESA was necessary for national security purposes in relation to Gulf oil- and gas-activities. The Committee voted to grant the exemption pursuant to Section 7(j) of the ESA. In accordance with 16 U.S.C. § 1536(j), post-lease oil- and gas-activities are therefore exempt from the ESA's consultation requirements and take prohibitions under the Committee's March 31, 2026, order. The order further directs BOEM and BSEE to implement all existing mitigation and monitoring measures, identified as project criteria, through their OCSLA approval processes, and these measures will continue to be imposed as COAs.

BOEM petitioned NMFS for rulemaking under the MMPA (16 U.S.C. §§ 1361 et seq.) relating to G&G surveys on the OCS in the Gulf. On January 19, 2021, NMFS published in the Federal Register a final ITR, which became effective on April 19, 2021 (NMFS, 2021). A draft revision to this regulation that corrects some calculation errors and therefore adjusts taking allowable under the regulations was published on January 5, 2023 (NMFS, 2023a). On April 24, 2024, NMFS published in the Federal Register its final rule, "Taking and Importing Marine Mammals: Taking Marine Mammals Incidental to Geophysical Surveys in the Gulf of Mexico" (NMFS, 2024a). The rule is effective from May 24, 2024, through April 19, 2026. There are no changes to the specified activities or the specified geographical region in which those activities would be conducted, nor to the original 5-year period of effectiveness. A new request for MMPA authorization was prepared and submitted by industry in March 2025. On September 3, 2025, NOAA Fisheries announced the receipt of a request from the NOAA Fisheries Office of Policy for the reimplementation of ITRs governing the incidental taking of marine mammals during geophysical surveys conducted in the Gulf and invited the public to provide information, suggestions, and comments on the request (NMFS, 2025c).

NMFS published the final rule implementing EFH provisions of the Magnuson-Stevens Fisheries Conservation and Management Act on January 17, 2002 (NMFS 2002); certain OCS oil- and gas-related activities authorized by BOEM may result in adverse effects to EFH and therefore require EFH consultation. BOEM prepared an EFH Assessment that described the proposed OCS

activities, analyzed the effects on EFH, and identified mitigating measures (BOEM, 2022). The EFH Assessment was sent to NMFS on May 25, 2022, with a letter requesting formal consultation. NMFS responded to BOEM's request with conservation recommendations on July 29, 2022. The regional programmatic EFH consultation concluded on September 27, 2022, when BOEM and BSEE responded via letter to NMFS' conservation recommendations. The programmatic EFH consultation covers reasonably foreseeable oil- and gas- related activities on the OCS. The conservation recommendations contain provisions for initiating supplemental discussions for site-specific or activity-specific consultations, if warranted (BOEM, 2025).

In accordance with the National Historic Preservation Act (54 U.S.C. §§ 300101 et seq.), Federal agencies are required to consider the effects of their undertakings on historic properties. The implementing regulations for Section 106 of the National Historic Preservation Act, issued by the Advisory Council on Historic Preservation (36 CFR § 800), specify the required review process. In accordance with 36 CFR § 800.8(c), BOEM intends to use the NEPA substitution process and documentation for preparing an Environmental Impact Statement/Record of Decision or an Environmental Assessment/Finding of No Significant Impact to comply with Section 106 of the National Historic Preservation Act in lieu of 36 CFR § 800.3-800.6.

5. BIBLIOGRAPHY

- Atauz AD, Bryant W, Jones T, Phaneuf B. 2006. Mica shipwreck project: Deepwater archaeological investigation of a 19th century shipwreck in the Gulf of Mexico. Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2006-072. 116 pp.
- Barkaszi MJ, Kelly CJ. 2019. Seismic survey mitigation measures and protected species observer reports: synthesis report - corrected version. New Orleans, LA. Bureau of Ocean Energy Management (BOEM), Gulf of Mexico OCS Region. 222 p. OCS Study BOEM 2019-012.
- Boeger WA, Pie MR, Ostrensky A, Cardoso MF. 2006. The effect of exposure to seismic prospecting on coral reef fishes. *Brazilian Journal of Oceanography* 54:235-239.
- Bureau of Ocean Energy Management (BOEM). 2012. Seismic Survey Mitigation Measures and Marine Mammal Observer Reports. Gulf of Mexico Region, New Orleans, LA. OCS Study BOEM 2012-015. 28 pp w Appendices.
- Bureau of Ocean Energy Management (BOEM). 2017. Gulf of Mexico OCS Proposed Geological and Geophysical Activities Western, Central, and Eastern Planning Areas Final Programmatic Environmental Impact Statement (GOM G&G PEIS). 4 vols. BOEM, Gulf of Mexico OCS Region, New Orleans, LA. OCS EIS/EA BOEM 2017-051.
- Bureau of Ocean Energy Management (BOEM). 2021. Biological Environmental Background Report for the Gulf of Mexico OCS Region (2021 BEBR). BOEM, Gulf of Mexico OCS Region, New Orleans, LA. OCS Report 2021-015.
- Bureau of Ocean Energy Management (BOEM). 2022. Essential Fish Habitat Assessment for Oil and Gas Activities in the Gulf of Mexico. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Report BOEM 2022-032. 107 pp.
- Bureau of Ocean Energy Management (BOEM). 2023. Sound source list: a description of sounds commonly produced during ocean exploration and industrial activity. Sterling, VA. BOEM, Center for Marine Acoustics. 69 p. BOEM OCS 2023-016.
- Bureau of Ocean Energy Management (BOEM). 2025. Gulf of America Regional OCS Oil and Gas Lease Sales and Post-Lease Activities. Final Programmatic Environmental Impact Statement (2025 PEIS). 917 pp. BOEM, Gulf of America OCS Region, New Orleans, LA. OCS EIS/EA BOEM 2025-042.
- Boertmann D, Tougaard J, Johansen K, Mosbech A. 2010. Guidelines to environmental impact assessment of seismic activities in Greenland waters. 2nd edition. National Environmental Research Institute, Aarhus University, Denmark. 42 pp. – NERI Technical Report no. 785.

- Booman C, Dalen H, Heivestad H, Levsen A, van der Meeren T, Toklum K. 1996. Effekter av luftkanonskyting på egg, larver og ynell. Undersekkelser ved Håuforskningstittuttet og toctolgisk Laboratorium, Universitet; Bergen. *Fisken og Havet*, 3.
- Chapman CJ, Hawkins AD. 1969. The importance of sound in fish behaviour in relation to capture by trawls. FAO Fisheries Report 62:717-729.
- Church RA, Warren DJ. 2008. Viosca Knoll wreck: Discovery and investigation of an early nineteenth-century sailing ship in 2,000 feet of water. Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2008-018. 41 pp.
- Cordes EE, McGinley MP, Podowski EL, Becker EL, Lessard-Pilon S, Viada ST, Fisher CR. 2008. Coral communities of the deep Gulf of Mexico. *Deep-Sea Research* 55(6):777-787.
- Dalen J, Raknes A. 1985. Scaring effects on fish from three dimensional seismic surveys. Institute of Marine Research Report FO 8504/8505, Bergen, Norway (Norwegian with English summary).
- Dalen J, Knutsen GM. 1986. Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic explorations. Symposium on Underwater Acoustics, Halifax.
- Dalen J, Ona E, Soldal AV, Saetre R. 1996. Seismic Investigations as Sea: An Evaluation of Consequences For Fish and Fisheries. Institute of Marine Research, *Fisken og Havet*, 9" 26 pp. (Norwegian with English summary).
- Engås A, Løkkeborg S, Ona E, Soldal AV. 1996. Effects of seismic shooting on local abundance and catch rates of cod (*G. morhua*) and haddock (*M. aeglefinus*). *Canadian Journal of Fisheries and Aquatic Science* 53:2238-2249.
- Erbe C, Marley SA, Schoeman RP, Smith JN, Trigg LE, Embling CB. 2019. The effects of ship noise on marine mammals – a review. *Frontiers in Marine Science*. 6:606. doi:10.3389/fmars.2019. 00606.
- Erbe C, Houser D, Bowles A, Porter MB. 2025. Marine Mammal Acoustics in a Noisy Ocean. 756 pp. <https://doi.org/10.1007/978-3-031-77022-7>.
- Falk MR, Lawrence MJ. 1973. Seismic exploration: Its nature and effects on fish. Canada Technical Report Series No. CEN/T-73-9. Department of the Environment, Fisheries and Marine Service, Resource Management Branch, Fisheries Operations Directorate, Central Region (Environment), Winnipeg, MB.
- Farmer NA, Powell JR, Morris Jr. JA, Soldevilla MS, Wickliffe LC, Jossart JA, MacKay JK, Randall AL, Bath GE, Ruvelas P, et al. 2022. Modeling protected species distributions and habitats to inform siting and management of pioneering ocean industries: a case study for Gulf of Mexico aquaculture. *PLoS ONE*. 17(9):e0267333. doi:10.1371/journal.pone.0267333.
- Fay RR, Popper AN. 2000. Evolution of hearing in vertebrates: The inner ears and processing. *Hearing Research* 149:1-10.
- Fay RR. 2005. Sound source localization by fishes. In: Popper AN, Fay RR, eds. *Sound Source Localization*. New York: Springer-Verlag. Pp. 36-66.
- Fewtrell JL, McCauley RD. 2012. Impact of air gun noise on the behavior of marine fish and squid. *Marine Pollution Bulletin* 64:984-993.
- Fish and Wildlife Service (FWS). 2018. Biological Opinion Oil and Gas Leasing, Exploration, Development, Production, Decommissioning, and All Related Activities in the Gulf of Mexico Outer Continental Shelf. Issued April 20, 2018.
- Fish and Wildlife Service (FWS). 2025. Endangered and Threatened Wildlife and Plants; threatened status for the Florida Manatee and endangered status for the Antillean Manatee. 90 Fed Regist. (January 14): 3131–3160.

- Fish and Wildlife Service (FWS) and Gulf States Marine Fisheries Commission. 1995. Gulf Sturgeon Recovery Plan. Atlanta Georgia. 170 pp (page 3).
- Fisher CR. 1990. Chemoautotrophic and methanotrophic symbioses in marine invertebrates. *Reviews in Aquatic Sciences* 2:399-436.
- Gall SC, Thompson RC. 2015. The impact of debris on marine life. *Marine Pollution Bulletin*. 92(1-2):170-179.
- Garrison, LP, Glenn III DW, Karrigan H. 2018. Sperm whale acoustic prey study in the northern Gulf of Mexico. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, New Orleans, LA. OCS Study BOEM 2018-035. 94 pp.
- Garrison LP, Glenn III DW, Karrigan H. 2020. The movement and habitat associations of sea turtles in the Northern Gulf of Mexico. New Orleans, LA. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. 69 p. Report No.: OCS Study BOEM 2020-010.
- Garrison LP, Soldevilla MS, Martinez A, Mullin K. 2024. A density surface model describing the habitat of the critically endangered Rice's whale *Balaenoptera ricei* in the Gulf of Mexico. *Endangered Species Research*. 54:41–57. doi:10.3354/esr01324.
- Garrison LP, Lisi NE, Gahm M, Patterson EM, Blondin H, Good CP. 2025. The effects of vessel speed and size on the lethality of strikes of large whales in U.S. waters. *Frontiers in Marine Science*. 11:1467387. doi:10.3389/fmars.2024.1467387.
- Geraci JR, St. Aubin DJ. 1980. Offshore petroleum resource development and marine mammals. A review and research recommendations. *Marine fisheries review*. 42:1-12.
- Goold JC, Fish PJ. 1998. Broadband spectra of seismic survey airgun emissions, with reference to dolphin auditory thresholds. *J. Acoust. Soc. Am*. 103(4): 2177-2184.
- Hassel A, Knutsen T, Dalen J, Løkkeborg S, Skaar K, Østensen Ø, Haugland EK, Fonn M, Høines A, Misund OA. 2003. Reaction of sandeel to seismic shooting: a field experiment and fishery statistics study. Institute of Marine Research, Fisken og Havet. Vol. 4. 63 pp.
- Hawkins AD. 1993. Underwater sound and fish behaviour. Pages 129-169 In: Pitcher TJ, ed. *Behaviour of Teleost Fishes*. Second Edition. Chapman and Hall, London, UK.
- Hawkins AD, Pembroke AE, Popper AN. 2014. Information gaps in understanding the effects of noise on fishes and invertebrates. *Reviews in Fish Biology and Fisheries* 1-26.
- Hayes SA, Josephson E, Maze-Foley K, Rosel PE, McCordic J. 2024. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments 2023. Woods Hole, MA. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center. 375 p. NOAA Technical Memorandum NMFS-NE-321.
- Hazel J, Lawler IR, Marsh H, Robson S. 2007. Vessel speed increases collision risk for the green turtle *Chelonia mydas*. *Endangered Species Research* 3:105–113.
- Hirsh AG, Rodhouse PG. 2000. Impacts of geophysical seismic surveying on fishing success. *Reviews in Fish Biology and Fisheries* 10:113-118.
- Holliday DV, Pieper RE, Clarke ME, Greenlaw CF. 1987. The effects of airgun energy releases on the eggs, larvae, and adults of the northern anchovy (*Engraulis mordax*). API Publication 4453. Report by Tracor Applied Sciences for American Petroleum Institute, Washington, DC.
- Irion JB. 2002. Cultural Resource Management of Shipwrecks on the Gulf of Mexico Outer Continental Slope. Paper presented at the 2nd MIT Conference on Technology, Archaeology, and the Deep Sea.
- Irion JB. 2011. Official Communication. Bureau of Ocean Energy Management, Regulation and Enforcement. New Orleans, LA. July 23, 2011.

- Jorgenson JK, Gyselman EC. 2009. Hydroacoustic measurements of the behavioral response of arctic riverine fishes to seismic airguns. *Journal of the Acoustical Society of America* 126:1598-1606.
- Kalmijn AJ. 1988. Hydrodynamic and acoustic field detection. In: Atema J, Fay RR, Popper AN, Tavolga WM, eds. *Sensory Biology of Aquatic Animals*, pp. 83-130. New York: Springer Verlag.
- Kalmijn AJ. 1989. Functional evolution of lateral line and inner ear systems. Pages 187-216 In: Coombs S, Görner P, Münz H, eds. *The Mechanosensory Lateral Line: Neurobiology and Evolution*. Springer-Verlag, New York, NY.
- Kostyvchenko LP. 1973. Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea. *Hydrobiological Journal* 9:45-48.
- Krivor MC, de Bry J, Linville NJ, Wells DJ. 2011. Archival investigations for potential colonial-era shipwrecks in ultra-deep water in the Gulf of Mexico. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEMRE 2011-004. 158 pp.
- La Bella G, Cannata S, Froggia C, Modica A, Ratti S, Rivas G. 1996. First assessment of effects of air-gun seismic shooting on marine resources in the Central Adriatic Sea. Pages 227-238 In: Society of Petroleum Engineers, International Conference on Health, Safety and Environment, New Orleans, Louisiana, 9-12 June.
- Ladich F, Popper AN. 2004. Parallel evolution in fish hearing organs. Pages 95-127 In: Manley GA, Popper AN, Fay RR, eds. *Evolution of the Vertebrate Auditory System*. Springer-Verlag, New York, NY.
- Laist DW, Knowlton AR, Mead JG, Collet AS, Podesta M. 2001. Collisions between ships and whales. *Marine Mammal Science* 17(1):35-75.
- Lamont MM, Hart KM. 2023. Gulf of Mexico marine assessment project for protected species: sea turtles. New Orleans, LA. U.S. Department of the Interior, Bureau of Ocean Energy Management. 40 p. OCS Study BOEM 2023-064.
- Lenhardt ML. 1994. Seismic and very low frequency sound induced behaviors in captive loggerhead marine turtles (*Caretta caretta*). In: Bjørndal KA, Bolten AB, Johnson DA, Eliazar PJ, eds. *Proceedings of the fourteenth annual symposium on sea turtle biology and conservation*. NOAA Technical Memorandum, NMFS-SEFC-351, National Technical Information Service, Springfield, Virginia, 238-241.
- Løkkeborg S. 1991. Effects of geophysical survey on catching success in longline fishing. Paper presented at the International Council for the Exploration of the Sea (ICES) Annual Science Conference. ICES CM B 40:1-9.
- Løkkeborg S, Ona E, Vold A, Salthaug A. 2012. Sounds from seismic air guns: gear- and species-specific effects on catch rates and fish distribution. *Canadian Journal of Fisheries and Aquatic Science* 69:1278-1291.
- Lutcavage ME, Plotkin P, Witherington B, Lutz PL. 1997. Human impacts on sea turtle survival. In: Lutz PL, Musick JA, eds. *The biology of sea turtles*. Boca Raton, FL: CRC Press. Pp. 387-409.
- MacDonald IR, ed. 1992. Chemosynthetic ecosystems study literature review and data synthesis: Volumes I-III. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 92-0033 through 92-0035.
- Madsen PT, Surlykke A. 2013. Functional convergence in bat and toothed whale biosonar. *Physiology (Bethesda)*. 28(5):276-283. doi:10.1152/physiol.00008.2013.
- Martin J, Sabatier Q, Gowan TA, Giraud C, Gurarie E, Calleson CS, Ortega-Ortiz JG, Deutsch CJ, Rycyk A, Koslovsky SM. 2016. A quantitative framework for investigating risk of deadly

- collisions between marine wildlife and boats. *Methods in Ecology and Evolution*. 7(1):42–50. doi:10.1111/2041-210x.12447.
- McCauley RD, Fewtrell J, Duncan AJ, Jenner C, Jenner M-N, Penrose JD, Prince RIT, Adhitya A, Murdoch J, McCabe K. 2000a. Marine seismic surveys: Analysis of airgun signals; and effects of air gun exposure on humpback whales, sea turtles, fishes and squid. Report from Centre for Marine Science and Technology, Curtin University, Perth, Western Australia, for Australian Petroleum Production Association, Sydney, NSW.
- McCauley RD, Fewtrell J, Duncan AJ, Jenner C, Jenner M-N, Penrose JD, Prince RIT, Adhitya A, Murdoch J, McCabe K. 2000b. Marine seismic surveys – a study of environmental implications. *APPEA Journal* 40:692-706.
- McCauley RD, Fewtrell J, Popper AN. 2003. High intensity anthropogenic sound damages fish ears. *Journal of the Acoustical Society of America* 113:638-642.
- McEachran JD. 2009. Fishes (Vertebrata: Pisces) of the Gulf of Mexico. In: Tunnell, JW, Jr., Felder DL, and Earle SA, eds. *Gulf of Mexico Origins, Waters, and Biota*. Texas A&M University Press, Texas.
- Miller MH, Klimovich C. 2016. Endangered Species Act Status Review Report: Giant Manta Ray (*Manta birostris*) and Reef Manta Ray (*Manta alfredi*). Draft Report to National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. December 2016. 127 pp.
- National Marine Fisheries Service (NMFS). 2006. Final Consolidated Atlantic Highly Migratory Species Fisheries Management Plan. National Oceanic Atmospheric Administration, NMFS, Office of Sustainable Fisheries, Highly Migratory Species Division, Silver Springs, MD. Public Document. 1600 pp.
- National Marine Fisheries Service (NMFS). 2009. Recovery Plan for Smalltooth Sawfish (*Pristis pectinata*). Prepared by the Smalltooth Sawfish Recovery Team for the NMFA. Silver Spring, MD 102 pp (page 8).
- National Marine Fisheries Service (NMFS). 2014. Endangered and Threatened Species: critical habitat for the Northwest Atlantic Ocean loggerhead sea turtle distinct population segment (DPS) and determination regarding critical habitat for the North Pacific Ocean loggerhead DPS. *Fed Regist.* 79 (July 10): 39856–39912.
- National Marine Fisheries Service (NMFS). 2019. Endangered and Threatened Wildlife and Plants; Endangered Status of the Gulf of Mexico Bryde’s Whale. *Fed Regist.* 84 (April 15): 15446–15488.
- National Marine Fisheries Service (NMFS). 2021. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Geophysical Surveys Related to Oil and Gas Activities in the Gulf of Mexico. *Fed Regist.* 86 (January 19): 5322–5450.
- National Marine Fisheries Service (NMFS). 2023a. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Geophysical Surveys in the Gulf of Mexico. *Fed Regist.* 88 (January 5): 916–948.
- National Marine Fisheries Service (NMFS). 2023b. Endangered and Threatened Wildlife and Plants: proposed rule to designate marine critical habitat for six distinct population segments of green sea turtles. *Fed Regist.* 88 (July 19): 46572–46671.
- National Marine Fisheries Service (NMFS). 2023c. Endangered and Threatened Species; designation of critical habitat for the Rice’s whale. *88 Fed Regist.* (July 24): 47453–47472.
- National Marine Fisheries Service (NMFS). 2024a. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Geophysical Surveys in the Gulf of Mexico. *89 Fed Regist.* (April 24): 31488–31541.
- National Marine Fisheries Service (NMFS). 2024b. 2024 update to: technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 3.0) - underwater and in-air criteria for onset of auditory injury and temporary threshold shifts. Silver

- Spring, MD. National Oceanic and Atmospheric Administration, NMFS, Office of Protected Resources. 193 p. NOAA Technical Memorandum NMFS-OPR-71.
- National Marine Fisheries Service (NMFS). 2025a. Biological and conference opinion on Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement's oil and gas program activities in the Gulf of America. Silver Spring, MD. National Oceanic and Atmospheric Administration, NMFS. 701 p. OPR-2022-03526.
- National Marine Fisheries Service (NMFS). 2025b. Attachments and Appendices for the 2025 Gulf of America Oil and Gas Biological Opinion. Silver Spring, MD. National Oceanic and Atmospheric Administration, NMFS. 87 p.
- National Marine Fisheries Service (NMFS). 2025c. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Geophysical Surveys in the Gulf of America. 90 Fed Regist. (September 3): 42569–42570.
- National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2024. Rice's whales spotted in the western Gulf of Mexico. Silver Spring, MD. Created 30 April 2024, updated 28 August 2025, accessed 25 June 2026. <https://www.fisheries.noaa.gov/feature-story/rices-whales-spotted-western-gulf-mexico>.
- National Oceanic and Atmospheric Administration (NOAA) Fisheries. 2025. Species Directory: Rice's whale. Silver Spring, MD. Updated 20 May 2026, accessed 25 June 2026. <https://www.fisheries.noaa.gov/species/rices-whale>.
- National Research Council. 1990. Decline of the sea turtles: causes and prevention. Washington, DC. The National Academies Press. 275 p.
- National Science Foundation (NSF). 2011. Final Programmatic Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement for Marine Seismic Research funded by the National Science Foundation or Conducted by the U.S. Geological Survey. Arlington, Virginia.
- Nelms SE., Piniak WED, Weir CR, Godley BJ. 2016. Seismic Surveys and Marine Turtles: An Underestimated Global Threat? *Biological Conservation* 193:49-65.
- Nowacek DP, Thorne LH, Johnson DW, Tyack PL. 2007. Responses of cetaceans to anthropogenic noise. *Mammal Rev.* 37(2): 81–115.
- O'Hara J, Wilcox JR. 1990. Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. *Copeia*. 2:564-567. doi:10.2307/1446362.
- Pace RM. 2011. Frequency of whale and vessel collisions on the US eastern seaboard: ten years prior and two years post ship strike rule. Woods Hole, MA. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center. 18 p. Northeast Fisheries Science Center Reference Document 11-15.
- Papale E, Prakash S, Singh S, Batibasaga A, Buscaino G, Piovano S. 2020. Soundscape of green turtle foraging habitats in Fiji, South Pacific. *PLOS ONE*. 15(8):e0236628. doi:10.1371/journal.pone.0236628.
- Payne JF, Coady J, White D. 2009. Potential effects of seismic airgun discharges on monkfish eggs (*Lophius americanus*) and larvae. Environmental Studies Research Funds Report 170. St. John's, NL.
- Pearson WH, Skalski JR, Malme CI. 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish (*Sebastes* spp.). *Canadian Journal of Fisheries and Aquatic Science* 49:1343-1356.
- Pearson CE, James SR Jr., Krivor MC, El Darragi SD, Cunningham L. 2003. Refining and Revising the Gulf of Mexico Outer Continental Shelf Region High-Probability Model for Historic Shipwrecks: Final report. Volume I: Executive Summary. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2003-060, 13 pp., 3 volumes.

- Pickett GD, Eaton DR, Seaby RMH, Arnold GP. 1994. Results of bass tagging in Poole Bay during 1992. Laboratory Leaflet Number 74. Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research, Lowestoft, UK.
- Piniak WED, Mann DA, Eckert SA, Harms CA. 2012. Amphibious hearing in sea turtles. *The Effects of Noise on Aquatic Life*. Springer; p. 83-87.
- Piniak WED, Mann DA, Harms CA, Jones TT, Eckert SA. 2016. Hearing in The Juvenile Green Sea Turtle (*Chelonia mydas*): A Comparison of Underwater and Aerial Hearing Using Auditory Evoked Potentials. *PLOS ONE* 11(10):e0159711.
- Popper AN. 2003. Effects of anthropogenic sound on fishes. *Fisheries* 28:24-31.
- Popper AN. 2005. A Review of Hearing by Sturgeon and Lamprey. Report for U.S. Army Corps of Engineers, Portland District, Portland, OR. 12 August.
- Popper AN, Hastings MC. 2009. The effects on fish of human-generated (anthropogenic) sound. *Integrative Zoology* 2009; 4:43-52.
- Popper AN, Fay RR. 2011. Rethinking sound detection by fishes. *Hearing Research*. doi: 10.1016/j.heares.2009.12.023.
- Popper AN, Smith ME, Cott PA, Hanna BW, MacGillivray AO, Austin ME, Mann DA. 2005. Effects of exposure to seismic airgun use on hearing of three fish species. *The Journal of the Acoustical Society of America*, Vol. 117, No. 6, June 2005.
- Popper AN, Hawkins AD, Fay RR, Mann D, Bartol S, Carlson T, Coombs S, Ellison WT, Gentry R, Halvorsen MB, Løkkeborg S, Rogers P, Southall BL, Zeddies D, Tavalga WN. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. Springer and ASA Press, Cham, Switzerland.
- Pritchard PCH. 1980. The Conservation of Sea Turtles: Practices and Problems. *American Zoologist*. 20(3): 609-617.
- Pritchard PCH. 1997. Evolution, phylogeny, and current status. In: Lutz PL, Musick JA, editors. *The Biology of Sea Turtles*. Boca Raton, FL. CRC Press. pp. 1-28.
- Prouty NG, Roark EB, Buster NA, Ross SW. 2011. Growth-rate and age distribution of deep-sea black corals in the Gulf of Mexico. *Marine Ecology Progress Series* 423:101–115.
- Rappucci G, Garrison L, Soldevilla M, Ortega-Ortiz J, Reid J, Aichinger-Dias L, Mullin K, Litz J. 2023. Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS): Marine Mammals. Volume 1: Report. New Orleans, LA. Bureau of Ocean Energy Management. 104 p. OCS Study BOEM 2023-042.
- Rawls JK, Bowker-Lee D. 2011. Shipwreck research in the New Orleans Notarial Archives. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Gulf of Mexico OCS Region, New Orleans, LA., OCS Study BOEMRE 2011-040.
- Reese A, Stolen M, Findlary CR, Smith JM, Varghese HK, Levenson JJ. 2023. Potential lifecycle impacts of renewable energy construction and operations on endangered sea turtles with a focus on the Northwest Atlantic. Sterling, VA. Bureau of Ocean Energy Management. 129 p. OCS Study BOEM 2023-073.
- Richardson WJ, Greene Jr. CR, Malme CI, Thomson DH. 1995. *Marine mammals and noise*. San Diego, CA. Academic Press. 576 pp.
- Ross JP, Barwani MA. 1982. Review of sea turtles in the Arabian area. In: Bjorndal KA, ed. *Biology and conservation of sea turtles*, pp. 373-383. Washington, DC, Smithsonian Institution Press.

- Ruppel CD, Weber TC, Staaterman ER, Labak SJ, Hart PE. 2022. Categorizing active marine acoustic sources based on their potential to affect marine animals. *Journal of Marine Science and Engineering*. 10(9):1278. doi:10.3390/jmse10091278.
- Santulli A, Messina C, Ceffa L, Curatolo A, Rivas G, Fabi G, Damelio V. 1999. Biochemical responses of European sea bass (*Dicentrarchus labrax*) to the stress induced by offshore experimental seismic prospecting. *Marine Pollution Bulletin* 38:1105-1114.
- Schellert AM, Popper AN. 1992. Functional aspects of the evolution of the auditory system of actinopterygian fish. Pages 295-323 In: Webster BD, Fay RR, Popper AN, eds. *Evolutionary Biology of Hearing*. Springer-Verlag, New York.
- Schroeder WW, Brooke SD, Olson JB, Phaneuf B, McDonough III JJ, Etnoyer P. 2005. Occurrence of deep-water *Lophelia pertusa* and *Madrepora oculata* in the Gulf of Mexico. In: Freiwald A, Murray Roberts J, eds. *Cold-Water Corals and Ecosystems*. New York, NY: Springer Berlin Heidelberg. 1,243 pp.
- Schuijf A. 1981. Models of acoustic localization. Pages 267-310. In: Tavolga WN, Popper AN, Fay RR, eds. *Hearing and Sound Communication in Fishes*. Springer-Verlag New York, NY.
- Senko JF, Nelms SE, Reavis JL, Witherington B, Wallace BP. 2020. Understanding individual and population-level effects of plastic pollution on marine megafauna. *Endanger Species Res*. 43:234–252.
- Skalski JR, Pearson WH, Malme CI. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp.). *Canadian Journal of Fisheries and Aquatic Science* 49:1357-1365.
- Slone DH, Butler SM, Reid JP, Beck CA, Bonde RK. 2022. Movements and habitat use of the Florida manatee (*Trichechus manatus latirostris*) in the northern Gulf of Mexico. New Orleans, LA. Bureau of Ocean Energy Management. 284 p. OCS Study BOEM 2022-075.
- Slotte A, Hansen K, Dalen J, Ona E. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research* 67:143-150.
- Sodal A. 1999. Measured underwater acoustic wave propagation from a seismic source. Proc. Airgun Environmental Workshop, 6 July, London, UK.
- Soldevilla M, Hildebrand J, Fraser K, Aichienger Dias L, Martinez A, Mullin K, Rosel P, Garrison LP. 2017. Spatial distribution and dive behavior of Gulf of Mexico Bryde's whales: potential risk of vessel strikes and fisheries interactions. *Endangered Species Research*. 32:533–550. doi:10.3354/esr00834.
- Soldevilla MS, Debich AJ, Garrison LP, Hildebrand JA, Wiggins SM. 2022. Rice's whales in the northwestern Gulf of Mexico: call variation and occurrence beyond the known core habitat. *Endangered Species Research*. 48:155–174. doi:10.3354/esr01196.
- Soldevilla MS, Debich AJ, Pérez-Carballo I, Jarriel S, Frasier KE, Garrison LP, Gracia A, Hildebrand JA, Rosel PE, Serrano A. 2024. Rice's whale occurrence in the western Gulf of Mexico from passive acoustic recordings. *Marine Mammal Science*. 40(30):1–8. doi:10.1111/mms.13109.
- Sonardyne. 2022. Pressure Inverted Echo Sounder (PIES). Internet website: <https://www.sonardyne.com/product/pressure-inverted-echo-sounder/>.
- Song J, Mann DA, Cot PA, Hanna BW, Popper AN. 2008. The inner ears of northern Canadian freshwater fishes following exposure to seismic air gun sounds. *Journal of the Acoustical Society of America* 124, 1360-6.
- Southall BL, Bowles AE, Ellison WT, Finneran JJ, Gentry RL, Greene Jr. CR, Kastak D, Ketten DR, Miller JH, Nachtigall PE, Richardson WJ, Thomas JA, Tyack PL. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. *Aquat. Mamm.* 33(4):411-522.

- Southall BL, Finneran JJ, Reichmuth C, Nachtigall PE, Ketten DR, Bowles AE, Ellison WT, Nowacek DP, Tyack PL. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2):125-232.
- Southall BL, Nowacek DP, Bowles AE, Senigaglia V, Bejder L, Tyack PL. 2021. Marine mammal noise exposure criteria: assessing the severity of marine mammal behavioral responses to human noise. *Aquatic Mammals*. 47(5):421–464. doi:10.1578/am.47.5.2021.421.
- Stevens TS, Fonseca M, Barkaszi MJ. 2024. Vessel strike risk to Rice's whale in the Gulf of Mexico: review of previous methodologies, information gaps, and recommendations for future efforts to predict strike risks. New Orleans, LA. Bureau of Ocean Energy Management, Gulf of Mexico Regional Office, Biological Sciences Unit. 58 p. OCS Study BOEM 2024-053.
- Sulak KJ, Randall MT, Luke KE, Norem AD, Miller JM, eds. 2008. Characterization of northern Gulf of Mexico deepwater hard-bottom communities with emphasis on *Lophelia* coral—*Lophelia* reef megafaunal community structure, biotopes, genetics, microbial ecology, and geology. U.S. Geological Survey. USGS Open-File Report 2008-1148, and Minerals Management Service, Herndon, VA. OCS Study MMS 2008-015.
- Sverdrup A, Kjellsby E, Krüger PG, Fløysand R, Knudsen FR, Enger PS, Serck-Hanssen G, Helle KB. 1994. Effects of experimental seismic shock on vasoactivity of arteries, integrity of the vascular endothelium and on primary stress hormones of the Atlantic salmon. *Journal of Fish Biology* 45:973-995.
- TGS (TGS). 2026. Application for Permit to Conduct Geological or Geophysical Exploration for Mineral Resources or Scientific Research in the Outer Continental Shelf, T26-004 and Permit, 2026.
- Teo SLH, Boustany A, Block BA. 2007a. Oceanographic preferences of Atlantic bluefin tuna, *Thunnus thynnus*, on their Gulf of Mexico breeding grounds. *Marine Biology* 152:1105-1119.
- Teo SLH, Boustany A, Dewar H, Stokesbury MJW, Weng KC, Beemer S, Seitz AC, Farwell CJ, Prince ED, Block BA. 2007b. Annual migrations, diving behavior, and thermal biology of Atlantic bluefin tuna, *Thunnus thynnus*, on their Gulf of Mexico breeding grounds. *Marine Biology* 151:1-18.
- Teo S, Block BA. 2010. Comparative influence of ocean conditions on yellowfin and Atlantic bluefin tuna catch from longlines in the Gulf of Mexico. *PLoS ONE* 5(5): e10756.
- Thomsen B. 2002. An experiment on how seismic shooting affects caged fish. Thesis, Faroese Fisheries Laboratory, University of Aberdeen, Aberdeen, Scotland. 16 August.
- Tyack PL. 2008. Implications for marine mammals of large-scale changes in the marine acoustic environment. *Journal of Mammalogy*, 89(3), pp.549-558.
- van Bergeijk WA. 1967. The evolution of vertebrate hearing. Pages 1-49 In: Neff WD, ed. *Contributions to Sensory Physiology*. Academic Press, New York, NY.
- Van Waerebeek K, Baker AN, Félix F, Gedamke J, Iñiguez M, Sanino GP, Secchi E, Sutaria D, van Helden A, Wang Y. 2007. Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment. *Latin American Journal of Aquatic Mammals*. 6(1):43–69. doi:0.5597/lajam00109.
- Vanderlaan AS, Taggart CT. 2007. Vessel collisions with whales: The probability of lethal injury based on vessel speed. *Marine Mammal Science* 23(1):144-156.
- Wardle CS, Carter TJ, Urquhart GG, Johnstone ADF, Ziolkowski AM, Hampson G, Mackie D. 2001. Effects of seismic airguns on marine fish. *Continental Shelf Research* 21:1005-1027.
- Webb JF, Fay RR, Popper AN (Eds). 2008. *Fish Bioacoustics*. New York, NY. Springer Science+Business Media, LLC.

Witherington BE. 1986. Human and natural causes of marine turtle clutch and hatchling mortality and their relationship to hatchling production on an important Florida nesting beach. Unpublished Master's Thesis, University of Central Florida, Orlando. 141 p.

Work PA, Sapp AL, Scott DW, Dodd MG. 2010. Influence of small vessel operation and propulsion system on loggerhead sea turtle injuries. *Journal of Experimental Marine Biology and Ecology*. 393(1-2):168-175.

6. PREPARERS

Douglas Peter –	NEPA Coordinator, Environmental Protection Specialist
Hayley Karrigan –	Marine Mammals and Sea Turtles, Protected Species Biologist
Tre Glenn –	Marine Mammals and Sea Turtles, Protected Species Biologist
Michelle Garig –	Fish, Marine Biologist
Scott Sorset –	Archaeology, Supervisory Marine Archaeologist
Alicia Caporaso –	Benthic Communities, Biologist

7. REVIEWERS

Sarah Vaughn –	Senior NEPA Coordinator; Environmental Protection Specialist
Perry Boudreaux –	Supervisor, Environmental Assessment Unit 2