National Marine Fisheries Service

Endangered Species Act Section 7

Conference and Biological Opinion

Title:	Conference and Biological Opinion on a High-Energy Marine Geophysical Survey in the Western Central Atlantic Ocean and Issuance of an Incidental Harassment Authorization Pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act
Action Agencies:	National Science Foundation and Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration
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1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1531 et seq.) establishes a mandate for conserving and recovering threatened and endangered species of fish, wildlife, plants, and the habitats on which they depend. Section 7(a)(2) of the Act and its implementing regulations require every Federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat.

Section 7(a)(4) of the ESA requires Federal agencies to confer with the Secretary on any action that is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat. For actions that are not likely to jeopardize the continued existence of a proposed species or adversely modify critical habitat, a conference can be requested by the action agency, though it is not required. If requested by the Federal action agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in 50 CFR §402.14. An opinion issued at the conclusion of the conference may be adopted as the biological opinion when the species is listed or critical habitat is designated.

Section 7(b)(3) of the ESA requires that, at the conclusion of consultation, the National Marine Fisheries Service (NMFS) provide an opinion stating whether the Federal agency's action is likely to jeopardize the continued existence of (or "jeopardize") ESA-listed species or destroy or adversely modify their critical habitat. Similarly, when conferring on proposed species or proposed critical habitat, NMFS also reaches a conclusion as to whether the action will, if finalized, satisfy 7(a)(2) for those entities as proposed. If NMFS determines that the action is likely to jeopardize ESA-listed species or destroy or adversely modify designated or proposed critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If the action (or reasonable and prudent alternative) is expected to cause incidental take without violating section 7(a)(2), section 7(b)(4), as implemented by 50 CFR §402.14(i), requires NMFS to provide an incidental take statement (ITS) that specifies the amount or extent of incidental taking. The blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), North Atlantic right whale (*Eubalaena glacialis*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*) in this consultation are regulated under the Marine Mammal Protection Act (MMPA) and the ESA. Each statute has defined the meaning of take independently. The MMPA defines take as to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal (16 U.S.C. §1632(13)). Take under the ESA is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. §1532(19)). Actions considered 'take' under one statute do not necessarily rise to the level of take under the other statute. The ITS includes reasonable and prudent measures (RPMs), which are actions necessary or appropriate to minimize impacts of incidental taking and terms and conditions to implement the RPMs. The action agencies for this consultation are the National Science Foundation (NSF) and the NMFS, Office of Protected Resources (OPR), Permits and Conservation Division (Permits and Conservation Division). Two Federal actions are considered in this conference and biological opinion (opinion). The NSF proposes to fund marine seismic research in the Western Central Atlantic Ocean between July and September 2026. Seismic surveys will be conducted by Columbia University's Lamont-Doherty Earth Observatory (L-DEO), University of Texas at Austin Institute for Geophysics (UTIG), and Syracuse University from the research vessel *Marcus G. Langseth* (R/V *Langseth*). The Permits and Conservation Division proposes to issue an incidental harassment authorization (IHA) authorizing nonlethal 'takes' by Level A and Level B harassment (as defined by the MMPA) of marine mammals incidental to the planned seismic surveys, pursuant to section 101(a)(5)(D) of the MMPA.

This opinion was prepared by NMFS pursuant to section 7(a)(2) of the ESA and implementing regulations at 50 CFR part 402. On March 30, 2026, in Center for Biological Diversity v. Burgum, No. 24-cv-04651 (N.D. Cal.), the U.S. District Court for the Northern District of California vacated aspects of four provisions from the 50 CFR part 402 regulations governing interagency consultation under section 7 of the ESA and reinstated the provisions that were previously in effect. Consistent with the Court's ruling, these are the governing provisions for this consultation:

- "Destruction or adverse modification means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features." 50 CFR §402.02 (2018).
- "Effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration."[1] 50 CFR §402.02 (2018).

[1] This definition includes the second sentence of the definition of "effects of the action." That sentence provided the definition of "environmental baseline" in effect as of 2018. In the 2019 rule amending the 50 CFR part 402

- 50 CFR §402.14(g)(8): "In formulating its biological opinion, any reasonable and prudent alternatives, and any reasonable and prudent measures, the Service will use the best scientific and commercial data available and will give appropriate consideration to any beneficial actions taken by the Federal agency or applicant, including any actions taken prior to the initiation of consultation." 50 CFR §402.14(g)(8) (2018).
- 50 CFR §402.16(a): "(a) Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service, where discretionary Federal involvement or control over the action has been retained or is authorized by law and ..." 50 CFR §402.16(a) (2023).

Consultation in accordance with section 7(a)(2) of the statute (16 U.S.C. §1536(a)(2)), associated implementing regulations (50 CFR part 402), and agency policy and guidance (USFWS and NMFS 1998) was conducted by the NMFS OPR ESA Interagency Cooperation Division (hereafter referred to as 'we' or 'us'). We prepared this opinion and ITS in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR part 402. This document represents NMFS's opinion on the effects of these actions on the blue whale, fin whale, North Atlantic right whale, sei whale, sperm whale, North Atlantic Distinct Population Segment (DPS) green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), leatherback turtle (*Dermochelys coriacea*), Northwest Atlantic Ocean DPS loggerhead turtle (*Caretta caretta*), Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), giant manta ray (*Manta birostris*), Nassau grouper (*Epinephelus striatus*), oceanic whitetip shark (*Carcharhinus longimanus*), shortnose sturgeon (*Acipenser brevirostrum*), queen conch (*Aliger gigas*), and boulder star coral (*Orbicella franksi*).

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA; section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file electronically with the NMFS OPR in Silver Spring, Maryland, and available in the NOAA Library Institutional Repository.

1.1 Background

The NSF is proposing to fund seismic surveys in the Western Central Atlantic Ocean, offshore the Eastern North American Margin, during July–September 2026, to investigate incipient seafloor spreading processes. The NSF, as the research funding and action agency, has a mission

regulations, the Services established "environmental baseline" as a stand alone definition. 84 Fed. Reg. 44976, 45016 (August 27, 2019). In the 2024 rule, the Services made minor revisions to the "environmental baseline" definition. 89 Fed. Reg. 24268, 24298 (April 5, 2024). The Court's ruling did not touch upon that definition of "environmental baseline," and it therefore remains valid. The definition is also fully consistent with the definition of "effects of the action" from 2018.

to "promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" The proposed seismic surveys were reviewed under the NSF merit review process and identified as a NSF program priority. The seismic surveys will be conducted from L-DEO's research vessel (R/V) *Marcus G. Langseth* (*Langseth*). In conjunction with this action, the Permits and Conservation Division proposes to issue an IHA pursuant to the MMPA requirements for incidental takes of marine mammals that could occur during the seismic surveys. The NSF and Permits and Conservation Division have conducted similar actions in the past, that have been the subject of ESA section 7 consultations. Those previous opinions (OPR-2022-02837 and OPR-2022-02949) in a similar area as this consultation determined that the proposed activities were not likely to jeopardize the continued existence of ESA-listed species.

1.1.1 Consultation History

- **January 30, 2025:** We received, via email, NSF's request for formal consultation and draft environmental assessment for high-energy seismic surveys in the Western Central Atlantic Ocean between September and October 2025.
- **March 3, 2025:** We participated in the Permits and Conservation Division's Early Review Team meeting to discuss the proposed seismic surveys.
- **May 21, 2025:** The Permits and Conservation Division notified us via email that NSF's action is being deferred to 2026.
- **February 19, 2026:** NSF requested, via email, formal consultation for the high-energy seismic surveys in the Western Central Atlantic Ocean between July and September 2026. NSF provided revised estimates of sea turtle and marine mammal exposure to the proposed seismic surveys.
- **March 12, 2026:** We and the Permits and Conservation Division met to discuss the proposed seismic surveys and timing considerations for NSF and the Permits and Conservation Division's IHA.
- **March 17–26, 2026:** We requested, and NSF provided, via email, additional information regarding the proposed activities, extent of the action area, and density calculations.
- **April 6, 2026:** We received, via email, the Permits and Conservation Division's request for formal consultation, draft IHA, and *Federal Register* notice for the proposed IHA.
- **May 13, 2026:** NSF provided, via email, updates to the proposed action.

1.1.2 Analytical Approach

This opinion includes analyses of the effects of the action to ESA-listed species and designated and proposed critical habitat analysis. The effects of this action are likely to adversely affect the blue whale, fin whale, sei whale, sperm whale, North Atlantic DPS green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS loggerhead turtle, and therefore, this opinion includes a jeopardy analysis. The 2016 critical habitat regulations (50 CFR §424.12) specified the use of physical and biological features (PBFs) essential to the conservation of the species, replacing the use of primary constituent element (PCE), essential features, or generally identified aspects of critical habitat that were essential to the conservation of the species. The designation of critical habitat for Northwest Atlantic Ocean DPS loggerhead turtles used the term PCE that we replaced with PBFs in the discussion of this opinion. The shift in terminology does not change the approach used in conducting the effects analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features.

We use the following approach to determine whether an action agency can insure its proposed action is not likely to jeopardize listed species:

- Identify all aspects of the proposed action (as defined in 50 CFR §402.02), including activities that are a consequence of the action but are not part of the proposed action.
- Identify the physical, chemical, and biological modifications to land, water, and air (stressors) that result from those actions and subsequent activities.
- Establish the spatial extent of those stressors, which is the action area (50 CFR §402.02).
- Identify the listed species (as defined at 16 U.S.C. §1532(16)) and designated and proposed critical habitat (as defined at 16 U.S.C. §1532(5)) that may be affected by the action.
- Identify any species and critical habitats that are not likely to be adversely affected by the action.
- Evaluate the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline (as defined in 50 CFR §402.02) as it pertains to the species and critical habitat.
- Evaluate the effects of the proposed action on listed species using a stressor-exposure-response approach. When complete, this section anticipates the amount or extent, as well as the forms (harass, harm, etc.), of take of listed species (or a surrogate) that is reasonably certain to occur as a result of the action. Because take is categorized differently under ESA and MMPA, the initiation documents provided by NSF, NMFS's Permits and Conservation Division, and the analysis in this opinion may discuss take differently and identify different numbers of takes as the reasonably certain outcomes of this action (see guidance here).
- Evaluate cumulative effects (as defined at 50 CFR §402.02).
- Produce an integration and synthesis, where we add the effects of the action and cumulative effects to the environmental baseline, and, considering the status of the species, analyze whether the proposed action is likely to jeopardize the continued existence of listed species.

- Complete a jeopardy analysis, relying on the justification in the integration and synthesis.
- Provide an incidental take statement that specifies the impact of the take on listed species (amount or extent), RPMs, and terms and the conditions to implement those measures for actions that do not violate section 7(a)(2) of the ESA, for an alternative action that does not violate section 7(a)(2) of the ESA, and when take of marine mammals is reasonably certain to occur, it is permitted under section 101(a)(5) of the MMPA.

In each of the steps above, NMFS relies on the best scientific and commercial data available to ensure we reach supportable conclusions. In order to ensure we reach supportable conclusions, we used information from NSF and the Permits and Conservation Division, including NSF's draft environmental assessment (LGL 2025), programmatic environmental impact statement (NSF and USGS 2011), the Permits and Conservation Division's draft IHA, government reports (including NMFS biological opinions and stock assessment reports), NOAA technical memoranda, monitoring reports, species listings and critical habitat designations, and peer-reviewed scientific literature.

2 PROPOSED FEDERAL ACTION

Action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or on the high seas. Examples include, but are not limited to: 1) actions intended to conserve listed species or their habitat; 2) the promulgation of regulations; 3) the granting of licenses, contracts, leases, easements, rights-of-way, permits, or grants in aid; or 4) actions directly or indirectly causing modifications to the land, water, or air (50 CFR §402.02).

2.1 Description of the Action

Two actions were evaluated in this consultation. The first action is NSF's funding of seismic surveys. The second action is the Permits and Conservation Division's issuance of an IHA authorizing incidental nonlethal MMPA "takes" by Level A and Level B harassment pursuant to section 101(a)(5)(D) of the MMPA for the seismic surveys.

2.1.1 National Science Foundation

The NSF proposes to fund seismic surveys conducted by researchers from L-DEO, UTIG, and University of Syracuse, in the Western Central Atlantic Ocean using the seismic surveying capabilities of the R/V *Langseth* during July–September 2026. The purpose of the seismic surveys is to investigate early seafloor spreading processes. This is done using an airgun array to collect seismic reflection and refraction data, a gravimeter, magnetometer, and expendable bathythermographs (XBTs), to inform mantle dynamics such as oceanic crustal thickness, composition, basement roughness, and seismic anisotropy.

While the gravimeter is mounted on the R/V, the magnetometer and XBTs are deployed in the water. The magnetometer, a Geometrics G-882 Marine Magnetometer, is small (approximately 7 centimeters [cm] by 137 cm) and towed by the R/V by a taut cable of up to 800 meters (m). XBTs are small torpedo-shaped probes that are deployed from the R/V with a launcher, and measure the ocean's temperature while sinking through the water column. XBTs will be deployed during seismic operations, approximately one per day.

2.1.1.1 Seismic Surveys

Seismic surveys use an active sound source (often an array of airguns) and a receiver system to record the reflected or refracted signal. For seismic reflection studies, the receiving system is typically a long string of hydrophones (hydrophone streamer) towed behind the R/V to record the reflected signals. This results in multiple channels of recorded data (multi-channel seismic; MCS). For seismic refraction studies, the receiving system is typically an array of ocean bottom seismometers (OBSs) deployed on the seafloor that record the refracted signals.

The R/V *Langseth* will deploy 36-airgun array (plus four spares) during the planned seismic surveys. The airgun array uses 36 Bolt 1500LL or Bolt 1900LLX airguns on four strings spaced 8 m apart. The four airgun strings will be distributed across a 24 m by 16 m area behind the R/V *Langseth,* towed approximately 140 m behind the vessel at a depth of 12 m. The airguns consist of a steel cylinder charged with high-pressure air. When fired, the compressed air is released nearly instantaneously at a pressure of 2,000 pounds per square inch into the water column. This generates a seismic signal that reflects, or refracts, off the seafloor and/or sub-surface layers. When fired, a brief (approximately 0.1 second) pulse of sound is emitted by all airguns nearly simultaneously. The nominal sound pressure level (zero-to-peak) of the airguns is 259 decibels (dB) referenced to (re) one microPascal (1 μPa) at 1 -m and generally low-frequency (2–188 Hertz; Hz). The total discharge volume of the 36-airgun array is 6,600 cubic inches (in^3). The airguns are typically fired at a fixed distance interval (or shot interval) and are silent during the intervening periods. The shot interval during the planned seismic surveys will be 50 m (approximately 24 seconds at 4.1 knots) for MCS or 200 m (approximately 78 seconds at 5 knots) for OBS. Airgun operations are expected to be continuous during seismic operations except for periods of unscheduled shutdowns (e.g., due to maintenance or mitigation measures).

The main receiving system will consist of a towed 4–12 kilometers (km) long solid-state hydrophone streamer (solid flexible polymer – not gel or oil-filled) and 52 OBSs. As the airgun array is towed along the survey lines, the hydrophone streamer will transfer data to the on-board processing system, and the OBSs will receive and store the returning acoustic signals internally for later analysis. Fifty-two OBSs will be deployed at the beginning of the survey and then recovered at the end of the survey after acquiring all seismic data. OBSs have a height of approximately 1 m and diameter of 1 m and are anchored by iron grates that are a maximum of 26 kilograms and 7 cm by 91 cm by 91 cm. Three MicrOBSs, which are smaller than the OBSs, may also be deployed on an experimental basis. An acoustic release transponder (pinger; see Section 2.1.1.2 Non-Seismic Acoustic Sources) signals the OBS for retrieval. The acoustic release is generally done while the R/V is stationary or moving at very slow speeds. The anchors are left on the seafloor and will eventually disintegrate.

The seismic surveys will occur in International Waters approximately 370 km from the east coast of the U.S., 25 km from the U.S. Exclusive Economic Zone (EEZ), and 7 km from the Bermuda EEZ, in water depths ranging from 4,800–5,550 m deep. The seismic surveys will take place over approximately 47 days, including 20 days of seismic operations (approximately 4,264 km of seismic acquisition; 691 km of MCS and 3,573 km of OBS), 13 days of OBS deployment and retrieval, 4.5 days of contingency, and 9.5 days of transit. The R/V *Langseth* will operate in three segments: 1) depart from Savannah, Georgia, for OBS deployments, to Bermuda; 2) depart from Bermuda for seismic operations, and return to Bermuda; and 3) depart from Bermuda for OBS retrieval, and return to Charleston, South Carolina (Figure 1).

The R/V *Langseth* has a length of 72 m, beam of 17 m, a maximum draft of 5.9 m, and is 3,834 tons. Because it is a seismic R/V, the propulsion system (two diesel Bergen BRG-6 engines) was designed to be quiet to avoid interference with the seismic signals. Vessel speed will be approximately 9.3 km per hour (5 knots) during seismic operations with the 36-airgun array to acquire OBS refraction data and 7.6 km per hour (4.1 knots) during MCS reflection data acquisition. When towing the airgun array and hydrophone streamer, the turning rate of the R/V *Langseth* is limited to 5° per minute. When not towing seismic survey gear, vessel cruising speed is 20.3 km per hour (11 knots).

2.1.1.2 Non-Seismic Acoustic Sources

Along with the airgun operations, three additional acoustic data acquisition systems will operate continuously during the seismic surveys: a multibeam echosounder (MBES), sub-bottom profiler (SBP), and an Acoustic Doppler Current Profiler (ADCP). Acoustic releases (pingers) will also be used. The MBES (a Kongsberg EM 122) and SBP (a Knudsen Chirp 3260) will map the ocean floor during seismic survey operations. The ADCP (a Teledyne RDI 75 kiloHertz [kHz] Ocean Surveyor) is mounted on the ship to measure water current velocities.

The MBES is a hull-mounted system operating at 10.5–13 (usually 12) kHz. The transmitting beamwidth is one or two degrees fore-aft and 150° (maximum) athwartship (i.e., perpendicular to the ship's line of travel). The maximum sound source level is 242 dB re 1 μPa-m. Each ping consists of eight successive fan-shaped transmissions, each ensonifying (filling with sound) a sector that extends one degree fore-aft. Continuous-wave signals increase from 2–15 milliseconds long in water depths up to 2,600 m. Frequency-modulated chirp signals up to 100 milliseconds long are used in water depths greater than 2,600 m. The successive transmissions span an overall cross-track angular extent of about 150°, with two millisecond gaps between the pings for successive sectors.

The SBP beam is transmitted as a 27° cone, which is directed downward by a 3.5 kHz transducer in the hull of the R/V *Langseth*. The nominal power output is 10 kilowatts, but the actual maximum radiated power is three kilowatts or 222 dB re 1 μPa-m. The ping duration is up to 64 milliseconds, and the ping interval is one second. A common mode of operation is to broadcast five pulses at one-second intervals followed by a five-second pause. The SBP is capable of reaching depths of 10,000 m.

The ADCP operates at a frequency of 35–1,200 kHz and a maximum source level of 224 dB re 1 µPa-m over a conically-shaped 30° beam. The ping rate is 0.7 Hz.

For OBS retrieval, a pinger signals the OBSs at a frequency of 8–11 kHz and a response is received at a frequency of 11–13 kHz, triggering a burn-wire assembly that releases the OBS from the anchor on the seafloor to float to the surface. The signal is omnidirectional with a source level of 187 dB re 1 µPa-m and ping duration of eight milliseconds.

2.1.2 NMFS Permits and Conservation Division

The Permits and Conservation Division proposes to issue an IHA pursuant to the MMPA, as amended (16 U.S.C. 1361 et seq.) to L-DEO, owner and operator of the R/V *Langseth*, on behalf of itself, UTIG, and University of Syracuse (the applicants) to "take" 32 marine mammal species, including four ESA-listed species, incidental to the seismic surveys. Issuance of an IHA by the Permits and Conservation Division is dependent in part on a determination that the total taking of the affected species or stocks of marine mammals from the proposed action as a whole would have a negligible impact on the affected species or stocks. NMFS has defined negligible impact in 50 CFR §216.103 as "an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

The Permits and Conservation Division's proposed IHA, which also includes proposed mitigation, monitoring, and reporting requirements, is available here (see Appendix A) and at the *Federal Register* (91 Fed. Reg. 18024). The public comment period closed on May 11, 2026. The Permits and Conservation Division did not receive any public comments. Appendix A contains the Permits and Conservation Division's proposed IHA, which is effective for one year upon written notification from the Holder to NMFS but not beginning later than one year from the date of issuance or extending beyond two years from the date of issuance and may be renewed for one year (see the proposed IHA in Appendix A for details on renewal criteria). The text in Appendix A was taken directly from the proposed IHA provided to us in the consultation initiation package.

The IHA will authorize the incidental harassment of the following ESA-listed species: blue whale, fin whale, sei whale, and sperm whale. In order to issue an IHA under section 101(a)(5)(D) of the MMPA, the Permits and Conservation Division must set forth permissible methods of taking pursuant to the activity, and other means of effecting the least practicable adverse impact on the marine mammal species or stock and its habitat. The Permits and Conservation Division regulations require incidental take authorization applicants to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting the activity or other means of effecting the least practicable adverse impact upon the affected species or stocks and their habitat (50 CFR §216.104(a)(11)).

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on marine mammal species or stocks and their habitat, where applicable, the Permits and Conservation Division considered two primary factors:

- The manner in which, and the degree to which, the successful implementation of the measure(s) is expected to reduce impacts to marine mammals, marine mammal species or stocks, and their habitat, as well as subsistence uses. This considers the nature of the potential adverse impact being mitigated (likelihood, scope, range). It further considers the likelihood that the measure will be effective if implemented (probability of accomplishing the mitigating result if implemented as planned), the likelihood of effective implementation (probability implemented as planned), and;
- The practicability of the measures for applicant implementation, which may consider such things as cost and impact on operations.

In order to satisfy the MMPA's least practicable adverse impact standard, the Permits and Conservation Division evaluated a suite of basic mitigation protocols for seismic surveys that are required regardless of the status of a stock. Additional or enhanced protections may be required for species whose stocks are in particularly poor health and/or subject to some significant additional stressor that lessens that stock's ability to weather the effects of the specified activities without worsening its status. The mitigation and monitoring measures (see Section 2.2) that will be implemented during the seismic surveys include visual monitoring of marine mammals by NMFS-approved protected species observers (PSOs), passive acoustic monitoring (PAM) of marine mammals, airgun array shutdown procedures, ramp-up and pre-start clearance procedures, and vessel strike avoidance measures.

2.2 Conservation Measures

The NSF and L-DEO must implement conservation measures (i.e., mitigation [pre-planning and during seismic survey activities], monitoring, and reporting measures) in order for their action to result in the least practicable adverse impact on marine mammal species or stocks and to reduce the likelihood of adverse effects to ESA-listed marine species in the action area. Mitigation is a measure that avoids or reduces the severity of the effects of the action on ESA-listed species and their habitat. Monitoring is used to observe or track the progress of the mitigation over time and to ensure that any measures implemented to reduce or avoid adverse effects on ESA-listed species are successful.

NSF and L-DEO indicated that they reviewed monitoring and conservation measures implemented during seismic surveys authorized by Permits and Conservation Division under previous IHAs, as well as recommended best practices (Acosta et al. 2017; Dolman and Jasny 2015; Nowacek et al. 2013; Pierson et al. 1998; Simmonds et al. 2014; Weir and Dolman 2007;

Wright 2014; Wright and Cosentino 2015) and incorporated a suite of monitoring and conservation measures, described below, into their proposed actions based on these sources.

Under the MMPA, the Permits and Conservation Division requires additional mitigation, monitoring, and reporting measures (vessel strike avoidance measures and reporting) that the NSF and L-DEO will also implement during the high-energy seismic survey, listed below. Additional detail for each mitigation and monitoring measure is in subsequent sections of this opinion:

- Exclusion (i.e., shutdown) and buffer zones;
- Shutdown procedures;
- Pre-start clearance and ramp-up procedures;
- Vessel-based visual monitoring by NMFS-approved PSOs;
- PAM;
- Vessel strike avoidance measures; and
- Reporting.

A summary of the mitigation and monitoring protocols is shown in Table 1. Additional details for the mitigation and monitoring measures (e.g., shutdown and ramp-up procedures) as well as reporting can be found in the Permits and Conservation Division's *Federal Register* notice of proposed IHA and possible renewal (91 Fed. Reg. 18024) and Appendix A.

Table 1. Summary of conservation measures included in NSF's proposed high-energy seismic surveys and NMFS's proposed IHA

Mitigation and Monitoring Protocols	High-Energy Airgun Array (36 Airguns with total volume of 6,600 in^3)
Vessel-Based Visual Mitigation Monitoring	Minimum of two NMFS-approved PSOs on duty during daylight hours (30 minutes before sunrise through 30 minutes after sunset); General limit of two consecutive hours on watch followed by a break of at least one hour; Maximum of 12 hours on watch per 24-hour period
Passive Acoustic Monitoring	Minimum of one NMFS-approved PAM operator on duty from 30 minutes before ramp-up and at all times during use of the airgun array; Limit of four consecutive hours on watch followed by a break of at least one hour; Maximum of 12 hours on watch per 24-hour period
Exclusion/Shutdown Zones	150 m (sea turtles) 500 m (marine mammals, except certain large assemblages) 1,500 m (large whales with calves, and groups of six or more large whales)

Mitigation and Monitoring Protocols	High-Energy Airgun Array (36 Airguns with total volume of 6,600 in^3)
Buffer Zones	500 m (marine mammals)
Pre-Start Clearance and Ramp-Up Procedures	Required; 30-minute pre-start clearance period of the following zones prior to ramp-up: • 1,000 m (marine mammals) Following detection within clearance zone (exclusion/shutdown and buffer zones), animal must be observed exiting the zone or an additional 30 minutes (mysticetes and large odontocetes) with no further sightings
Ramp-Up Procedures	Required; duration ≥ 20 minutes
Shutdown Procedures	Shutdown required for marine mammals detected within or approaching the 500-m exclusion/shutdown zone (except for certain small delphinids); Shutdown required if ESA-listed sea turtles detected within the 150-m exclusion/shutdown zone; Airgun activity may resume if the marine mammal or ESA-listed sea turtle has cleared[†] the respective exclusion/shutdown zones
Vessel Strike Avoidance Measures	Vigilant watch by PSOs and crew; vessel speeds reduced to 10 knots or less when assemblages of marine mammals or mother/calf pairs are observed near the research vessel; maintain a minimum separation distance between species of concern; avoid vessel course changes in the vicinity of marine mammals

[†]An animal is considered to have cleared the exclusion/shutdown zone if 1) it was visually observed to have left the exclusion/shutdown zone, 2) it was not seen within the exclusion/shutdown zone for 15 minutes (ESA-listed sea turtles, small odontocetes) or 30 minutes (marine mammals, except small odontocetes)

2.2.1 Exclusion/Shutdown and Buffer Zones

The Permits and Conservation Division (for marine mammals) will require, and the NSF and L-DEO will implement exclusion/shutdown and buffer zones around the R/V *Langseth* to minimize any potential adverse effects of the sound from the airgun array on MMPA and ESA-listed species. The exclusion/shutdown zones are areas within which occurrence of a marine mammal or ESA-listed sea turtle triggers a shutdown of the airgun array, to reduce exposure of marine mammals and ESA-listed sea turtles to sound levels expected to have adverse effects on the species. The buffer zone means an area beyond the exclusion/shutdown zone monitored for the presence of marine mammals that may enter the exclusion/shutdown zone. The exclusion/shutdown zones are based on the radial distance from any element (the edges) of the airgun array (rather than being based on the center of the airgun array or around the vessel itself). Exclusion/shutdown and buffer zones for the proposed seismic surveys were derived from L-

DEO modeled distances to behavioral disturbance thresholds and auditory injury (AUD INJ; which includes permanent threshold shifts [PTS]) thresholds (NMFS 2024a).

For behavioral harassment, L-DEO conducted modeling on behalf of the NSF. Received sound levels were predicted by L-DEO's model (Diebold et al. 2010), which uses ray tracing for the direct wave traveling from the airgun array to the receiver and its associated source ghost (i.e., reflection at the air-water interface in the vicinity of the airgun array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). Using this model, L-DEO estimated distances to the NMFS acoustic behavioral disturbance thresholds for marine mammals and sea turtles. NMFS predicts that marine mammals and sea turtles are likely to be behaviorally disturbed when exposed to underwater noise above root-mean-square (rms) received levels of 160 dB re 1 µPa and 175 dB re 1 µPa respectively, for non-explosive, impulsive sources, including a 36-airgun array (LGL 2024; NMFS 2018b). For more information on L-DEO's model, see Appendix A in NSF's draft environmental assessment.

Table 2. Predicted distances from the 36-airgun array to NMFS's impulsive behavioral disturbance acoustic thresholds for ESA-listed marine mammals and sea turtles

Source and Volume	Tow Depth (m)	Water Depth (m)	Distance to marine mammal 160 dB re 1 µPa threshold (m)	Distance to sea turtle 175 dB re 1 µPa threshold (m)
36 airguns, 6,600 in^3	12	>1,000	6,733	1,864

in^3 = cubic inches; m = meters; dB re 1 µPa = decibels referenced to a pressure of one microPascal

Predicted distances to the AUD INJ thresholds for the proposed seismic survey were calculated based on modeling performed by L-DEO (same as used for behavioral disturbance) and the NMFS User Spreadsheet (Table 3). To determine the onset of AUD INJ for impulsive sources, NMFS uses dual metrics: weighted cumulative sound exposure level (SEL_{cum}) and an unweighted peak sound pressure level (SPL_{peak}). As dual metrics, NMFS considers the onset of AUD INJ to have occurred when either one of the two metrics is exceeded. The thresholds in the SEL_{cum} metric incorporate auditory weighting functions (by species hearing groups) to account for the fact that different species groups use and hear sound differently. Blue, fin, and sei whales are categorized in the low-frequency cetacean hearing group and sperm whales in the high-frequency cetacean hearing group (see Table 9). The largest distance (Table 3, in bold italics) of the dual criteria was used as the AUD INJ threshold distance. For moving sound sources such as seismic surveys, the User Spreadsheet predicts the closest distance at which a stationary animal will not incur AUD INJ if the sound source traveled by the animal in a straight line at a constant speed. Inputs used in the User Spreadsheet and the resulting isopleths are described further in the NSF's draft environmental assessment (LGL 2024) and L-DEO's IHA application and the Permits and Conservation Division's proposed IHA and possible renewal (91 Fed. Reg. 18024).

Table 3. Predicted distances from the 36-airgun array to NMFS's impulsive AUD INJ thresholds for ESA-listed marine mammals and sea turtles

Hearing Group	SEL_{cum} Threshold	SPL_{peak} Threshold	Distance to SEL_{cum} Threshold (m)[1]	Distance to SEL_{cum} Threshold (m)[2]	Distance to SPL_{peak} Threshold (m)
Sea turtles	184 dB	232 dB	***644.9***	***161.2***	10.6
Low-frequency cetaceans	183 dB	222 dB	***468.7***	***117.2***	28.3
High-frequency cetaceans	193 dB	230 dB	0.2	0.0	***13.6***

m = meters; SPL_{peak} = peak sound pressure level; SEL_{cum} = cumulative sound exposure level
Note: SPL_{peak} has a reference value of 1 µPa (referenced to a pressure of one microPascal) and SEL_{cum} has a reference value of 1 $\mu Pa^2 s$ (referenced to a pressure of one microPascal squared second); the largest distances are in bold italics
[1] Distances for a shot interval of 50 meters and a speed of 4.1 knots (MCS)
[2] Distance for a shot interval of 200 meters and a speed of 5 knots (OBS)

2.2.2 Shutdown Procedures

The shutdown of the airgun array requires the immediate deactivation of all elements of the airgun array. Any PSO on duty will have the authority to delay the start of seismic survey activities or to call for shutdown of the airgun array if a marine mammal or ESA-listed sea turtle is detected within or approaching the respective exclusion/shutdown zones. The operator must also establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the airgun array to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch. Except for specific non-ESA-listed small delphinid species, when the airgun array is active (i.e., anytime one or more airguns are active, including during ramp-up) and a marine mammal or ESA-listed sea turtle occurs within the buffer zone, PSOs must communicate with the operator to prepare for a potential shutdown. Additionally, if a marine mammal or ESA-listed sea turtle occurs within or enters the exclusion/shutdown zone and/or a marine mammal is detected acoustically within the exclusion/shutdown zone, the airgun array must be shut down. When shutdown is called for by a PSO, the airgun array must be immediately deactivated and any dispute regarding a PSO shutdown must be resolved only following deactivation. Additionally, shutdown will occur whenever PAM alone (without visual sighting) confirms the presence of marine mammals in the shutdown zone. If the acoustic PSO cannot confirm presence within the shutdown zone, visual PSOs would be notified but shutdown is not required.

Following a shutdown, airgun array activity will not resume until the marine mammal or ESA-listed sea turtle has cleared the exclusion/shutdown zone. The animal will be considered as having cleared the exclusion/shutdown zone if:

- It is visually observed to have left the exclusion/shutdown zone; or
- It has not been seen within the exclusion/shutdown zone after a clearance period of
  - 15 minutes in the case of ESA-listed sea turtles, or
  - 30 minutes in the case of mysticetes and all other odontocetes (except small odontocetes), with no further observation of the marine mammal(s).

Visual PSOs will use best professional judgement in making the decision to call for a shutdown if there is uncertainty regarding identification (i.e., whether the observed marine mammal[s] belongs to one of the delphinid genera for which shutdown is waived or one of the species with a larger shutdown zone).

Shutdown of the airgun array will also be required upon visual observation of a marine mammal species for which MMPA authorization has not been granted, or a marine mammal species for which authorization has been granted but the authorized number of takes are met, that is observed approaching, or observed within MMPA Level A or Level B harassment zones.

In addition to the shutdown procedure described above, during the survey, the Permits and Conservation Division's MMPA IHA will require NSF and L-DEO to implement an extended exclusion/shutdown zone of 1,500 m for:

- Any large whale (defined as a sperm whale or any mysticete [baleen whale]) species with a calf (defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult); and/or
- An aggregation of six or more large whales.

No buffer zone is required for the extended 1,500 m zone. See Appendix A for additional details on shutdown procedures.

2.2.3 Pre-Start Clearance and Ramp-Up Procedures

A 30-minute pre-start clearance observation period ensures no protected species are observed within the buffer zone and exclusion/shutdown zone prior to the beginning of ramp-up. Pre-start clearance is the only time observations of protected species in the buffer zone will prevent operations (i.e., the beginning of ramp-up). Ramp-up (sometimes referred to as "soft-start") means the gradual and systematic increase of emitted sound levels from an airgun array. The intent of ramp-up is to warn protected species of pending seismic survey actions (if the sound source is sufficiently aversive) and to allow sufficient time for those animals to leave the immediate vicinity prior to the sound source reaching full intensity. A ramp-up procedure, involving a step-wise increase in the number of airguns firing and an increase in total airgun array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the airgun array. Ramp-up begins by first activating a single airgun of the smallest volume, followed by doubling the number of active elements in stages until the full complement of airgun arrays are active. The total duration of ramp-up should not be less than 20 minutes. One acoustic PSO and two visual PSOs will be required to begin monitoring at least 30 minutes prior to ramp-up.

Operators must adhere to the following pre-start clearance and ramp-up requirements:

- Thirty minutes of pre-start clearance observation of the exclusion/shutdown and buffer zone is required prior to ramp-up for any shutdown of longer than 30 minutes (e.g., when the airgun array is shutdown during transits from one trackline to another). This pre-start clearance period may occur during any vessel activity (e.g., transit):
    - If any marine mammal or ESA-listed sea turtle is observed within or approaching the exclusion/shutdown or buffer zone during the 30 minute pre-start clearance period, ramp-up may not begin until the animal(s) has been observed exiting the exclusion/shutdown zone or until an additional time period has elapsed with no further sightings (i.e., 15 minutes for small odontocetes and ESA-listed sea turtles, and 30 minutes for mysticetes and all other odontocetes).
- The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO:
    - The notification time must not be less than 60 minutes prior to the planned ramp-up in order to allow the PSOs time to monitor the exclusion/shutdown zone and buffer zone for 30 minutes prior to the initiation of ramp-up (pre-start clearance).
    - Ramp-ups must be scheduled so as to minimize the time spent with the airgun array activated prior to reaching the designated run-in.
    - One of the PSOs conducting pre-start clearance observations must be notified again immediately prior to initiating ramp-up procedures, and the operator must receive confirmation from the PSO to proceed.
- Ramp-up may not be initiated if any marine mammal or ESA-listed sea turtle is within the applicable exclusion/shutdown zone or buffer zone:
    - If a marine mammal or ESA-listed sea turtle is observed within the applicable exclusion/shutdown zone or the buffer zone during ramp-up, a shutdown must be implemented as though the full airgun array were operational.
    - Ramp-up may not begin until the animal(s) has been observed exiting the shutdown or buffer zones or until an additional period has elapsed with no further sightings (15 minutes for small odontocetes and ESA-listed sea turtles, and 30 minutes for mysticetes and all other odontocetes).
- Ramp-up must begin by activating a single airgun of the smallest volume in the airgun array and must continue in stages by doubling the number of active airguns at the commencement of each stage, with each stage of approximately the same duration. Duration must not be less than 20 minutes. The operator must provide information to the PSO documenting the appropriate procedures were followed.

- PSOs must monitor the exclusion/shutdown and buffer zones during ramp-up:
  - Ramp-up may not be initiated or must cease and the airgun array must be shutdown upon detection of a marine mammal or ESA-listed sea turtle within the applicable exclusion/shutdown zone.
  - Once ramp-up has begun, detections of marine mammals or ESA-listed sea turtles within the buffer zone do not require shutdown, but such observation must be communicated to the operator to prepare for the potential shutdown.
  - Ramp-up may occur at times of poor visibility, including nighttime, if appropriate PAM has occurred with no detections in the 30 minutes prior to beginning ramp-up where operational planning cannot reasonably avoid such circumstances. Ramp-up may occur at night and during poor visibility if the shutdown and buffer zone have been continually monitored by PSOs for 30 minutes prior to ramp-up. Airgun array activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances.
- If the airgun array is shutdown for brief periods (i.e., less than 30 minutes) for reasons other than that described for shutdown (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant acoustic and/or visual monitoring and no acoustic or visual detections of marine mammals or ESA-listed sea turtles have occurred within the applicable exclusion/shutdown zone.
  - For any longer shutdown, pre-start clearance observation and ramp-up are required.
- Testing of the airgun array involving all airguns requires normal mitigation protocols (e.g., ramp-up). Testing limited to individual sound source elements or strings of the airgun array does not require ramp-up but does require pre-start clearance (visual monitoring for 30 minutes).

More details on pre-start clearance and ramp-up procedures are in Appendix A.

2.2.4 Vessel-Based Visual Monitoring

Visual monitoring requires the use of trained PSOs to scan the ocean surface visually for the presence of marine mammals. The area to be scanned visually includes primarily the exclusion/shutdown zones, but also the buffer zone, to implement the conservation measures discussed above.

The NSF and L-DEO must use independent, dedicated, trained, NMFS-approved visual and acoustic PSOs. The PSOs must be employed by a third-party observer provider and have no tasks other than to conduct observational effort, record observational data, communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements, and have successfully completed an approved PSO training course appropriate for their designated task (visual or acoustic). Individual PSOs may perform acoustic and visual PSO duties, though not at the same time. The PSO resumes shall be provided to NMFS for approval as part of the IHA application process.

At least one visual PSO and two acoustic PSOs aboard the vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, during a deep penetration (i.e., high-energy) seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. One visual PSO with such experience shall be designated as the lead for the entire PSO team. The lead PSO shall serve as the primary point of contact for the vessel operator and ensure all PSO requirements detailed in the MMPA IHA and the ITS are met. To the maximum extent practicable, experienced PSOs will be on duty with PSOs that have appropriate training but who have not yet gained relevant field experience.

During seismic survey activities (e.g., any day in which use of the airgun array is planned to occur, and whenever the airgun array is in the water, whether activated or not), a minimum of two visual PSOs must be on duty conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset). Visual monitoring of the shutdown and buffer zones must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the airgun array ceases or until 30 minutes past sunset. Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner. Visual PSOs will systematically scan around the research vessel with the naked eye, reticle binoculars, or Big-Eye reticle binoculars (25 x 150) which must be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. During darkness, PSOs will also have night vision devices (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), if necessary.

Visual PSOs will immediately communicate all observations to the on-duty acoustic PSO(s), including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination. Any observations of marine mammals by crew members will be relayed to the PSO team. During good conditions (e.g., daylight hours, Beaufort sea state of 3 or less), visual PSOs will conduct observations when the airgun array is not operating for comparison of sighting rates and behavior with and without use of the airgun array and between acquisition periods, to the maximum extent practicable. Visual PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic, but not at the same time) may not exceed 12 hours per 24-hour period for any individual PSO.

More details on monitoring can be found in Appendix A.

2.2.5 Passive Acoustic Monitoring

The Permits and Conservation Division will require the use of PAM. PAM uses trained personnel (i.e., acoustic PSOs) to operate underwater recording equipment (hydrophones) and detect the presence of marine mammals. PAM involves acoustically detecting marine mammals, regardless of distance from the airgun array, because visual localization of animals is not always possible. PAM is intended to further support visual monitoring (during daylight hours) in maintaining a shutdown zone around the airgun array that is clear of marine mammals. In cases where visual monitoring is not effective (e.g., due to weather, nighttime), PAM may be used to allow certain activities to occur, as further detailed below.

The PAM system must be monitored by a minimum of one on-duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times (day and night) during the use of the airgun array. When both acoustic and visual PSOs are on-duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs and to allow for the implementation of mitigation measures, if necessary. An acoustic PSO may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period of any individual PSO. Combined observational duties (acoustic and visual but not at the same time) may not exceed 12 hours of observation per 24-hour period for any individual PSO. At least two acoustic PSOs aboard the research vessel must have a minimum of 90 days at-sea experience working in that role during deep penetration or high-energy seismic surveys, with no more than 18 months elapsed since the conclusion of their at-sea experience.

Seismic survey activities may continue for 30 minutes when the PAM system malfunctions or is damaged, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional 10 hours without PAM during daylight hours only under the following conditions:

- Beaufort sea state is less than or equal to 4;
- No marine mammals (excluding delphinids) detected solely by PAM in the applicable shutdown zone in the previous two hours;
- NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and
- Operations with an active airgun array, but without an operating PAM system, do not exceed a cumulative total of 10 hours in any 24-hour period.

2.2.6 Monitoring Data Collection

For data collection purposes, PSOs must use standardized data collection forms, whether hard copy or electronic. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of animals to the airgun array and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the airgun array. If required mitigation is not implemented, PSOs shall record a description of the circumstances. See Appendix A for details on information that must be recorded, including additional information that must be recorded if a protected species is visually observed or acoustically detected.

2.2.7 Vessel Strike Avoidance Measures

Vessel strike avoidance measures are intended to minimize the potential for collisions with marine mammals. The Permits and Conservation Division notes that these requirements do not apply when the safety of the vessel or crew is in doubt or the safety of life at sea is in question. These requirements do not apply in any case where compliance will create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply. These vessel strike avoidance measures include the following:

- Vessel personnel should use an appropriate reference guide that includes identifying information on all marine mammals that may be encountered. Vessel operators must comply with the requirements except in the circumstances mentioned above;
- The vessel operator (R/V *Langseth*) and crew must maintain a vigilant watch for all marine mammals and slow down, stop, or alter course of the vessel, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (specific distances detailed below). Visual observers monitoring the vessel strike avoidance zone may either be third-party PSOs or crew members, but crew members responsible for these duties would be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal to broad taxonomic group;
- Vessel speeds must be reduced to 18.5 km per hour (10 knots) or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near the vessel;
- The vessel (R/V *Langseth*) must maintain a minimum separation distance of 100 m from all baleen whales and sperm whales.
- The vessel must, to the maximum extent practicable, maintain a minimum separation distance of 50 m from all other marine mammals, with an understanding that at times this may not be possible (e.g., for animals that approach the vessel).
- When marine mammals are sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's source, avoid excessive speed or abrupt changes in direction until the animal has left the area). If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral,

not engaging the engines until the animal(s) are clear of area. This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

2.2.8 Reporting

In order to issue an IHA for an activity, section 101(a)(5)(D) of the MMPA states that the IHA shall prescribe requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR §216.104(a)(13) indicate that requests for IHAs must include the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the action area while conducting the seismic survey activities. Effective reporting is critical both to compliance with the MMPA IHA, as well as ensuring that the most value is obtained from the required monitoring.

Thus, NSF and L-DEO must submit a draft comprehensive report to the Permits and Conservation Division on all activities and monitoring results within 90 days of the completion of the seismic survey or expiration of the IHA, whichever comes sooner. The report will summarize all activities that were conducted including full documentation of methods, results, and interpretation pertaining to all monitoring, the dates and locations of seismic survey activities, all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities), geo-referenced time-stamped vessel tracklines for all periods during which the airgun arrays were operating (including points recording any change in airgun status), and raw observational data. A final report must be submitted within 30 days following resolution of any comments on the draft report.

More details on reporting (e.g., reporting injured or dead marine mammals) and actions to minimize additional harm to live-stranded (or milling) marine mammals can be found in Appendix A.

2.3 Stressors Resulting from the Components of the Proposed Action

In this section, the direct or indirect modifications to the land, water, or air caused by an action are identified as stressors. This section identifies all the stressors resulting from the proposed action, as well as the sources of those stressors. Some stressors may have multiple sources. Likewise, multiple sources may combine to create a stressor that would not exist if only one of the sources was present. The following is a summary of stressors that are reasonably certain to be caused by this action:

- Pollution (e.g., exhaust, fuel, oil, trash, OBS anchors);
- Vessel strike;
- Acoustic and visual disturbance (R/V, MBES, SBP, ADCP, OBS pingers, and seismic airgun array); and
- Entanglement in towed seismic equipment (hydrophone streamers).

The proposed action includes several conservation measures (Section 2.2) designed to minimize effects that may result from the proposed action. While we consider these measures important and expect them to be effective in minimizing the effects of the potential stressors, they do not eliminate the identified stressors. Nevertheless, we treat them as part of the proposed action and fully consider them when evaluating the effects of the proposed action.

3 Action Area

Action area means "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). The action area is defined by the extent of the environmental changes the stressors cause on the physical environment (e.g., land, air or water, detailed in the previous section). The action area is the portion of the Western Central Atlantic Ocean where the proposed seismic survey will occur, where sound levels from the seismic survey are above ambient sound levels, and the rivers and marine environments between the Port of Savannah, Georgia, the Port of Charleston, South Carolina, Bermuda, and the seismic survey area (i.e., where the R/V *Langseth* will depart and return to; Figure 1).

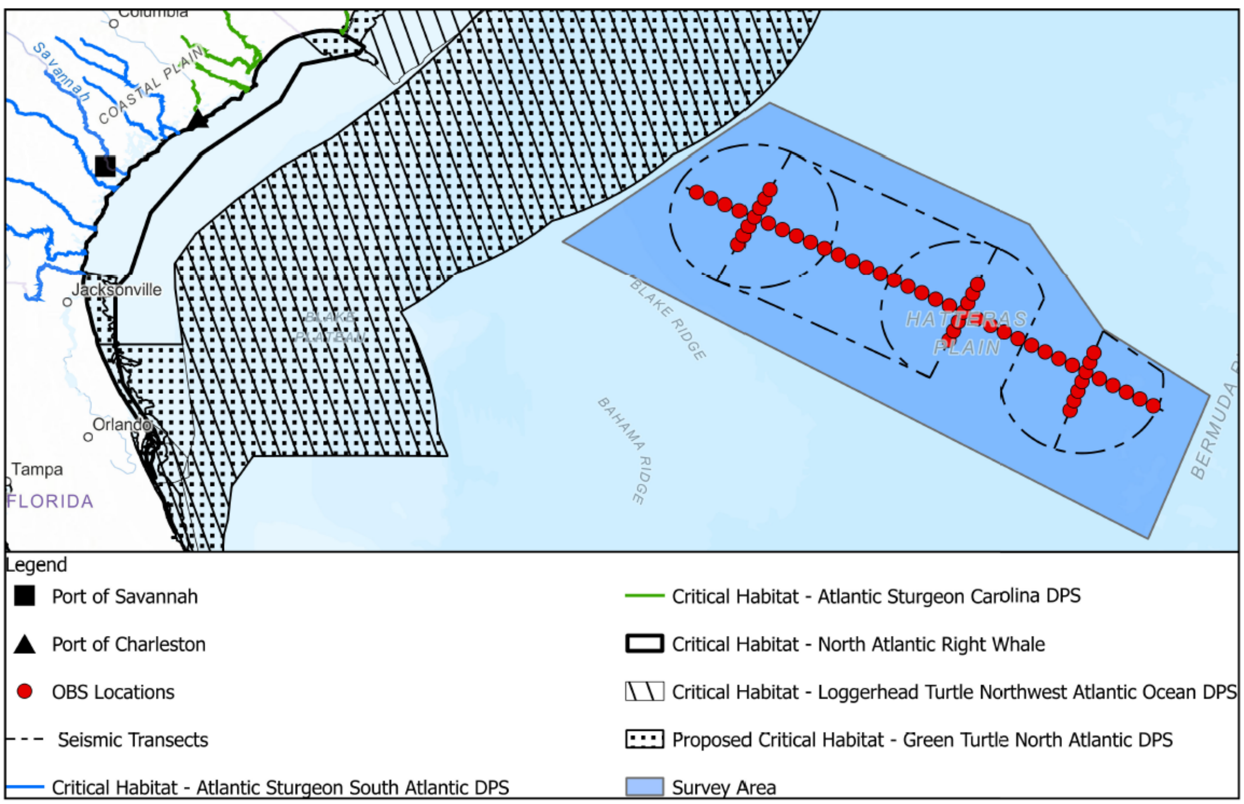

Figure 1. Seismic survey area (not pictured: transit to Bermuda)

4 Species and Critical Habitat that May be Affected by the Proposed Action

Implementing regulations for the ESA (50 CFR part 402) allow for three general determinations when analyzing the effects of an action on listed species and critical habitat: 1) no effect, 2) may affect, likely to adversely affect (formal consultation), and 3) may affect, not likely to adversely affect (NLAA). Action agencies, prior to requesting ESA consultation, determine whether their proposed action may affect ESA-listed species or their designated or proposed critical habitat. Generally, a "no effect" determination means there is no plausible exposure or response to stressors generated by the proposed action for any ESA-listed species or designated or proposed critical habitat. A "no effect" determination does not require consultation. Any scenario where there is a plausible exposure to stressors generated by the action is considered "may affect." For any action that "may affect" an ESA-listed species or its designated critical habitat, the action agency shall consult with the Services under section 7(a)(2) of the ESA. An action agency is also required to confer with the Services on any action which is likely to jeopardize the continued existence of the proposed species or destroy or adversely modify the proposed critical habitat. However, action agencies may voluntarily confer with the Services for all proposed species or proposed critical habitat in the action area when the action may affect those proposed entities, consistent with the procedures for formal consultation in § 402.14. The NSF has requested such consultation for proposed ESA entities in the action area.

This section identifies the ESA-listed species and designated or proposed critical habitat that occur in the action area (Table 4) and thus may be affected by the stressors introduced to the action area by the proposed action.

Table 4. Species and critical habitat present in the action area

Species	ESA Status	Critical Habitat	Recovery Plan
Blue Whale (*Balaenoptera musculus)*	E – 35 Fed. Reg. 18319	-- --	07/1998 11/2020
Fin Whale (*Balaenoptera physalus)*	E – 35 Fed. Reg. 18319	-- --	07/2010
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 Fed. Reg. 12024	81 Fed. Reg. 4837	08/2004
Sei Whale (*Balaenoptera borealis*)	E – 35 Fed. Reg. 18319	-- --	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 Fed. Reg. 18319	-- --	12/2010
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 Fed. Reg. 20057	63 Fed. Reg. 46693* 88 Fed. Reg. 46572 (Proposed)	10/1991 – U.S. Atlantic

Species	ESA Status	Critical Habitat	Recovery Plan
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 Fed. Reg. 8491	63 Fed. Reg. 46693*	08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico 05/1998 – U.S. Pacific
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 Fed. Reg. 18319	-- --	03/2010 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 Fed. Reg. 8491	44 Fed. Reg. 17710* 77 Fed. Reg. 4170*	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 05/1998 – U.S. Pacific
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 Fed. Reg. 58868	79 Fed. Reg. 39855	12/2008
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS	E – 77 Fed. Reg. 5913	82 Fed. Reg. 39160	02/2012 (Outline)
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Chesapeake Bay DPS	E – 77 Fed. Reg. 5880	82 Fed. Reg. 39160*	02/2012 (Outline)
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – South Atlantic DPS	E – 77 Fed. Reg. 5913	82 Fed. Reg. 39160	02/2012 (Outline)
Giant Manta Ray (*Mobula birostris*)	T – 83 Fed. Reg. 2916	-- --	12/2019 (Outline)
Nassau Grouper (*Epinephelus striatus*)	T – 81 Fed. Reg. 42268	89 Fed. Reg. 126*	08/2018 (Outline)

Species	ESA Status	Critical Habitat	Recovery Plan
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 Fed. Reg. 4153	-- --	07/2024
Shortnose Sturgeon (*Acipenser brevirostrum*)	E – 32 Fed. Reg. 4001	-- --	12/1998
Queen conch (*Aliger gigas*)	T – 89 Fed. Reg. 11208	-- --	-- --
Boulder Star Coral (*Orbicella franksi*)	T – 79 Fed. Reg. 53851	88 Fed. Reg. 54026*	03/2015 (Outline)

E = Endangered; T = Threatened; Fed. Reg = *Federal Register*; DPS = Distinct Population Segment; * = not in the action area

4.1 May Affect, Not Likely to Adversely Affect

Once we have determined the action may affect ESA-listed species or their designated or proposed critical habitat, the next analytical filter in this opinion is to consider whether the action is NLAA for each listed species and critical habitat in the action area. We accomplish this by evaluating individual stressors in the proposed action for each listed species and critical habitat. An action warrants an NLAA finding when its effects are completely beneficial, discountable, or insignificant. Completely beneficial effects have an immediate positive effect without any adverse effects to the species or habitat. Completely beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected, albeit positively. Discountable effects are those that could occur while an ESA-listed species is in the action area but, because of the intensity, magnitude, frequency, duration, or timing of the stressor, exposure to the stressor is extremely unlikely to occur. Insignificant effects relate to the response of exposed individuals where the response, in terms of an individual's growth, survival, or reproduction, would be too small to be measured or undetectable, or an impact to the conservation value of a PBF would be too small to be measured or undetectable. For stressors that meet these criteria for completely beneficial, discountable, or insignificant, the appropriate conclusion is NLAA.

To assist in reaching an NLAA determination if appropriate, we perform a two-step assessment that considers all of the stressors identified in Section 2.3 of this opinion and all of the species and critical habitats identified in Table 4 to understand the likelihood of the stressors having an effect on the ESA-listed species or their designated or proposed critical habitat. First, we consider whether it is likely that a listed species or critical habitat is exposed to a stressor or there is a reasonable expectation of the stressor and an individual or habitat co-occurring. If we conclude that exposure of a species or critical habitat to a stressor caused by the proposed action or activity is discountable, we must also conclude it is NLAA. However, if exposure is probable, the second step is to evaluate the probability of a response to the stressor. Where the negative effects to any species or critical habitat or from any stressor to those species or critical habitat are found to exceed the standards of insignificant or discountable, we must analyze those consequences in the Analysis of Effects.

If all stressors of an action are found to be NLAA for a listed species or a critical habitat, we conclude informal consultation for that particular species or critical habitat. Likewise, if a stressor associated with this action is found to be NLAA for all listed species and all critical habitats, there is no need to continue analyzing the consequences of that stressor in the Analysis of Effects.

4.1.1 Stressors Not Likely to Adversely Affect Species or Critical Habitat

This section identifies the stressors that are NLAA for every ESA-listed species and their designated or proposed critical habitat in the action area and will not be analyzed further in this opinion. These stressors include: pollution, vessel strike, vessel noise and visual disturbance, acoustic noise from the MBES, SBP, ADCP, and OBS pingers, and gear entanglement and interaction. We expect the effects from these stressors to either be discountable or insignificant due to the implementation of standard operating procedures that manage pollution, conservation measures to reduce vessel strike, undetectable or immeasurable effects of other sound sources relative to the airgun array, and rigid equipment preventing entanglement. Section 7.1 in OPR-2023-03396 (NMFS 2024d; pages 30–36) describes in detail how we reached our NLAA determination for these stressors, and our determination remains the same for this consultation.

Use of the gravimeter, magnetometer, and XBTs (not discussed in OPR-2023-03396) may also contribute to stressors such as visual disturbance and gear interaction, for which we determined effects are NLAA (as discussed in Section 7.1 of OPR-2023-03396). The gravimeter is mounted to the R/V; thus, any visual disturbance effects would be similar to those of visual disturbance from the R/V and are insignificant. The magnetometer cable is rigid and is not expected to encircle, wrap around, or in any other way entangle any ESA-listed species considered in this consultation. Thus, the effects are discountable. XBTs are small (generally 0.3 m long) and will be deployed only once a day during seismic operations far offshore. Given the limited number of times XBTs will be deployed, the large seismic survey area, and vast areas over which ESA-listed species occur, the likelihood of an animal encountering an XBT is extremely unlikely. Thus, the effects are discountable.

4.1.2 Species Not Likely to be Adversely Affected

The remaining potential stressor that may affect ESA-listed species within the action area is sound generated by the airgun array. ESA-listed species that are likely to be adversely affected by this stressor are further analyzed and evaluated in Section 6. ESA-listed species that are not likely to be adversely affected by this stressor are evaluated below.

4.1.2.1 North Atlantic Right Whale

North Atlantic right whales are primarily found in the western North Atlantic Ocean, from their calving grounds in lower latitudes off the coast of the southeastern U.S. to their feeding grounds in higher latitudes off the coast of New England and Nova Scotia (Hayes et al. 2018). During fall, North Atlantic right whales migrate south through coastal waters of the U.S. Atlantic (Firestone et al. 2008; Knowlton et al. 2002), to the Southeast U.S. where they calve and nurse overwinter in shallow, coastal waters (Kenney 2009; Krzystan et al. 2018). In the coastal and shelf waters that are adjacent to the seismic survey area, North Atlantic right whales are primarily found in areas that are 25 km or less from shore (Gowan and Ortega-Ortiz 2014). The closest distance from the proposed seismic survey area to the U.S. coast is more than 370 km. No sightings of North Atlantic right whale have been documented within the proposed seismic survey area. Further, the proposed seismic surveys will occur in July–September, when North Atlantic right whales are found in their northern feeding grounds and are not expected to be in southern calving areas off the Southeast U.S., which overlaps the action area (Gowan and Ortega-Ortiz 2014; Roberts et al. 2024). Thus, given North Atlantic right whale seasonality and distribution, it is rare for North Atlantic right whales to occur in the seismic survey area, and it is extremely unlikely that North Atlantic right whales will be exposed to sound from the airgun array. Therefore, the effects are discountable. We conclude that the proposed seismic surveys may affect, but are not likely to adversely affect, North Atlantic right whales.

4.1.2.2 Hawksbill Turtle

Hawksbill sea turtles are considered rare and possibly extralimital in the Northwest Atlantic (Eckert 1995; Lazell 1980; NMFS and USFWS 2013b) and are rarely sighted farther north than the southern tip of Florida (Meylan 2006). Hawksbill turtles have not been sighted, and there are no records of hawksbill turtle bycatch or strandings, in the seismic survey area (Epperly et al. 2002; Epperly et al. 1996; NMFS 2010a; NMFS 2011a; NMFS 2012; NMFS 2013; NMFS 2014; NMFS 2015; NMFS 2016). Thus, given the rarity of hawksbill turtles in the seismic survey area, it is extremely unlikely that hawksbill turtles will be exposed to sound from the airgun array, and the effects are discountable. We conclude that the proposed seismic surveys may affect, but are not likely to adversely affect, hawksbill turtles.

4.1.2.3 Fishes

The Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS of Atlantic sturgeon, giant manta ray, Nassau grouper, oceanic whitetip shark, and shortnose sturgeon may be affected by sound from the airgun array.

Atlantic Sturgeon – Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS

Atlantic sturgeon occur in bays, estuaries, rivers, and the marine environment from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment.

Available data show Atlantic sturgeon use nearshore, shallow marine habitats, generally less than 20 m in depth, though they have been observed in waters 75 m deep (ASMFC 2017; Colette and Klein-MacPhee 2002; Sokolowski et al. 2012; Stein et al. 2004). Off South Carolina, tagged Atlantic sturgeon were detected up to 24 km from shore. The proposed seismic surveys will take place more than 370 km from shore and in water depths over 4,000 m. Thus, given that Atlantic sturgeon are not expected to occur in the seismic survey area, it is extremely unlikely (i.e., discountable) that the Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS of Atlantic sturgeon will be exposed to sound from the airgun array.

Giant Manta Ray

Giant manta rays most commonly occur at productive nearshore and shelf-edge upwelling zones at surface thermal frontal boundaries (Farmer et al. 2022). In the Atlantic Ocean, giant manta rays have been observed along the U.S. eastern seaboard. They can exhibit diel distribution patterns, and may be found in shallow waters (less than 10 m) during the day (Miller 2016), but can also dive down to depths of 200–450 m and may make dives to 1,000 m depth (NMFS 2024b) to forage at night. The proposed seismic surveys will take place more than 370 km from shore and in water depths over 4,000 m. Thus, given the rarity of giant manta rays in the seismic survey area, it is extremely unlikely (i.e., discountable) that giant manta rays will be exposed to sound from the airgun array.

Nassau Grouper

Nassau grouper may occur in the action area near Bermuda, in relatively shallow reefs less than approximately 130 m deep. Because the proposed seismic surveys will take place more than 7 km from the Bermuda EEZ, in water depths ranging from 4,800–5,550 m deep, it is extremely unlikely (i.e., discountable) that Nassau grouper will be exposed to sound from the airgun array.

Oceanic Whitetip Shark

Oceanic whitetip sharks may occur in the action area, as they have a global distribution and are found in epipelagic tropical and subtropical waters. In the Western Atlantic Ocean, they are found from Maine to Argentina, including the Caribbean and Gulf of America/Gulf of Mexico. Oceanic whitetip sharks are typically observed offshore in the open ocean, on the outer continental shelf, or around oceanic islands in deep water (NMFS 2024c). Satellite tagging studies showed oceanic whitetip sharks in the action area (Howey-Jordan et al. 2013; Kohler and Turner 2021). Oceanic whitetip sharks have an inner ear capable of detecting sound and a lateral line capable of detecting water motion (i.e., particle motion) caused by sound (Hastings and Popper 2005; Popper and Schilt 2009). Elasmobranchs, such as oceanic whitetip sharks, are capable of detecting sounds from approximately 20 Hz to 1 kHz (within the range of sound from the airgun array) with the highest sensitivity to sounds at lower ranges (Casper et al. 2012a; Casper and Mann 2009; Casper 2006; Ladich and Fay 2013; Myrberg Jr. 2001; Yan 2003). However, elasmobranchs do not have swim bladders (or any other air-filled cavity), and thus are unable to detect sound pressure (Casper et al. 2012b). Particle motion is presumably the only sound stimulus that can be detected by elasmobranchs and they are not considered particularly sensitive to sound (Casper et al. 2012b).

There have been a limited number of studies examining the direct effects of sound exposure to elasmobranchs: the oceanic silky shark (*Carcharhinus falciformis*) and coastal lemon shark (*Negaprion brevirostris*) have been observed withdrawing from pulsed low-frequency sounds played from an underwater speaker (Klimley and Myrberg 1979; Myrberg et al. 1978); Myrberg (2001) observed that free-ranging sharks were attracted to sounds such as irregular pulsed, broadband frequencies below 80 Hz (resembling struggling fish); and Ryan et al. (2017) observed reductions in foraging (number of times bait was taken) by captive Port Jackson sharks (*Heterodontus portusjacksoni*) and epaulette sharks (*Hemiscyllium ocelltum*), and wild great white sharks (*Carcharodon carcharius*) in response to low-frequency sound and strobe lights.

Popper et al. (2014b) concluded that the relative risk of fishes with no swim bladders exhibiting a behavioral response, or experiencing a recoverable injury, mortal injury, or mortality, to low-frequency active sonar was low, regardless of the distance from the sound source. The authors did not find any data on masking by sonar in fishes, and concluded that if it were to occur, masking will result in a narrow range of frequencies being masked (Popper et al. 2014b).

Therefore, the exact expected response of oceanic whitetip sharks to sound from the airgun array is not completely understood. However, given the available literature and knowledge on elasmobranch hearing/sound detection, the most likely response of oceanic whitetip sharks exposed to seismic survey activities, if any, would be minor temporary changes in their behavior including increased swimming rate, avoidance of the sound source, or changes in orientation to the sound source, none of which are expected to result in fitness consequences or adverse effects to the individual sharks exposed. Therefore, the potential effects of sound from the airgun array on oceanic whitetip sharks are insignificant.

Shortnose Sturgeon

Shortnose sturgeon occur in the rivers, estuaries, and seas along the east coast of North America, from Canada to Florida (Evermann and Bean 1898; Scott and Scott 1988; Vladykov and Greeley 1963). Shortnose sturgeon overwinter in the lower portion of rivers and migrate upriver to spawn in the spring. Shortnose sturgeon transit from freshwater portions of rivers to estuaries and coastal areas, but typically stay nearshore and do not spend as much time in the ocean as Atlantic sturgeon. The proposed seismic surveys will take place more than 370 km from shore and in water depths over 4,000 m. Thus, given that shortnose sturgeon are not expected to occur in the seismic survey area, it is extremely unlikely (i.e., discountable) that shortnose sturgeon will be exposed to sound from the airgun array.

4.1.2.4 Invertebrates

Queen Conch

Queen conch may occur in the action area near Bermuda, in shallow waters less than approximately 30.5 m deep. Because the proposed seismic surveys will take place more than 7 km from the Bermuda EEZ, in water depths ranging from 4,800–5,550 m deep, it is extremely unlikely (i.e., discountable) that queen conch will be exposed to sound from the airgun array.

Boulder Star Coral

Boulder star coral may occur in the action area near Bermuda, in shallow waters less than approximately 90 m deep. Because the proposed seismic surveys will take place more than 7 km from the Bermuda EEZ, in water depths ranging from 4,800–5,550 m deep, it is extremely unlikely (i.e., discountable) that boulder star coral will be exposed to sound from the airgun array.

4.1.3 Critical Habitat Not Likely to be Adversely Affected

PBFs of designated and proposed critical habitat in the action area that may be affected, but are not likely to be adversely affected by the proposed action are listed in Table 5.

Table 5. Physical or Biological Features of designated or proposed critical habitat present in the action area that may be affected by the proposed action

Designated or Proposed Critical Habitat	PBFs
Loggerhead Turtle – Northwest Atlantic Ocean DPS	Currently Designated CH: Northwest Atlantic Ocean DPS range – neritic (nearshore reproductive, foraging) and *Sargassum* habitat Designated CH PBFs: 1. Nearshore Reproductive Habitat – (1) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water 2. Foraging Habitat – (1) Sufficient prey availability and quality, such as benthic invertebrates, including crabs (spider, rock, lady, hermit, blue, horseshoe), mollusks, echinoderms and sea pens 3. *Sargassum* Habitat – (1) *Sargassum* in concentrations that support adequate prey abundance and cover; and (2) Available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and

Designated or Proposed Critical Habitat	**PBFs**
	animals native to the *Sargassum* community such as hydroids and copepods
Atlantic Sturgeon – Carolina DPS	Currently Designated CH: Unit 7 – Santee Rivers, Rediversion Canal, Cooper River, West Cooper River, and Tailrace Canal Designated CH PBFs: Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (1) unimpeded movement of adults to and from spawning sites; (2) seasonal and physiologically depends movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (3) staging, resting, or holding of subadults and spawning condition adults
Atlantic Sturgeon – South Atlantic DPS	Currently Designated CH: Unit 3 – Savannah River, Back River, Middle River, Front River, Little Back River, South River, Steamboat River, McCoy's Cut Designated CH PBFs: Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (1) unimpeded movement of adults to and from spawning sites; (2) seasonal and physiologically depends movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (3) staging, resting, or holding of subadults and spawning condition adults
Green Turtle – North Atlantic DPS	Currently Proposed CH: Atlantic Ocean – surface-pelagic areas from 10 m depth to the outer boundary of the U.S. EEZ, with the exception of areas north of Cape Canaveral, where the nearshore boundary follows the edge of the Gulf Stream Proposed CH PBFs: Surface-pelagic foraging/resting feature: convergence zones, frontal zones, surface-water downwelling areas, the margins of major

Designated or Proposed Critical Habitat	PBFs
	boundary currents, and other areas that result in concentrated components of the *Sargassum*-dominated drift community, as well as the currents which carry turtles to *Sargassum*-dominated drift communities, which provide sufficient food resources and refugia to support the survival, growth, and development of post-hatchlings and surface-pelagic juveniles, and which are located in sufficient water depth (at least 10 m) to ensure offshore transport via ocean currents to areas which meet forage and refugia requirements

CH = critical habitat; PBFs = physical or biological features; DPS = distinct population segment

4.1.3.1 Northwest Atlantic Ocean DPS Loggerhead Turtle Designated Critical Habitat

Designated critical habitat for the Northwest Atlantic Ocean DPS loggerhead turtle may be affected by stressors such as vessel noise and visual disturbance and sound from the airgun array. The PBF related to waters free of artificial lighting may be affected by lighting on the R/V *Langseth*; however, the R/V *Langseth* will be in constant motion, transiting out of the Port of Charleston or Port of Savannah, and will not meaningfully affect this PBF. PBFs related to prey (in foraging habitat and *Sargassum* habitat) may be affected by the R/V *Langseth*, because the R/V may temporarily displace prey for the duration it transits through an area. However, because the R/V *Langseth* will be moving constantly over a large area, it is not expected to measurably affect the availability or abundance of prey. Sound may also affect prey species: McCauley et al. (2017b) found that the use of a single airgun (approximately 150 in^3) led to a decrease in zooplankton abundance by over 50% and a two- to three-fold increase in dead adult and larval zooplankton when compared to control scenarios. Those effects were observed 1.2 km from the source, which was the maximum distance changes could be detected in the study. McCauley et al. (2017b) also noted that for seismic surveys to have a measurable effect on zooplankton at an ecological scale, the spatial or temporal scale of the seismic surveys must be large in comparison to the ecosystem in question in order to outweigh the naturally fast turnover rate of zooplankton (McCauley et al. 2017a). On the other hand, Fields et al. (2019) observed limited effects to copepods in an experiment using two airguns, each with a chamber of 260 in^3. Though the authors observed mortality at distances of 5 m or less from the airguns, they conclude that seismic blasts have limited effects on copepod mortality within 10 m of the source, and no measurable effects at distances greater than 10 m.

Thus, it is difficult to assess the exact impact the airgun array may have on the immediate or long-term survivability of prey species that are exposed. The majority of copepod prey available to loggerhead turtles in *Sargassum* habitat are expected to be near the water's surface (Witherington et al. 2012), but results of McCauley et al. (2017b) provide little information on the effects to copepods at the water's surface because their analyses excluded zooplankton at the surface bubble layer. Nonetheless, given that airguns primarily transmit sound downward, and that those associated with the proposed actions would be towed at a depth of 12 m, we expect that sounds from the airgun array would be relatively low at the water's surface and as such, would affect copepod prey in *Sargassum* habitat less than that reported in McCauley et al. (2017b). The seismic survey activities are less likely to have significant effects on zooplankton given the high turnover rate of zooplankton and the currents in the North Atlantic Ocean gyre and the Gulf Stream, which would circulate *Sargassum* within the action area (see Richardson et al. (2017) for simulations based on the results of McCauley et al. (2017) that suggest ocean circulation greatly reduces the impact of seismic surveys on zooplankton at the population level). Further, the airgun array will not be operational within critical habitat, so sound may travel into critical habitat indirectly, but will not occur directly in critical habitat. Thus, the effects on prey-related PBFs are too small to be measured, and therefore, insignificant.

We conclude that the proposed actions may affect, but are not likely to adversely affect, Northwest Atlantic Ocean DPS loggerhead critical habitat.

4.1.3.2 Carolina DPS and South Atlantic DPS Atlantic Sturgeon Designated Critical Habitat

Designated critical habitat for the Carolina DPS and South Atlantic DPS of Atlantic sturgeon may be affected by vessel noise. Sound was identified as a potential barrier to passage between the river mouth and spawning sites. However, sound from the R/V *Langseth* is not likely to measurably contribute to the overall soundscape, especially in comparison to other commercial and recreational vessel traffic at the Port of Charleston or the Port of Savannah. Additionally, the time that the R/V *Langseth* would be in designated critical habitat would be limited, as it would only be in or adjacent to designated critical habitat when returning to or departing from a port. Thus, any effects to the PBFs of Carolina DPS and South Atlantic DPS Atlantic sturgeon critical habitat would be insignificant. We conclude that the proposed actions may affect, but are not likely to adversely affect, Carolina DPS and South Atlantic DPS Atlantic sturgeon critical habitat.

4.1.3.3 North Atlantic DPS Green Turtle Proposed Critical Habitat

Proposed critical habitat for the North Atlantic DPS of green turtle may be affected by stressors such as vessel noise and visual disturbance and sound from the airgun array. PBFs related to food resources and refugia may be affected by the R/V *Langseth*, because the R/V may temporarily displace prey or refugia for the duration it transits through an area. However, because the R/V *Langseth* will be moving constantly over a large area, it is not expected to measurably affect food resources or refugia to the point where they are not sufficient to support the survival, growth, or development of the species. Sound may also affect food resources, as discussed in the Northwest Atlantic Ocean DPS loggerhead turtle critical habitat section (see Section 4.1.3.1). For the same reasons we determined effects from the proposed action to be insignificant for Northwest Atlantic Ocean DPS loggerhead *Sargassum* habitat, we also determine effects from the proposed action to be insignificant for North Atlantic DPS green turtle proposed critical habitat. We conclude that the proposed actions may affect, but are not likely to adversely affect, North Atlantic DPS green turtle proposed critical habitat.

4.2 Status of the Species for Further Analysis

The remainder of this opinion examines the status of each species with effects caused by the proposed actions that were not discountable or insignificant. The status section establishes the current demography of the species by assessing the abundance, recent trends in abundance, survival rates, life stages present, limiting factors, and sub-lethal or indirect changes in population trends such as inter-breeding period, shifts in distribution or habitat use, and shifts in predator distribution that contribute to the extinction risk that the listed species face. The status of each species below is described in terms of life history, threats, population dynamics, critical habitat, and recovery planning.

The information used in each of these sections is based on parameters considered in documents such as status reviews, recovery plans, and listing decisions and based on the best available scientific and commercial information. This section establishes a reference to the condition of the species' likelihood of both survival and recovery in terms of their "reproduction, numbers, or distribution" as described in 50 CFR §402.02 and informs the environmental baseline (section 5 below) to put the effects of the action in context. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the *Federal Register*, status reviews, recovery plans, and on the NMFS OPR website.

4.2.1 Life History Common to Blue, Fin, Sei, and Sperm Whale

The blue whale, fin whale, sei whale, and sperm whale are widely distributed large whales found in all major oceans. In general, all four whale species migrate seasonally between high latitude feeding and low latitude calving areas. Blue, fin, and sei whales belong to the low-frequency cetacean hearing group (generalized hearing range 7 Hz – 36 kHz), and sperm whales belong to the high-frequency cetacean hearing group (generalized hearing range 150 Hz – 160 kHz; NMFS 2024a).

4.2.2 Threats Common to Blue, Fin, Sei, and Sperm Whale

The primary driver behind the endangered status of blue, fin, sei, and sperm whales is the legacy of commercial whaling. Between the late 19th and mid-20th centuries, hundreds of thousands of these large whales were harvested, depleting populations to a fraction of their pre-exploitation levels. While large-scale commercial whaling has largely ceased, these species remain vulnerable. Fin and sei whales are still subject to limited takes through Japan's commercial program or aboriginal subsistence hunts in Greenland, and Iceland has maintained interest in targeting both species.

In the modern ocean these whales face a suite of shared threats. Vessel strikes and entanglements in fishing gear or marine debris remain leading causes of direct mortality. Furthermore, anthropogenic noise from seismic projects and shipping interferes with their acoustic activity, which is vital for communication and navigation. All four species are threatened by shifts in climate and ecosystems, which may cause habitat loss and reduce the availability of their prey base. Because most population trends remain unknown, it is difficult to gauge how effectively these species can adapt to changing environmental conditions.

4.2.3 Blue Whale

Life History

The average lifespan of blue whales is 80 to 90 years. They have a gestation period of 10–12 months, and calves nurse for 6–7 months. Blue whales reach sexual maturity at about 10 (between five and 15) years of age with an average calving interval of two to three years.

Blue whale vocalizations are characterized by long-duration, low-frequency signals—primarily songs and calls—that typically fall below 100 Hz and can reach source levels up to 195 dB (Aburto et al. 1997; Berchok et al. 2006; Clark and Gagnon 2004b; Cummings and Thompson 1971; Ketten 1998; McDonald et al. 2001; Samaran et al. 2010). While males produce complex, repetitive songs likely for mating and reproductive displays (Edds-Walton 1997; Oleson et al. 2007; Payne and Webb 1971; Thompson et al. 1992b Cummings and Thompson 1971; McDonald et al. 2001), both sexes utilize singular calls for social interaction and contact. Calling rates often fluctuate based on behavior, with increased calling typically observed during migration compared to lower calling rates during deep-dive foraging (Burtenshaw et al. 2004). Vocalizations exhibit significant geographic variability, suggesting distinct regional populations or even subspecies (Stafford et al. 2001); however, a worldwide decline in call frequency has been documented over recent decades (McDonald et al. 2009). There are many theories for this observed call frequency decline in blue whale populations (e.g., sexual selection, increasing ocean noise, increasing whale body size, population density); however, none of the current theories account for all aspects of this frequency shift.

Population Dynamics

There are currently five recognized subspecies of blue whales, *B. m. musculus*, which occurs in the Northern Hemisphere, *B. m. intermedia*, which occurs in the Southern Ocean, *B. m. indica* which occurs in the Northern Indian Ocean, and *B. m. brevicauda*, a pygmy species found in the Indian Ocean and South Pacific Ocean. A recently recognized unnamed subspecies also occurs off Chile and migrates annually to waters off Peru, Ecuador, and the Galapagos Islands (Branch et al. 2007 Hucke-Gaete et al. 2018).

Current global abundance is estimated to be between 10,000 and 25,000 individuals (Cooke 2018; Hayes et al. 2020a). The International Whaling Commission (IWC) recognizes three blue whale stocks that correspond to the three major ocean basins (North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere). In U.S. waters, NMFS recognizes three stocks: the eastern North Pacific Ocean, central North Pacific Ocean, and western North Atlantic Ocean. There is much uncertainty when estimating abundance for the western North Atlantic stock due to low numbers of encountered and photographed individuals; however, researchers believe there may be between 400 to 600 individuals based on the Gulf of St. Lawrence photographic-identification catalog (Hayes et al. 2020a). There are insufficient data to determine population trends for this species (Hayes et al. 2020a).

During the fall and winter, adult and juvenile blue whales from the western North Atlantic population undergo a southward migration from high-latitude feeding grounds, such as the Gulf of St. Lawrence, toward subtropical wintering areas via deep-ocean transit corridors (Davis et al. 2020; Lesage et al. 2017a). Historical blue whale observations collected by Reeves et al. (2004) show a broad longitudinal distribution in tropical and warm temperate latitudes during the winter months, with a narrower, more northerly distribution in summer. This migratory behavior may be driven by ecological memory of historically productive areas, resulting in a broad distribution of individuals across the Mid-Atlantic Bight and southeastern U.S. offshore waters during the fall and winter months (Abrahms et al. 2019; Davis et al. 2020). While migration is often a directed movement, individuals in the North Atlantic may opportunistically suspend transit to forage at mid-latitudes if they encounter high prey densities, indicating that foraging adults may be present throughout deep-water migratory corridors (Silva et al. 2013). Blue whale mating and calving generally occurs between late fall and mid-winter in lower-latitudes of the Northern Hemisphere, which necessitates that pregnant females transit through central Atlantic migratory corridors during the fall.

The seasonal and interannual distribution of blue whales is strongly associated with both the static and dynamic oceanographic features that result in krill aggregations (Benson et al. 2002; Croll et al. 2005; Croll et al. 1998; Del Angel-Rodriguez 2018; Fiedler et al. 1998; Matteson 2009). Blue whales depend on a critical density of prey to feed efficiently, and thus seek out highly productive areas near upwelling zones and thermal fronts where krill abundance is greatest (Doniol-Valcroze et al. 2007). Since krill, the primary prey for blue whales, has relatively limited capacity for horizontal displacement, its distribution is strongly linked to areas of phytoplankton blooms and enhanced biomass retention. Clark and Gagnon (2004a) found that blue whale singers strongly prefer shelf breaks, seamounts, and other highly productive areas throughout the year.

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover blue whale populations. These threats are discussed in further detail in the Environmental Baseline of this consultation. NMFS defines nine blue whale management units in the Revised Recovery Plan (NMFS 2020). The two main objectives for the blue whale for complete downlisting/delisting criteria are:

1. Increase blue whale resiliency and ensure geographic and ecological representation by achieving sufficient and viable populations in all ocean basins and in each recognized subspecies; and
2. Increase blue whale resiliency by managing or eliminating significant anthropogenic threats.

4.2.4 Fin Whale

Life History

Fin whales can live, on average, 80 to 90 years. They have a gestation period of less than one year, and calves nurse for six to seven months. Sexual maturity is reached between six and ten years of age with an average calving interval of two to three years. They mostly inhabit deep, offshore waters of all major oceans. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed, although some fin whales appear to be residential to certain areas (e.g., potentially in the Mediterranean Sea, East China Sea/Sea of Japan, and Gulf of California; (Geijer et al. 2016; Mizroch et al. 2009; Bérubé et al. 2002; Rivera-León et al. 2019). Fin whales eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lance (NMFS 2010b).

Fin whales primarily communicate through low-frequency vocalizations ranging from 10 to 200 Hz (Edds 1988; Thompson et al. 1992a; Thompson et al. 1992b; Watkins 1981; Watkins et al. 1987a; Watkins et al. 1987b), most notably via 20 Hz "pulses" and 40 Hz downsweeps (Charif et al. 2002b; Charif et al. 2002a; Clark et al. 2002b; Clark et al. 2002a; Edds 1988; Garcia et al. 2018; Richardson et al. 1995a; Richardson et al. 1995b; Sirovic et al. 2007b; Sirovic et al. 2007a; Watkins 1981; Watkins et al. 1987a; Watkins et al. 1987b). The 20 Hz pulses are typically produced by males in long, patterned "songs" associated with reproductive displays and breeding seasons; these song variations, such as differences in internote intervals, often serve as indicators of distinct population structures and regional subpopulations (Watkins et al. 1987b Croll et al. 2002; Morano et al. 2012 Delarue et al. 2009; Širović et al. 2017). In contrast, 40 Hz pulses are generally recorded in foraging contexts and correlate with higher prey biomass, similar to feeding calls in other baleen species (Charif et al. 2002b; Charif et al. 2002a; Clark et al. 2002b; Clark et al. 2002a; Croll et al. 2001; Edds 1988; Garcia et al. 2018; Richardson et al. 1995a;

Richardson et al. 1995b; Romagosa et al. 2021; Sirovic et al. 2007b; Sirovic et al. 2007a; Watkins 1981; Watkins et al. 1987a; Watkins et al. 1987b).

Population Dynamics

There are currently three recognized subspecies, *B. p. physalus* in the North Atlantic Ocean, *B. p. velifera* in the North Pacific Ocean, and *B. p. quoyi* in the Southern Hemisphere. There are over 100,000 fin whales worldwide, occurring primarily in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere where they appear to be reproductively isolated. NMFS currently manages four stocks: Western North Atlantic, Northeast Pacific, California/Oregon/Washington, and Hawaii. The current population abundance estimate for the Western North Atlantic stock is 6,802 individuals (CV=0.24), and minimum population estimate (N_{min}) is 5,573 individuals (Hayes et al. 2022). Population trends for the Western North Atlantic are not currently available.

Fin whales generally undertake annual migrations from low-latitude wintering grounds to high latitude feeding grounds, except for apparent resident populations in the Mediterranean Sea, East China Sea/Sea of Japan, and Gulf of California, as mentioned previously. Off the U.S. East Coast distribution and movement is largely driven by prey availability, particularly of sand lance (NMFS 2010b). On feeding grounds in the Antarctic, fin whale 'hotspots' were observed where there were currents and eddys associated with krill aggregations. In the North Atlantic Ocean, fin whales may temporarily suspend their migration and forage in 'hot spots' around the Mid-Atlantic Bight (NMFS 2019).

Fin whales are most frequently sighted off North Carolina during winter, with some sightings also reported for spring (Conley et al. 2017). There is a single sighting record for the U.S. Navy's Cherry Point Operating Area, which was reported during winter, and numerous strandings have been reported during the winter (DoN 2008b; DoN 2008c). One sighting has been made during NMFS Northeast Fisheries Science Center and Southeast Fisheries Science Center summer surveys off North Carolina (Hayes et al. 2022). Fin whales have been detected acoustically off North Carolina during all seasons, with the greatest number of detections during winter; there were no detections south of Cape Hatteras, North Carolina during summer (May through July; Davis et al. 2020; Palka et al. 2021). Fin whales were also acoustically detected year-round off Virginia (Davis et al. 2020). There are numerous records of fin whales off Norfolk, Virginia to the seismic survey area.

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover fin whale populations. These threats are discussed in further detail in the Environmental Baseline of this consultation. See the 2010 Final Recovery Plan for the fin whale (NMFS 2010d) for complete downlisting/delisting criteria for both of the following recovery goals:

1. Achieve sufficient and viable population in all ocean basins; and
2. Ensure significant threats are addressed.

4.2.5 Sei Whale

Life History

Sei whales lifespan is about 60 years (Wiles 2017). They have a gestation period of approximately 10.5 months, calves nurse for six to nine months, and the average calving interval is two to three years. Sexual maturity is thought to be reached between eight and ten years of age; however, a more recent study on age determination, based on growth layers in earplugs, of sei whales in the western North Pacific Ocean found that age at sexual maturity was 6.7 for males, and 6.9 for females (Bando and Maeda 2020).

While research into the vocal repertoire of sei whales remains limited compared to other baleen species, recent passive acoustic monitoring (PAM) in the western North Atlantic has clarified that their primary vocalization is the downsweep. Characterized as a continuous frequency modulation typically descending from 82 to 34 Hz over approximately 1.4 to 1.6 seconds, these calls often occur in unique patterns of singlets, doublets, or triplets. In regions ranging from Atlantic Canada to the New York Bight and southern New England, sei whales exhibit a consistent year-round presence with a distinct peak in acoustic activity during spring (March–May), which likely corresponds to seasonal migrations (Jasinski et al. 2025; Papadopoulos et al. 2026).

Population Dynamics

Two subspecies of sei whale are recognized, *B. b. borealis* in the Northern Hemisphere and *B. b. schlegellii* in the Southern Hemisphere. Though there are no current estimates of global abundance for sei whales, Wiles (2017) provides a rough estimate of 250,000 sei whales pre-whaling to 32,000 sei whales during the 1970s and 1980s. There are no estimates of pre-exploitation abundance for the North Atlantic Ocean. Three relatively small stocks occur in U.S. waters: Nova Scotia, Hawaii, and the Eastern North Pacific Ocean. The Nova Scotia stock (Halifax, Nova Scotia to Florida) population is estimated at 6,292 individuals (CV=1.02; N_{min}=3,098 individuals) from surveys conducted in the spring from 2010 through 2013 (March through May, when sei whale density is predicted to be highest; Hayes et al. 2022). Population growth rates for sei whales are not available at this time as there are little to no systematic survey efforts to study sei whales.

Sei whales generally undertake seasonal migrations, from low-latitude winter breeding grounds, where they calve and nurse, to high-latitude summer foraging grounds, where they feed on a range of prey types including plankton (copepods and krill), small schooling fishes, and cephalopods. However, winter breeding areas are currently unknown and feeding areas can change substantially between years and seasons. Sei whales are mainly seen offshore, where they mostly inhabit waters in deep ocean basins or along the continental shelf and slope far from the coastline.

Sei whales have been detected acoustically off North Carolina and Virginia mainly during winter. A few detections were recorded off North Carolina and Virginia during summer and fall (Davis et al. 2020; Palka et al. 2021). Passive acoustic monitoring conducted along the U.S. East Coast in 2015 through 2016 reported acoustic detections of sei whales through the late fall and winter from Cape Hatteras, North Carolina, to the Blake Plateau (Cholewiak et al. 2018). No sightings of sei whales have been made during summer surveys conducted by NMFS Northeast Fisheries Science Center and Southeast Fisheries Science Center (Hayes et al. 2022). In the Ocean Biodiversity Information System (OBIS) database, there are less than ten sightings of sei whales from Norfolk, Virginia to the seismic survey area, and of those ten sightings, three sightings occur in the seismic survey area, which were recorded in January through February.

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover sei whale populations. These threats are discussed in further detail in the Environmental Baseline of this consultation. See the 2011 Final Recovery Plan for the sei whale (NMFS 2011b) for complete downlisting/delisting criteria for both of the following recovery goals:

1. Achieve sufficient and viable populations in all ocean basins; and
2. Ensure significant threats are addressed.

4.2.6 Sperm Whale

Life History

The average lifespan of sperm whales is estimated to be at least 50 years (Whitehead 2009). They have a gestation period ranging from 15 months to more than one and a half years, and calves nurse for approximately two years, though they may begin to forage for themselves within the first year of life (Tønnesen et al. 2018). Sexual maturity is reached between seven and 13 years of age for females with an average calving interval of four to six years, though females over 40 years of age rarely become pregnant. Male sperm whales reach full sexual maturity around age 20, after which they undergo a second growth spurt, reaching full physical maturity at around age 40 (Mizroch and Rice 2013).

Sound production and reception by sperm whales are among the best understood in cetaceans, characterized by a diverse repertoire including clicks, codas, creaks, and squeals. These whales primarily produce repetitive broadband clicks ranging from below 100 Hz to over 30 kHz, with source levels reaching 236 dB re 1 µPa at 1 m. (Goold and Jones 1995a; Goold and Jones 1995b; Mohl et al. 2003b; Mohl et al. 2003a; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997b; Weilgart and Whitehead 1997a). While repetitive clicks enable echolocation, unique coda patterns define distinct "vocal clans" and geographic dialects, suggesting cultural transmission through parent-offspring learning (Rendell and Whitehead 2003; Watkins and Schevill 1977; Weilgart and Whitehead 1993). Vocalizations in neonates are significantly lower in frequency and less directional than those of adults, highlighting a developmental shift as they adapt to their specialized roles as deep-diving predators (Madsen et al. 2003).

Population Dynamics

The sperm whale is the most abundant of the large whale species. The current global sperm whale population abundance estimate is about 850,000 individuals (Whitehead and Shin 2022). There are six recognized sperm whale stocks in U.S. waters: Puerto Rico and the U.S. Virgin Islands, Northern Gulf of Mexico, North Atlantic, North Pacific, California/Oregon/Washington, and Hawaii. There are no reliable estimates for sperm whale abundance across the entire North Atlantic Ocean. The best abundance estimate for the North Atlantic stock, based on 2021 survey data from Central Florida to the lower Bay of Funday is 5,895 (CV=0.29; Hayes et al. 2023). No trend analysis has been conducted for the North Atlantic stock.

Sperm whale females and juveniles form stable social units while breeding males move among these units. Population structure is largely driven by female site fidelity. Sperm whales mostly inhabit areas with a water depth of 600 m or more, and are uncommon in waters less than 300 m deep. However, if there are shelf breaks or submarine canyons close to land, sperm whales can occur there. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed primarily on squid; other prey includes octopus and demersal fish (including teleosts and elasmobranchs).

Sperm whales appear to have a well-defined seasonal cycle in the Northwest Atlantic Ocean (CETAP 1982; Stanistreet et al. 2018). In winter, most historical records are in waters east and northeast of Cape Hatteras, North Carolina, with few animals north of 40°N; in spring, they shift the center of their distribution northward to areas east of Delaware and Virginia, but they are widespread throughout the central area of the Mid-Atlantic Bight and southern tip of Georges Bank (DoN 2005; Hayes et al. 2020b). During summer, they expand their spring distribution to include areas east and north of Georges Bank, the Northeast Channel, and the continental shelf south of New England (Hayes et al. 2020b). By fall, sperm whales are most common south of New England on the continental shelf but also along the shelf edge in the MidAtlantic Bight (DoN 2005; Hayes et al. 2020b). Numerous sightings have been made off North Carolina, including in the action area, during NMFS Northeast Fisheries Science Center and Southeast

Fisheries Science Center summer surveys (Hayes et al. 2020b). DoN (2008b) and DoN (2008c) also reported sperm whale sightings in the northern portion of the seismic survey area from winter through spring, and (Conley et al. 2017) reported sperm whales in the northern portion of the survey area during summer. Four sightings were made between September 16 through October 18, 2014 during an L-DEO seismic survey that overlapped the seismic survey area (RPS 2015). Acoustic detections have also been made off North Carolina and Virginia during most of the year; however, the months of May through July have not been monitored (Stanistreet et al. 2018).

Critical Habitat

Critical habitat has not been designated for this species.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover sperm whale populations. These threats would be discussed in further detail in the Environmental Baseline of this consultation. See the 2010 Final Recovery Plan for the sperm whale (NMFS 2010e) for complete downlisting/delisting criteria for both of the following recovery goals:

1. Achieve sufficient and viable populations in all ocean basins; and
2. Ensure significant threats are addressed.

4.2.7 Life History Common to Green, Kemp's Ridley, Leatherback, and Loggerhead Turtles

Green, Kemp's ridley, leatherback, and loggerhead turtles share a general life history pattern. Females lay their eggs on coastal beaches where the eggs incubate in sandy nests. After embryonic development, the hatchlings emerge and swim offshore into deeper, oceanic waters where they feed and grow until returning at a larger size. Mating occurs in waters off nesting beaches.

Sea turtles are low-frequency hearing specialists, generally perceiving sounds between 30 Hz and 2 kHz, with peak sensitivity typically concentrated between 100–800 Hz (Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). A recent study of green, Kemp's ridley, and loggerhead turtles suggest their greatest hearing sensitivity occurs from approximately 100–400 Hz, followed by a decrease in sensitivity somewhere between 400–600 Hz, and lowest sensitivity above 1,000 Hz (Muirhead et al. 2025).

4.2.8 Threats Common to Green, Kemp's Ridley, Leatherback, and Loggerhead Turtles

Green, Kemp's ridley, leatherback, and loggerhead sea turtles face a suite of shared anthropogenic and environmental threats that may compromise their survival across all life stages. Historically, over-exploitation for food and products, particularly through egg harvesting and the hunting of nesting females, drove significant population declines. While legal protections have mitigated some direct take, these species remain highly vulnerable to incidental bycatch in commercial fisheries (e.g., long-lines, gillnets, and trawls), vessel strikes in high-traffic corridors, and the ingestion or entanglement in marine debris and "ghost" fishing gear. Furthermore, habitat degradation continues to threaten recovery; coastal development, beachfront lighting, and shoreline stabilization disrupt nesting behaviors and hatchling orientation, while changing environmental conditions pose long-term risks by altering sex ratios through increased nest temperatures and reducing available habitat via sea-level rise and intensified storm events.

4.2.9 Green Turtle – North Atlantic DPS

Life History

Green turtles reach sexual maturity between 20 and 50 years of age (Chaloupka and Musick 1997; Hirth and USFWS 1997), at which point females begin a migratory cycle to return to their natal beaches every two to five years. During the nesting season, which typically peaks between June and July in the southeastern U.S. (Witherington and Ehrhart 1989), females deposit an average of three to four clutches (Johnson and Ehrhart 1996) of approximately 110 eggs into sandy nests, where they incubate for about two months. Once emerged, hatchlings enter a poorly understood pelagic phase (NMFS and USFWS 2007), feeding near the surface on algae and debris before transitioning to a more herbivorous diet of seagrass as they mature (Rebel 1974).

Sea turtles are low-frequency hearing specialists. Specifically, juvenile green turtles exhibit a hearing range of approximately 50 Hz to 1.6 kHz, with their greatest auditory response occurring between 200–400 Hz (Piniak et al. 2016). Studies of free-ranging juveniles have identified four distinct categories of vocalizations including pulses, croaks, rumbles, and frequency-modulated calls that largely align with their sensitive hearing range, though some high-pitched "squeaks" can exceed 3 kHz (Charrier et al. 2022).

Population Dynamics

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries (Hirth and USFWS 1997). The North Atlantic DPS of green turtles maintains a vast geographical range extending from Canada to South America and across to Europe and Africa, with primary nesting concentrated in Costa Rica, Mexico, Cuba, and Florida. In the continental U.S., green turtle nesting occurs along the coast of the Atlantic Ocean, primarily along the central and southeast coast of Florida where an estimated 200 to 1,100 females nest each year (Meylan et al. 1994; Weishampel et al. 2003). Occasional nesting has also been documented along the Gulf Coast of Florida, Georgia, North Carolina, and Texas (Meylan et al. 1995). A recent study modeled the mean annual abundance for the U.S. East Coast at 63,674 green turtles (90% Confidence Interval [CI] = 23,381–117,610 green turtles; DiMatteo et al. 2024).

Compared to other DPSs, the North Atlantic DPS of green turtle exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites. The largest nesting site in the North Atlantic DPS of green turtle is in Tortuguero, Costa Rica (on the Caribbean Sea coast), which hosts 79% of nesting females for the North Atlantic DPS (Seminoff et al. 2015). While global standardized monitoring remains inconsistent, localized data shows significant annual growth rates (Chaloupka et al. 2008). Apparent increases in nester abundance for the North Atlantic DPS of green turtle in recent years are encouraging, but must be viewed cautiously, as the datasets represent a fraction of green turtle generation, up to 50 years.

As adults, these turtles exhibit strong site fidelity (Hart et al. 2013; McMichael et al. 2003), living primarily in nearshore tropical waters and coastal foraging grounds while migrating thousands of kilometers between their feeding areas and protected nesting sites. While adult sightings in deeper seismic survey areas are relatively rare, recent satellite tagging and dispersal modeling suggest that young turtles (ages 0.5 to 3.5 years) frequently inhabit the Gulf Stream and the Sargasso Sea (Putman et al. 2020; Mansfield et al. 2021), often congregating off the coast of North Carolina during warmer months. These findings indicate that green turtle presence in offshore Atlantic waters may be higher than traditional observational data suggests, particularly for younger age classes that rely on oceanic currents and drift lines before transitioning to coastal benthic feeding areas.

Critical Habitat

North Atlantic DPS green turtle proposed critical habitat was found to be NLAA (section 4.1.3.3) and is not considered further in this opinion.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover green turtle populations. These threats will be discussed in further detail in the Environmental Baseline of this consultation. See the 1998 and 1991 recovery plans for the Pacific, East Pacific, and Atlantic populations of green turtles for complete down-listing/delisting criteria for recovery goals for the species (NMFS 1991). Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics. The following items were identified as major priorities to recover green turtles in the Atlantic Ocean:

1. Provide long-term protection to important nesting beaches;
2. Ensure at least 60% hatch success on major nesting beaches;
3. Implement effective lighting ordinances or lighting plans on nesting beaches;
4. Determine distribution and seasonal movements for all life stages in the marine environment;
5. Minimize mortality from commercial fisheries; and
6. Reduce threat to pollution and foraging habitat from marine pollution.

4.2.10 Kemp's Ridley Turtle

Life History

The Kemp's ridley turtle is considered to be the most endangered sea turtle, internationally (Groombridge 1982; Zwinenberg 1977). The Kemp's ridley turtle occurs from the Gulf of America and Gulf of Mexico, along the Atlantic coast of the U.S., with nesting beaches limited to a few sites in Mexico and Texas (TEWG 2000).

Kemp's ridley turtles typically return to nearshore coastal habitats around two years of age (Ogren 1989), although the time spent in the oceanic habitat may vary from one to four years or perhaps more (TEWG 2000). Females generally reach sexual maturity at an average of 12 years. They are known for their massive "arribada" nesting events, which occur primarily between April and July on Gulf of Mexico beaches like Rancho Nuevo, though nesting has increasingly been documented along the U.S. Atlantic coast. Females lay an average of 2.5 clutches per season, producing roughly 100 eggs per nest, after which hatchlings migrate to oceanic waters before returning to shallow, muddy-bottomed coastal habitats as adults. These adults exhibit seasonal movement patterns, foraging on a diet of crabs, fish, jellyfish, tunicates and mollusks (NMFS and USFWS 2011) in waters usually less than 37 m deep while migrating to deeper offshore areas as temperatures drop in the winter.

Sea turtles are low-frequency hearing specialists. Specific studies on juvenile Kemp's ridley turtles further highlight this narrow specialization, showing a functional range of 100 to 500 Hz and a maximum sensitivity concentrated at the lower end between 100 and 200 Hz (Bartol and Ketten 2006). However, a more recent study on juvenile Kemp's ridley turtles showed a hearing range between 50–800 Hz. Peak hearing sensitivity occurred between 200–300 Hz, followed by a decline in sensitivity above 400 Hz (Muirhead et al. 2026).

Population Dynamics

The Kemp's ridley turtle remains the most endangered sea turtle species, having faced a dramatic population collapse from 40,000 nesting females in 1947 to just 300 by the mid-1980s. While conservation efforts led to a steady recovery and record nesting highs in 2012 (NPS 2013), recent years have seen significant and unexplained fluctuations (NMFS and USFWS 2015). Nest counts in Mexico dropped sharply in 2010 and 2013, falling well below previous recovery predictions (Caillouet et al. 2018; Gallaway et al. 2016a; Gallaway et al. 2016b; NMFS and USFWS 2015; Plotkin 2016). A recent study modeled the mean annual abundance for the U.S. East Coast at 10,762 Kemp's ridley turtles (90% CI = 2,620–19,443 Kemp's ridley turtles; DiMatteo et al. 2024).

As adults, most Kemps' ridley turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS and USFWS 2011). Carried by oceanic currents, young Kemp's ridley turtles, some as young as 1.5 years, often aggregate in the shallow shelf waters off

North Carolina and as far north as Cape Cod during the summer months (Danton and Prescott. 1988; Frazier et al. 2007; Morreale et al. 1989; Musick et al. 1994).

Satellite tagging and sighting models indicate that these turtles migrate seasonally to avoid cold water, moving into deeper or more southern offshore waters during the winter. This migratory behavior and the presence of younger age classes in oceanic currents suggest a wider distribution than traditional coastal sightings might imply.

Critical Habitat

No critical habitat has been designated for Kemp's ridley turtles.

Recovery Planning

In response to current threats facing the species, NMFS developed goals to recover Kemp's ridley turtle populations. These threats will be discussed in further detail in the Environmental Baseline of this consultation. See the 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's ridley turtles for complete down listing/delisting criteria for each of their respective recovery goals (NMFS and USFWS 2011). The following items were identified as priorities to recover Kemp's ridley turtles:

1. Protect and manage nesting and marine habitats;
2. Protect and manage populations on the nesting beaches and in the marine environment;
3. Maintain a stranding network;
4. Manage captive stocks;
5. Sustain education and partnership programs;
6. Maintain, promote awareness of and expand U.S. and Mexican laws;
7. Implement international agreements; and
8. Enforce laws.

4.2.11 Leatherback Turtle

Life History

The leatherback turtle ranges from tropical to subpolar latitudes, worldwide, and occurs from nearshore habitats to oceanic environments (Shoop and Kenney 1992). Longevity data are limited, but leatherbacks are estimated to live up to 90 years, the longest lifespan among sea turtle species (Mayne et al. 2020). Age at maturity has been difficult to ascertain, with estimates ranging from 12 to 29 years (Avens et al. 2009; Dutton et al. 2005; Girondot et al. 2021; Jones et al. 2011; Piboon et al. 2025; Spotila et al. 1996). Recent research shows that leatherback turtles need a specific balance of food and warmth to reach adulthood, finding that even a small 5% drop in food can prevent them from maturing or lead to smaller body sizes and lower energy levels (Ortega et al. 2026).

Unlike other sea turtles, leatherbacks possess specialized adaptations, including a thick layer of insulating fat (Davenport et al. 1990; Goff and Lien 1988), a countercurrent circulatory system

(Greer et al. 1973), and the ability to generate metabolic heat through gigantothermy (Paladino et al. 1990), that allow them to thrive in frigid northern waters. These traits support an incredibly high-energy lifestyle; leatherbacks migrate up to 10,000 km annually to hunt nutrient-poor, gelatinous prey like jellyfish (Benson et al. 2007; Benson et al. 2011b; Eckert 2006; Eckert et al. 2006).

Piniak (2012) measured hearing of leatherback turtle hatchlings in water and in air, and observed reactions to low-frequency sounds, with responses to stimuli occurring between 50 Hz and 1.6 kHz in air between 50 Hz and 1.2 kHz in water (lowest sensitivity recorded was 93 dB re 1 μPa at 300 Hz).

Population Dynamics

Leatherback turtles are globally distributed across the Atlantic, Indian, and Pacific Oceans, organized into seven major regional management units (Wallace et al. 2010a). In the Atlantic Ocean, they are found as far north as the North Sea, Barents Sea, Newfoundland, and Labrador, and as far south as Argentina and the Cape of Good Hope, South Africa (NMFS and USFWS 2013a). In the U.S., important nesting areas include Florida, St. Croix, and Puerto Rico. Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey (Benson et al. 2011a). While leatherback turtles will look for food in coastal waters, they appear to prefer the open ocean at all life stages (Heppell et al. 2003). While adults often return to specific foraging areas after nesting (Seminoff et al. 2012), individuals from different nesting beaches frequently converge in the same productive waters, creating a mosaic of overlapping populations. These migrations are largely driven by ocean currents that facilitate both the dispersal of hatchlings and the transoceanic travels of adults as they move between equatorial nesting sites and temperate high-latitude feeding grounds (Gaspar et al. 2012).

Despite their vast range, many leatherback populations are facing critical declines. While the Northwest Atlantic holds the largest remaining abundance with over 20,000 nesting females, even this population has shown a steady, pronounced decline over the last decade. The total index of nesting female abundance in the Northwest Atlantic Ocean is 20,659 females (NMFS and USFWS 2020). Leatherback turtles in the Northwest Atlantic Ocean exhibited a decreasing nest trend at nesting beaches with the greatest known nesting female abundance. This decline has become more pronounced between 2008–2017 and the available nest data reflect a steady decline for more than a decade (Eckert and Mitchell 2018). The situation is even more dire in the Pacific, where nesting in Mexico plummeted from 70,000 females in the 1980s to fewer than 250 by the late 1990s, and the Malaysian population is now considered functionally extinct. Only the Southwest Atlantic population has shown a recent increase, highlighting the inconsistent recovery across different ocean basins. A recent study modeled the mean abundance for the U.S. East Coast at 21,984 leatherback turtles (90% CI = 10,049–33,600 leatherback turtles; DiMatteo et al. 2024).

In the waters off the U.S. East Coast, leatherbacks are frequent seasonal visitors, particularly during the summer months. Data from satellite tagging and aerial surveys confirm that these turtles, including juveniles as young as two years old, regularly move through shelf and offshore waters. Specifically, tracking data and sighting models show that leatherbacks utilize the waters off North Carolina for both foraging and migratory transit, placing them in areas where they may overlap with human activities like seismic surveys.

Critical Habitat

Designated critical habitat for leatherback turtles is outside the action area and is not considered in this opinion.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover leatherback turtle populations. These threats will be discussed in further detail in the Environmental Baseline of this consultation. See the 1998 and 1991 Recovery Plans (NMFS 1998) for the U.S Pacific and U.S. Caribbean, Gulf of Mexico, and Atlantic leatherback turtles for complete downlisting/delisting criteria for each of their respective recovery goals. The following items were the top five recovery actions identified to support in the Leatherback Five Year Action Plan:

1. Reduce fisheries interactions;
2. Improve nesting beach protection and increase reproductive output;
3. International cooperation;
4. Monitoring and research; and
5. Public engagement.

4.2.12 Loggerhead Turtle – Northwest Atlantic Ocean DPS

Life History

Loggerhead turtles are a circumglobal species that relies on a complex variety of terrestrial, oceanic, and coastal ecosystems. They reach sexual maturity between 20 and 38 years of age (Frazer and Ehrhart 1985; NMFS 2001). For the Northwest Atlantic Ocean DPS of loggerhead turtles, most nesting occurs along the U.S. East Coast, from southern Virginia to Alabama. Females typically lay four clutches (Murphy and Hopkins 1984) of roughly 100 to 126 eggs per season (Dodd 1988). The incubation temperature of the sand plays a critical role in the life cycle by determining the sex of the hatchlings, which eventually emerge to begin a multi-stage migration through the Atlantic.

The life history of the loggerhead is defined by a shift in habitat and diet. Post-hatchlings enter an "oceanic juvenile" phase, often associating with *Sargassum* mats in the open ocean (Carr 1986; Conant et al. 2009; Witherington 2002) for up to 12 years (Bolten et al. 1998). As they grow, they transition to coastal "neritic" zones, where they become benthic foragers, preying on crabs and mollusks. While juveniles frequently inhabit enclosed estuaries, adults tend to prefer shelf waters with greater access to the open ocean.

Population Dynamics

A recent study modeled the mean annual abundance for the U.S. East Coast at 193,423 loggerhead turtles (90% CI = 159,158–227,668 loggerhead turtles; DiMatteo et al. 2024). Scientists rely heavily on annual U.S. nest counts, which currently exceed 110,000 for the Northwest Atlantic DPS, as the primary indicator of population health (NMFS and USFWS 2023b). While large-scale in-water estimates are rare, a preliminary 2010 survey suggested a regional abundance of roughly 588,000 individuals along the continental shelf from Florida to Canada (NMFS 2011c).

The annual rate of increase for the Northern Recovery Unit, based on nesting females and measured over the period from 1983–2019, is positive 1.3% (p=0.04; Bolten et al. 2019; NMFS and USFWS 2023a). There is no significant trend in the annual number of nesting females in either the Peninsular Florida (1989–2018) or Northern Gulf of Mexico (1997–2018) Recovery units over the last several decades (NMFS and USFWS 2023a). Lasala et al. (2023) reported a significant increase in loggerhead nest counts and hatchling production from 1982 to 2021 based on data covering a 50.9 km stretch of Florida's Gulf of America coastline (Sarasota County). Similarly, McNally et al. (2024) reported a significant increase in loggerhead nest counts in Pinellas County from 1990 to 2022. While these data indicate a positive trend for at least some nesting beaches within the Peninsular Florida recovery unit, the total nesting count in the Gulf of America annually accounts for only 7% of all loggerhead nesting in Florida (Lasala et al. 2023). The Dry Tortugas Recovery Unit includes all islands west of Key West, while the Greater Caribbean Recovery Unit encompasses nesting sub-populations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. Data are insufficient to estimate trends in nesting females for either the Dry Tortugas or the Greater Caribbean recovery units. Overall, the latest five-year status review concluded that the DPS as a whole demonstrates a stable (neither increasing nor decreasing) population trend (NMFS and USFWS 2023a).

In-water research further illuminates these dynamics, suggesting that while the abundance of larger neritic juveniles may be steady or increasing, there has been a concerning decrease in the smallest juvenile classes. Off the coast of North Carolina, loggerheads are the most frequently sighted sea turtle species, utilizing the continental shelf as a critical migratory and overwintering corridor. Satellite tracking confirms these turtles exhibit strong seasonal movements, often shifting south of Cape Hatteras to avoid temperatures below 20°C and frequently overlapping with areas designated for seismic surveys and commercial fishing (DoN 2008a; DoN 2008b; Palka et al. 2021; SWOT 2022).

Critical Habitat

Northwest Atlantic Ocean DPS loggerhead turtle designated critical habitat was found to be NLAA (section 4.1.3.1) and is not considered further in this opinion.

Recovery Planning

In response to the current threats facing the species, NMFS developed goals to recover loggerhead turtle populations. These threats will be discussed in further detail in the Environmental Baseline of this consultation. See the 2009 Final Recovery Plan for the Northwest Atlantic Population of loggerhead turtles for complete down-listing/delisting criteria for each of the following recovery objectives (NMFS 2008).

1. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females;
2. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes;
3. Manage sufficient nesting beach habitat to ensure successful nesting;
4. Manage sufficient feeding, migratory, and inter-nesting marine habitats to ensure successful growth and reproduction;
5. Eliminate legal harvest;
6. Implement scientifically based nest management plans;
7. Minimize nest predation;
8. Recognize and respond to mass/unusual mortality or disease events appropriately;
9. Develop and implement local, state, Federal, and international legislation to ensure long-term protection of loggerheads and their terrestrial and marine habitats;
10. Minimize bycatch in domestic and international commercial and artisanal fisheries;
11. Minimize trophic changes from fishery harvest and habitat alteration;
12. Minimize marine debris ingestion and entanglement; and
13. Minimize vessel strike mortality.

4.3 Effects of Changing Environmental Conditions on ESA-Listed Species and Critical Habitat

There is a large and growing body of literature on past, present, and future impacts of global environmental changes driven by elevated greenhouse gas emissions. The average temperature on land and in the ocean has continued to rise over the last 150 years (IPCC 2023). The average global surface temperature was 1.09°C higher from 2011 to 2020 than from 1850 to 1906, with larger increases over land (1.59°C) than over the ocean (0.88°C; IPCC 2023). Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years, and 2024 was the hottest year on record. Warming greater than the global average has already been experienced in many regions and seasons, with most land regions experiencing greater warming than over the ocean (Allen et al. 2018). In the continental U.S., annual average temperatures have increased by 1.8°C since the beginning of the 20th century, and warming is increasing around 60% faster than the global average since 1970 (Jay et al. 2018; Marvel et al. 2023; USGCRP 2023). Global environmental change has led to more frequent heatwaves in most land regions and an increase in the frequency and duration of marine heatwaves. Average global warming up to 1.5°C as compared to pre-industrial levels is expected to lead to regional changes in extreme temperatures, and increases in the frequency and intensity of precipitation and drought (USGCRP 2023).

This warming has triggered many changes in the earth's environmental conditions, with numerous independent lines of evidence documenting these changes occurring from the atmosphere to the ocean to the poles. This warming, primarily in response to human activities, is causing widespread effects in the physical environment (Wuebbles et al. 2017). Changing environmental conditions have led to increased frequency, severity, and magnitude of severe weather events like storms and hurricanes, which have resulted in greater storm damage and erosion in coastal areas. Additionally, environmental changes are also causing sea level rise, changes in air and water temperatures, and changes in precipitation patterns, all of which are likely to impact marine ecosystems and ESA-listed species and their habitats. NOAA's climate information portal provides basic and updated background information on these and other measured or anticipated effects of changing environmental conditions.

Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred and changing environmental conditions are already affecting many weather and climate extremes in every region across the globe (IPCC 2023). These effects are especially well-documented in the ocean and coastal regions. Between 1993 and 2019, consistent and pronounced warming has been observed across the global oceans, especially associated with key boundary currents (Johnson et al. 2020). Global mean sea level increased by 0.20 m between 1901 and 2018, and the average rate of sea level rise has increased from 1.3 millimeters per year between 1901 and 1971 to 3.7 millimeters per year between 2006 and 2018. In the U.S., coastal sea levels are predicted to rise 28 cm between 2020 and 2050, leading to greater probability of flooding (USGCRP 2023).

The Atlantic Ocean, particularly the North Atlantic, is warming significantly faster than most other ocean basins, second only to the Southern Ocean, and is projected to continue to experience substantial warming in the upper 2,000 m even under conservative emissions scenarios (Cheng et al. 2022). On average, the general warming trend in the North Atlantic Ocean over the last 80 years is 0.031±0.0006 °C per decade in the upper 2,000 m (6,561.7 ft) of the ocean (Polyakov et al. 2009).

Through physical and biological interactions between the atmosphere and ocean, changing environmental conditions are significantly altering marine life and ecosystems, and have the potential to impact species abundance, geographic distribution, migration patterns, susceptibility to disease and contaminants, and the timing of seasonal activities and community composition and structure (Evans and Bjørge 2013; IPCC 2014; Kintisch 2006; Learmonth et al. 2006; MacLeod et al. 2005; McMahon and Hays 2006; Robinson et al. 2005; USGCRP 2023). Recent peer-reviewed research shows that long-term warming and changes in ocean circulation have altered the migration timing of marine species (Langan et al. 2021).

These changes in species distributions and community structure could potentially affect ESA-listed species. Though predicting the precise consequences of changing environmental conditions on highly mobile marine species is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring. Marine mammal species with restricted geographical distributions and habitat tolerances will have limited opportunities to adapt to the changing conditions of their environment. Macleod (2009) estimated, based upon expected shifts in water temperature, 88% of marine mammals will be affected by changing environmental conditions, with 47% predicted to experience unfavorable conditions (e.g., range contraction). Marine mammals rely on stable environments where prey availability is relatively predictable (Lettrich et al. 2023). Changes in the marine ecosystems caused by large-scale environmental changes could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, and forage fish), ultimately affecting primary foraging areas of ESA-listed species including marine mammals, sea turtles, and fish. For example, as feeding specialists, blue whales are likely to change their distribution in response to changes in the distribution of their prey (Clapham et al. 1999; Payne et al. 1986; Payne et al. 1990). Pecl and Jackson (2008) predicted changing environmental conditions will likely result in squid that hatch out smaller and earlier, undergo faster growth over shorter lifespans, and mature younger at a smaller size. This could have negative consequences for species such as sperm whales, whose diets can be dominated by cephalopods. For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperatures regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott 2009).

Vulnerability assessments can provide a framework for evaluating the impacts of changing environmental conditions over a broad range of species using currently available information. Vulnerability to changing environmental conditions was determined to be very high for 47 U.S. marine mammal stocks in the North Atlantic, Gulf of America, and Caribbean when exposure (projected change in environmental conditions) and sensitivity (ability to tolerate and adapt to changing conditions) were assessed to categorize stocks with a vulnerability index (Lettrich et al. 2023). Based on this assessment, the overall vulnerability rank was “High” (fin, sei, blue, and sperm whales) for all ESA-listed marine mammal species considered in this opinion (Lettrich et al. 2023). Temperature, ocean pH, and dissolved oxygen (DO) were the primary drivers, which, in turn, impacted prey and habitat parameters.

Environmental conditions can influence marine mammal female body condition and impact reproductive success via changes in prey, from distribution and abundance to composition and caloric value (Keen et al. 2021). Changes in prey availability can occur across a range of spatial and temporal scales, from hour-long tidally driven hotspots and mesoscale features that can persist for months (e.g. eddies and fronts) to ocean basin-wide shifts resulting from within- (e.g. seasonal variability) and between-year (e.g. climatic oscillations) variability (Keen et al. 2021).

Changing environmental conditions affect these natural oceanographic and atmospheric processes and, subsequently, the distribution and viability of marine mammal populations.

Sea turtles are affected by multiple threats associated with changing environmental conditions across their different life stages (Patrício et al. 2021). Changing environmental conditions have, therefore, been described as a threat multiplier that interacts in additive and synergistic ways with almost all other stressors that sea turtles face (Fuentes et al. 2023; Staudt et al. 2013). Notably, sex is determined by the ambient sand temperature (during the middle third of incubation) with female offspring produced at higher temperatures and males at lower temperatures within a thermal tolerance range of 25–35°C (Ackerman 1997). Increases in global temperature could skew future sex ratios toward higher numbers of females (Fuentes et al. 2024), which can reduce genetic diversity, or even population viability, if males become a small proportion of populations (Hulin et al. 2009). Rising incubation temperatures can also decrease hatching success and hatchling fitness (Montero et al. 2018; Santidrián Tomillo et al. 2012). Sea surface temperatures on loggerhead foraging grounds have also been linked to the timing of nesting, with higher temperatures leading to earlier nesting (Mazaris et al. 2009; Schofield et al. 2009). Green sea turtles emerging from nests at cooler temperatures likely absorb more yolk that is converted to body tissue than do hatchlings from warmer nests (Ischer et al. 2009). However, warmer temperatures may also decrease the energy needs of a developing embryo (Reid et al. 2009).

Additionally, sea level rise may cause the loss of nesting areas and higher clutch mortality due to seawater inundation (Lyons et al. 2020). The greater frequency of extreme weather events, can destroy nests and alter hatchling dispersal patterns (DuBois et al. 2020). For in-water life stages, future changes in environmental conditions may push sea turtles into novel regions and habitats where they experience new anthropogenic, trophic, and ecological interactions (Fuentes et al. 2020).

This brief review highlights evidence of major impacts to ESA-listed species within the action area due to large-scale changes in environmental conditions. While it is difficult to accurately predict the consequences of such changes to a particular species or habitat, a range of consequences are expected that are likely to change the status of the species and the condition of their habitats.

5 Environmental Baseline

The *environmental baseline* refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR §402.02).

5.1 Vessel Interactions

Within the action area, vessel interactions pose a threat to ESA-listed marine mammals and sea turtles. Overall, the action area sees a great deal of vessel activity, from cargo and commercial shipping, to recreational vessels, cruise ships, and coastal dolphin watching vessels. Vessels have the potential to affect animals through strikes, sound, and disturbance associated with their physical presence. Responses to vessel interactions include interruption of vital behaviors and social groups, separation of mothers and young, and abandonment of resting areas (Boren et al. 2001; Constantine 2001; Mann et al. 2000; Nowacek 2001; Samuels et al. 2000). For example, in the Northwest Atlantic, Lesage et al. (2017b) found that the presence of vessels within 400 m of blue whales resulted in surface and dive times that were, on average, 49% and 36% shorter, respectively. Further, it was noted that the number of breaths taken by blue whales was reduced by 51% compared to control observations without vessel presence within 2,000 m of whales (Lesage et al. 2017b). In contrast to cetaceans, sea turtles are limited in their reactions to vessels and are not as adept at avoiding vessels that are moving at more than 4 km per hour (2.6 knots; Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010). For example, Hazel et al. (2007) suggests that green turtles may use auditory clues to react to approaching vessels rather than visual cues, making them more susceptible to vessel strike or vessel speed increases.

The following sections provide more information on vessel interactions with ESA-listed cetaceans and sea turtles in the action area.

5.1.1 Vessel Strike

Vessel strikes are a serious and widespread threat to ESA-listed cetaceans (especially large whales) in the action area and are the most well-documented "marine road" interaction with large whales (Pirotta et al. 2019). In a review of global vessel strike data from 1820 to 2019, Winkler et al. (2020) found that a majority (62.4%) of reported vessel strikes occurred in the Atlantic Ocean.

Vessel strike is an increasing threat as commercial shipping lanes cross important breeding and feeding habitats and as whale populations recover and populate new areas or areas where they were previously extirpated (Swingle et al. 1993; Wiley et al. 1995). As vessels become faster and more widespread an increase in vessel interactions with cetaceans is expected. All sizes and types of vessels can hit whales, but most lethal and severe injuries are caused by vessels 80 m or longer (Laist et al. 2001). For whales, studies show that the probability of fatal injuries from vessel strikes increases as vessels operate at speeds above 26 km per hour (14 knots; Laist et al. 2001). Evidence suggests that not all whales killed as a result of vessel strike are detected, particularly in offshore waters, and some detected carcasses are never recovered while those that are recovered may be in advanced stages of decomposition that preclude a definitive cause of death determination (Glass et al. 2010). Most commercial vessel strike mortalities of cetaceans are undetected and unreported. Most animals killed by vessel strike likely end up sinking rather than washing up on shore (Cassoff 2011). Kraus et al. (2005) estimated that 17% of vessel strikes are actually detected. Therefore, it is likely that the number of documented cetacean mortalities related to vessel strikes is much lower than the actual number of moralities associated with vessel strikes, especially for less buoyant species such as blue, humpback, and fin whales (Rockwood et al. 2017).

The potential lethal effects of vessel strikes are particularly profound on species with low abundance. However, all whale species have the potential to be affected by vessel strikes. Of the species of cetaceans known to be threatened by vessel strikes in the Northern Hemisphere, fin whales are one of the most commonly struck species, but sperm whales are also struck at higher rates (Laist et al. 2001; Vanderlaan and Taggart 2007). In some areas, one-third of all fin whale strandings appear to involve vessel strikes (Laist et al. 2001). Vessel traffic within the action area can come from both private (e.g., commercial and recreational) and Federal vessels (e.g., military and research), but traffic that is most likely to result in vessel strikes comes from commercial shipping. Table 6 shows the latest five-year annual average (2018–2022, unless otherwise indicated) of vessel strike mortalities and serious injuries for ESA-listed U.S. marine mammal stocks likely to be found in the action area. These data represent only known mortalities and serious injuries. More undocumented mortalities and serious injuries within the action area are assumed to have occurred.

Table 6. Average Annual Mortalities and Serious Injuries Related to Vessel Strikes for Endangered Species Act-Listed Marine Mammals for Stocks in the Northwest Atlantic Ocean (Henry et al. 2024)

Species	Observed
Blue Whale	NA (one reported in 1998)*
Fin Whale	0.44
Sei Whale	0
Sperm Whale	0 (four reported 1994–2012)*

NA=not available

*2017–2021

Vessel strikes are a poorly studied threat to sea turtles, but can be significant because they can result in serious injury and mortality (Work et al. 2010). All sea turtles must surface to breathe, and several species are known to bask at the sea surface for long periods, increasing their risk of vessel strike. For example, in areas of southeast Florida, during the 2019 and 2020 nesting seasons, 450 loggerhead females were examined by Gainsbury et al. (2021) for external injuries with a large portion showing evidence of vessel strike. Injuries were categorized by anatomic location, condition, and cause. Gainsbury et al. (2021) found that 24% of loggerheads had at least one injury. Vessel strikes accounted for 75% of the 60 injuries. Although sea turtles can move somewhat rapidly, they apparently are not adept at avoiding vessels that are moving at more than four kilometers per hour (2.6 knots); most vessels move far faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010). Both live and dead sea turtles are often found with deep cuts and fractures indicative of a collision with a vessel hull or propeller (Hazel et al. 2007). Hazel et al. (2007) suggests that green turtles may use auditory clues to react to approaching vessels rather than visual cues, making them more susceptible to vessel strike or vessel speed increases.

5.1.2 Whale Watching

Whale watching is a profitable and rapidly growing business with more than 3,300 operators worldwide, serving 13 million participants in 119 countries and territories, and may increase types of disturbance and negatively affect the species (Hoyt 2001; O'connor et al. 2009). As of 2010, commercial whale watching was a one billion dollar global industry per year (Lambert et al. 2010). Private vessels may partake in this activity as well. NMFS has issued regulations and guidelines relevant to whale watching. As noted previously, the cetaceans considered in this consultation are highly migratory, so may also be exposed to whale watching activity occurring outside the action area.

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational and scientific benefits, whale watching is not without potential negative impacts, as reviewed in Parsons (2012) and Pacheco et al. (2021) and can harass whales by altering feeding, breeding, and social behavior, or even injure them if the vessel gets too close or strikes the animal. Preferred habitats may be abandoned if disturbance levels are too high. Animals may also become more vulnerable to vessel strikes if they habituate to vessel traffic.

Although numerous short-term behavioral responses to whale watching vessels were documented, little information is available on whether long-term negative effects result from whale watching (NMFS 2006b). Christiansen et al. (2014) estimated the cumulative time minke whales spent with whale watching boats in Iceland to assess the biological significance of whale watching disturbances and found that, though some whales were repeatedly exposed to whale watching boats throughout the feeding season, the estimated cumulative time they spent with boats was very low. Christiansen et al. (2014) suggested that the whale watching industry, in its current state, is likely not having any long-term negative effects on vital rates.

It is difficult to precisely quantify or estimate the magnitude of the risks posed to marine mammals in general from vessel approaches associated with whale watching. There are only a couple of whale and dolphin watching operators off the U.S. coast within the action area, and it is unlikely that they would travel as far offshore as the proposed seismic surveys, which will occur at least 370 km from the U.S. coast. Though there are several whale watching operators in Bermuda because of the opportunity to see humpback whales on their migration. Disturbing, harassing, or harming marine mammals is illegal in Bermuda, and whale watching guidelines are similar to those in the U.S.

5.2 Fisheries

Fisheries constitute an important and widespread use of ocean resources throughout the action area. Fisheries can adversely affect fish populations, other species, and habitats. Direct effects of fisheries interactions on marine mammals and sea turtles include entanglement and entrapment, which can lead to fitness consequences or mortality because of injury or drowning. Non-target species are captured in fisheries (i.e., bycatch) and this stressor can represent a significant threat to non-target ESA-listed species. Indirect effects include reduced prey availability, including overfishing of targeted species, and destruction of habitat. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost fishing gear may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine mammals and sea turtles.

Fisheries can have a profound influence on fish populations. In a study of retrospective data, Jackson et al. (2001) concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic environmental change. Marine mammals are known to feed on several species of fish that are harvested by humans (Waring et al. 2008). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of several populations of marine mammals and sea turtles.

5.2.1 Fisheries Interactions

Globally, 6.4 million tons of fishing gear is lost in the oceans every year (Wilcox et al. 2015). Marine mammal and sea turtle entanglement (bycatch) is a global problem that every year results in the death of hundreds of thousands of animals worldwide. Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in cetaceans (see Dietrich et al. 2007). Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual’s health (Derraik 2002). Entanglements also make animals more vulnerable to additional threats (e.g., predation and vessel strikes) by restricting agility and swimming speed. Most marine mammals that die from entanglement in fishing gear likely sink at sea rather than strand ashore, making it difficult to accurately determine the extent of such mortalities. In excess of 97% of entanglement is caused by derelict fishing gear (Baulch and Perry 2014b). From 2007 through 2020, the U.S. Southeast Atlantic Ocean had an average of 2.8 large whale entanglements per year.

Table 7 shows the latest five-year annual average (2018–2022, unless otherwise indicated) of fishery interaction-related mortalities and serious injuries for ESA-listed U.S. marine mammal stocks likely to be found in the action area within the Gulf of America, U.S. East Coast, and Atlantic Canadian provinces. Data represent only known human-caused mortalities and serious injuries; more undocumented mortalities and serious injuries for these and other marine mammals found within the action area have likely occurred.

Table 7. Five-year annual average mortalities and serious injuries related to fisheries interactions for Endangered Species Act-listed marine mammals (Henry et al. 2024)

Species	Serious Injury and Mortality
Blue Whale	0*
Fin Whale	1.45
Sei Whale	0.2
Sperm Whale	0*

*2017–2021

Marine mammals are also known to ingest fishing gear, likely mistaking it for prey, which can lead to fitness consequences and mortality. Necropsies of stranded whales have found that ingestion of net pieces, ropes, and other fishing debris has resulted in gastric impaction and ultimately death (Jacobsen et al. 2010). As with vessel strikes, entanglement or entrapment in fishing gear likely has the greatest impact on populations of ESA-listed species with the lowest abundance (e.g., Kraus et al. 2016). Nevertheless, all species of marine mammals may face threats from derelict fishing gear.

In addition to these direct impacts, cetaceans may also be subject to indirect impacts from fisheries. Marine mammals probably consume at least as much fish as is harvested by humans (Kenney et al. 1985). Many cetacean species (particularly fin whales) are known to feed on species of fish that are harvested by humans (Carretta et al. 2016). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of ESA-listed marine mammal populations. Even species that do not directly compete with human fisheries could be indirectly affected by fishing activities through changes in ecosystem dynamics. However, in general, the effects of fisheries on marine mammals through changes in prey abundance in the action area remain unknown.

Fishery interactions remain a major factor in sea turtle recovery. Wallace et al. (2010b) estimated that worldwide 447,000 sea turtles are killed each year from bycatch in commercial fisheries. Although sea turtle excluder devices and other bycatch reduction devices have significantly reduced the level of sea turtle and other species bycatch in U.S. waters, mortality still occurs.

Recreational fishing occurs throughout the action area. Commercial and recreational fisheries may impact marine mammals and sea turtles as they migrate through the action area through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations.

5.3 Pollution

Within the action area, pollution poses a threat to ESA-listed marine mammals and sea turtles. Pollution can come in the form of marine debris, pollutants and contaminants, and hydrocarbons.

5.3.1 Marine Debris

Marine debris is an ecological threat that is introduced into the marine environment through ocean dumping, littering, or hydrologic transport of these materials from land-based sources (Gallo et al. 2018). Even natural phenomena, such as tsunamis and continental flooding, can cause large amounts of debris to enter the ocean environment (Watters et al. 2010). Marine debris accumulates in gyres throughout the oceans. Marine mammals often become entangled in marine debris, including fishing gear (Baird et al. 2015). Despite debris removal programs and outreach to heighten public awareness, marine debris in the environment has not been reduced (NRC 2008) and continues to accumulate in the ocean and along shorelines within the action area.

Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it (Gall and Thompson 2015). Entanglement in marine debris can lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and mortality for ESA-listed species in the action area. Entanglement can also result in drowning for air breathing marine species including marine mammals and sea turtles. The ingestion of marine debris has been documented to result in blockage or perforation of the digestive tract, mouth, and stomach lining of various species and can lead to serious internal injury or mortality (Derraik 2002; Roman et al. 2021). It can also result in sublethal effects such as malnutrition and transfer of pollutants into the animal ingesting the debris (Derraik 2002; Roman et al. 2021). Morét-Ferguson et al. (2010) presented a time series of plastic content at the ocean surface of the western North Atlantic Ocean and Caribbean Sea from 1986 through 2008. More than 60% of 6,136 surface plankton net tows collected floating plastics.

Cetaceans may ingest plastics, glass, metal, polystyrene foam, rubber, and derelict fishing gear (Baulch and Perry 2014a; Li et al. 2016). Over half of cetacean species (including blue whales, fin whales, sei whales, and sperm whales) are known to ingest marine debris, with up to 31% of individuals in some populations containing marine debris in their guts, a cause of death for up to 22% of individuals found stranded on shorelines (Baulch and Perry 2014b). In a recent global review of ingested marine debris, a majority of mortalities in marine mammals were caused by ingestion of film-like plastic (e.g., plastic bags), plastic fragments (hardness not specified), rope/nets, and fishing debris (Roman et al. 2021).

Ingestion of marine debris can be a serious threat to sea turtles as well. Floating material has been shown to concentrate in ocean gyres and convergence zones where *Sargassum* and juvenile sea turtles are known to occur (Carr 1987). When feeding, sea turtles (e.g., leatherback turtles) can mistake debris (e.g., tar and plastic) for natural food items, such as jellyfish. Some types of marine debris, such as oil, may be toxic. One study found plastic in 37% of dead leatherback turtles and determined that 9% of those deaths were caused by plastic ingestion (Mrosovsky et al. 2009). Plastic ingestion is very common in leatherback turtles and can block gastrointestinal tracts, leading to death (Mrosovsky et al. 2009). For sea turtles, a majority of mortalities were caused by ingestion of hard plastic, film-like plastic, and fishing debris (Roman et al. 2021).

In a study on marine debris ingestion in 115 green turtles and hawksbill turtles stranded in Queensland, Australia, Schuyler et al. (2012) found that the probability of debris ingestion was inversely correlated with size (curved carapace length), and when broken down into size classes, smaller pelagic sea turtles were significantly more likely to ingest debris than larger benthic feeding sea turtles. Parker et al. (2005) conducted a diet analysis of 52 loggerhead turtles collected as bycatch from 1990 through 1992 in the high seas drift gillnet fishery in the central North Pacific Ocean. The authors found that 34.6% of the individuals sampled had anthropogenic debris in their stomachs (e.g., plastic, Styrofoam, paper, rubber). Similarly, a study of green turtles found that 61% of those observed stranded ingested some form of marine debris, including rope or string, which may have originated from fishing gear (Bugoni et al. 2001). In a study looking at oceanic-stage juvenile loggerhead turtles on a feeding ground near the Azores, 83% (20 loggerhead turtles) had ingested plastic marine debris (Pham et al. 2017). Green turtles in their oceanic life stage are also vulnerable to pollutants like tar balls because they tend to accumulate in *Sargassum* mats at convergence zones, where young green turtles feed (Seminoff 2015).

Plastic debris is a major concern because it degrades slowly and many plastics float. Plastic waste in the ocean can leach chemical additives into the water such as brominated flame retardants, stabilizers, phthalate esters, biphenyl A, and nonylphenols (Panti et al. 2019). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane. Marine mammals and sea turtles can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. Once consumed, plastics can act as nutritional dilutants in the gut, making the animal feel satiated before it has acquired the necessary amount of nutrients required for general fitness (reviewed in Machovsky-Capuska et al. 2019). Marine mammals and sea turtles may be exposed to marine debris over the course of the proposed actions. Given that our knowledge on impacts from marine debris is mainly determined through necropsies of deceased animals, it is difficult to determine the extent of the threats that marine debris poses to marine mammals and sea turtles.

However, marine debris is consistently present and has been found in marine mammals and sea turtles in and near the action area.

5.3.2 Pollutants and Contaminants

Exposure to pollution and contaminants has the potential to cause adverse health effects in marine species. Pollutants can enter the marine environment from a variety of local, regional, and international sources, and their levels and sources are therefore difficult to identify and monitor (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata 1993). Contaminants may be introduced by rivers, coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities, including offshore oil and gas or mineral exploitation (Garrett 2004; Grant and Ross 2002; Hartwell 2004).

The accumulation of persistent organic pollutants, including PCBs, dibenzo-p-dioxins, dibenzofurans and related compounds, through trophic transfer may cause mortality and sub-lethal effects, including immune system abnormalities, endocrine disruption, and reproductive effects (Krahn et al. 2007), in long-lived higher trophic level animals (Waring et al. 2016). Persistent organic pollutants may also facilitate disease emergence and lead to the creation of susceptible “reservoirs” for new pathogens in contaminated marine mammal populations (Ross 2002).

Numerous factors, such as age, sex and birth order, diet, and locality/habitat use, can affect concentrations of persistent pollutants in marine mammals and sea turtles (Mongillo et al. 2012; Muñoz and Vermeiren 2020). In marine mammals, contaminant load for males increases with age, whereas females pass on contaminants to offspring during pregnancy and lactation (Addison and Brodie 1987; Borrell et al. 1995). Pollutants can be transferred from mothers to juveniles at a time when their bodies are undergoing rapid development, putting juveniles at risk of immune and endocrine system dysfunction later in life (Krahn et al. 2009). PCBs have been found in muscle tissue samples taken from stranded sperm whales in the North Atlantic Ocean (Megson et al. 2022). While exposure to pollutants and other contaminants is likely to occur for marine mammals in the action area through the duration of the seismic survey activities, the level of risk and degree of impact is unknown.

In sea turtles, a variety of heavy metals (e.g., arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver and zinc) have been found in tissues in levels that increase with sea turtle size (Anan et al. 2001; Barbieri 2009; Fujihara et al. 2003; Garcia-Fernandez et al. 2009; Gardner et al. 2006; Godley et al. 1999; Saeki et al. 2000; Storelli et al. 2008). Cadmium has been found in leatherback turtles at the highest concentration compared to any other marine vertebrate (Caurant et al. 1999; Gordon et al. 1998). Maternal transfer of persistent organic pollutants threatens developing embryos with a pollution legacy, posing potential adverse effects on subsequent generations (Muñoz and Vermeiren 2020). Newly emerged hatchlings have higher concentrations than are present in eggs, suggesting that metals may be accumulated during incubation from surrounding sands (Sahoo et al. 1996).

Sea turtle tissues have been found to contain organochlorines and many other persistent organic pollutants. PCB concentrations in sea turtles are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (PCB 209: 500-530 ng/g wet weight; Davenport 1990; Oros 2009). PCBs have been found in leatherback turtles at concentrations lower than expected to cause acute toxic effects, but they might cause sub-lethal effects on hatchlings (Stewart 2011). Organochlorines can cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007) and are known to depress immune function in loggerhead turtles (Keller et al. 2006). Females, from sexual maturity through reproductive life, should have lower levels of contaminants than males because contaminants are transferred to embryos through egg formation. Exposure to sewage effluent may also result in green turtle eggs harboring antibiotic resistant strains of bacteria (Al-Bahry et al. 2009). Per- and poly-fluoroalkyl substances (more commonly known as PFAS) have been detected in the plasma of loggerhead and Kemp's ridley turtles; adverse impacts could have endocrine and reproductive implications for turtle species (Khan et al. 2023). No information on detrimental threshold concentrations is available, and little is known about the consequences of exposure of sea turtles to organochlorine compounds. More research is needed to better understand the short- and long-term health and fecundity effects of these chemical pollutants and heavy metal accumulation in sea turtles.

Because persistent organic pollutants are both ubiquitous and persistent in the environment, marine mammals, sea turtles, and other forms of marine life in the action area would continue to be exposed to persistent organic pollutants for all their lives. It is possible that the effects from pollutants and contaminants could be sub-lethal and long-term in nature, and include impacts on reproduction, immune function, and endocrine activity. These effects may become more apparent as time goes on.

5.3.3 Hydrocarbons

Hydrocarbons that may pose a threat to ESA-listed marine mammals and sea turtles due to natural seeps and oil spills. Hydrocarbons may also affect prey populations, affecting ESA-listed species' food availability.

Oil spills are accidental and unpredictable events that can result from oil and gas development, production, and other activities, such as vessel use. Oil spills can be caused by vessel collisions, groundings, hull failures; equipment failures; fires and explosions; and other events such as weather damage and human error. Oil releases can occur during the exploration, development, production, and transport of oil. There is no known oil and gas activity in the action area in the Western Central Atlantic. Most oil spills are small (less than 1,000 barrels), but larger spills occur as well. Over the last two decades, there has not been a large-scale oil spill in the action area. However, small-scale vessel spills likely have occurred. A nationwide study examining vessel oil spills from 2002 through 2006 found that over 1.8 million gallons of oil were spilled from vessels in all U.S. waters (Dalton and Jin 2010). In this study, "vessel" included numerous types of vessels, including barges, tankers, tugboats, and recreational and commercial vessels, demonstrating that the threat of an oil spill can come from a variety of vessel types.

The International Tanker Owners Pollution Federation Limited's (ITOPF) tanker spill statistics (ITOPF 2022) provide information on persistent and non-persistent oil spills from tankers since 1970. Globally, the number of oil spills and volume of oil spilled from tankers has significantly decreased over the last few decades. The annual average number of large oil spills per year has decreased by 90% from 79 in the 1970's to six in the 2010's and five in the 2020's. The average annual number of medium oil spills has also significantly decreased since 1970; however, the data on small oil spills is not reliable due to lack of reporting. In addition to vessels, oil spills and contamination can come from other sources like pipelines, oil industry activities, and runoff from roads, rail cars, other land-based sources, and natural seepage. Below we review the effects of oil spills on marine mammals and sea turtles more generally. Much of what is known comes from studies of large oil spills such as the *Deepwater Horizon* oil spill because no information exists on the effects of small-scale oil spills within the action area. The *Deepwater Horizon* oil spill in the Gulf of America (formerly Gulf of Mexico) in 2010 led to the exposure of tens of thousands of marine mammals to oil, causing reproductive failure, adrenal disease, lung disease, and poor body condition.

Exposure to hydrocarbons released into the environment via oil spills and other discharges poses risks to marine species. Marine mammals and sea turtles are generally able to metabolize and excrete limited amounts of hydrocarbons, but exposure to large amounts of hydrocarbons and chronic exposure over time pose greater risks (Arienzo 2023; Grant and Ross 2002). Acute exposure of marine mammals to petroleum products causes changes in behavior and may directly injure animals (Geraci 1990). Also, sea turtles may experience serous health and reproductive problems, with toxicity varying between species and largely depending on the route of exposure, sex, and life stage of the organism (Arienzo 2023).

Cetaceans have a thickened epidermis that greatly reduces the likelihood of petroleum toxicity from skin contact with oils (Geraci 1990), but they may inhale these compounds while at the surface and ingest them while feeding (Matkin and Saulitis 1997). For example, because of the *Deepwater Horizon* oil spill, sperm whales could have been exposed to toxic oil components through inhalation, aspiration, ingestion, and dermal exposure. There were 19 observations of 33 sperm whales swimming in *Deepwater Horizon* surface oil or that had oil on their bodies (Diaz 2015 as cited in Deepwater Horizon NRDA Trustees 2016). The effects of oil exposure likely included physical and toxicological damage to organ systems and tissues, reproductive failure, and death. Large whales may have experienced multiple routes of exposure at the same time, over intermittent timeframes and at varying rates, doses, and chemical compositions of oil. This estimation of effects to large whales is largely based on observed impacts to bottlenose dolphins resulting from exposure to oil from the *Deepwater Horizon* event. The oil spill from the *Deepwater Horizon* event occurred in deep water, which is sperm whale habitat. The same routes of internal oil exposure (ingestion, inhalation, and aspiration) would have occurred in sperm whales that have been shown to adversely affect bottlenose dolphins in coastal habitat. The surface oil and vapors at the water's surface were more concentrated offshore near the leaking well head, possibly exposing sperm whales to high levels of contaminants between dives. Linnehan et al. (2021) concluded that bottlenose dolphins impacted by oil showed evidence of cardiac abnormalities (i.e., significantly thinner left ventricular walls, smaller left atria, and higher prevalence of valvular abnormalities) as well as pulmonary hypertension. Hydrocarbons also have the potential to impact prey populations, and therefore may affect ESA-listed species indirectly by reducing food availability.

Oil can also be hazardous to sea turtles. For example, the *Deepwater Horizon* oil spill extensively oiled vital foraging, migratory, and breeding habitats of sea turtles throughout the northern Gulf of America (Deepwater Horizon Trustees 2016). *Sargassum* habitats, benthic foraging habitats, surface and water column waters, and sea turtle nesting were all affected by the *Deepwater Horizon* oil spill. Sea turtles may have been exposed to *Deepwater Horizon* oil in contaminated habitats, through breathing oil droplets, oil vapor, and smoke, by ingesting oil-contaminated water and prey, and through maternal transfer of oil compounds to developing embryos. Translocation of eggs from the Gulf of America to the Atlantic Ocean coast of Florida resulted in the loss of sea turtle hatchlings. Other response activities, including vessel strikes and dredging, also resulted in sea turtle deaths.

As noted above, the past and present impacts of oil spills on ESA-listed species (blue whale, fin whale, sei whale, sperm whale, North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle) within the action area are limited to those associated with small-scale vessel spills. Nevertheless, the documented effects of oil spills outside the action area, such as the *Deepwater Horizon* oil spill and small-scale vessel spills, show how oil spills can impact ESA-listed species within the action area.

5.4 Invasive Species

Invasive species are nonindigenous species that threaten the diversity or abundance of native species, the ecological stability of infested waters, or any commercial, agricultural or recreational activities dependent on such waters. Invasive species include nonindigenous species that may occur within inland, estuarine, or marine waters and that presently or potentially threaten ecological processes and natural resources. Invasive species have been referred to as one of the top four threats to the world's oceans (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005). Introduction of these species is cited as a major threat to biodiversity, second only to habitat loss (Wilcove et al. 1998). A variety of vectors are thought to have introduced non-native species including, but not limited to aquarium and pet trades, recreation, and ballast water discharges from ocean-going vessels. Common impacts of invasive species are alteration of habitat, nutrient availability, and species composition and diversity within an ecosystem (Strayer 2010). Shifts in the base of food webs, a common result of the introduction of invasive species, can fundamentally alter predator-prey dynamics throughout food chains (Moncheva and Kamburska 2002), potentially affecting prey availability and habitat suitability for ESA-listed species. They have been implicated in the endangerment of 48% of ESA-listed species (Czech and Krausman 1997). Many studies have demonstrated a close relationship between trade and invasive species, with shipping as the main vector of aquatic nuisance species in aquatic ecosystems (Chan et al. 2022; Chan et al. 2019; Nong et al. 2018). Olson (2006) reviewed numerous studies of biological invasions and highlighted that international trade is an important vector that links to the existence and spread of invasive species internationally. Globally, shipping is responsible for 69% of marine invasive species (Molnar et al. 2008), as species can hitchhike on vessel hulls and in ballast water (Drake and Lodge 2007; Keller and Perrings 2011).

Within the action area, there is little information on the level of invasive species and the impacts they may have on marine mammals and sea turtles. However, the well-known invasive species, the lionfish (*Pterois* sp.), has been documented in coastal waters within the action area. Schofield (2010) determined that lionfish have been detected along the U.S. Atlantic coast, from Florida to North Carolina, since 2002. Lionfish are voracious predators to native fishes, having decimated native fish populations on Caribbean reefs, and have a broad habitat distribution with few natural predators in the region (Ingeman 2016; Mumby et al. 2011). Though Schofield (2010) notes that waters off North Carolina (just north of the action area) may be too cold in winter to support an established population of lionfish, other studies modeled an expansion of the lionfish's range and year-round distribution with warming water temperatures (Grieve et al. 2016; Kimball et al. 2004). It is currently unclear what impact lionfish will have on prey species of ESA-listed marine mammals and sea turtles in the action area. Although it is not possible to predict which invasive species will arrive and thrive in the action area, it is reasonably certain that they will be another stressor to native biota, which may affect either the health or prey base of native fauna.

5.5 Anthropogenic Sound

The ESA-listed species that occur in the action area are regularly exposed to several sources of anthropogenic sound. These include but are not limited to maritime activities (vessel sound and commercial shipping), aircraft, seismic surveys (exploration and research), marine construction, and military readiness activities. These activities occur to varying degrees throughout the year. Cetaceans generate and rely on sound to navigate, hunt, avoid predators, and/or communicate with other individuals and anthropogenic sound can interfere with these important activities (Nowacek et al. 2007). ESA-listed species can be impacted by either increased levels of anthropogenic-induced background sound or high intensity, short-term anthropogenic sounds.

The addition of anthropogenic sound to the marine environment is a known stressor that can harm marine animals or significantly interfere with their normal activities (NRC 2005). Within the action area, ESA-listed marine mammals and sea turtles may be impacted by anthropogenic sound in various ways. Responses to sound exposure can vary, and may include auditory and non-auditory injury, temporary hearing impairment, behavioral harassment and stress, or no observable response. For example, some sounds may produce a behavioral response, including but not limited to, avoidance of impacted habitat areas affected by irritating sounds, changes in diving behavior, or (for cetaceans) changes in vocalization patterns (MMC 2007).

Many researchers have described behavioral responses of marine mammals to sounds produced by boats and vessels, as well as other sound sources such as helicopters and fixed-wing aircraft, and dredging and construction (reviewed in Gomez et al. 2016; and Nowacek et al. 2007). Most observations have been limited to short-term behavioral responses, which included avoidance behavior and temporary cessation of feeding, resting, or social interactions (Barber et al. 2010). Masking, in which an animal may not be able to detect, interpret, and/or respond to biologically relevant sounds, may also occur. Masking can reduce the range of communication, particularly long-range communication, which can negatively impact an animal's fitness by interfering with predator avoidance and reproduction, for instance (MMC 2007). Scientific evidence suggests that marine mammals, including several baleen whales, compensate for masking by changing the frequency, source level, redundancy, or timing of their signals, but the long-term implications of these adjustments are currently unknown (Mcdonald et al. 2006; Parks 2003; Parks 2009b). We assume similar impacts have occurred and would continue to affect marine mammals in the action area.

Despite the potential for these impacts to affect individual ESA-listed marine mammals and sea turtles, information is not currently available to determine the potential population level effects of anthropogenic sound levels in the marine environment (MMC 2007). For example, we currently lack empirical data on how sound affects growth, survival, reproduction, and vital rates, nor do we understand the relative influence of such effects on the population being considered. As a result, the consequences of anthropogenic sound on ESA-listed marine mammals and sea turtles at the population or species scale remain uncertain, although recent efforts have made progress establishing frameworks to consider such effects (NAS 2017).

5.5.1 Commercial Shipping and Vessels

Individual vessels produce unique acoustic signatures that may change with vessel speed, load, and activities. Sound levels are typically higher for the larger and faster vessels. Peak spectral levels for individual commercial vessels are in the frequency band of 10–50 Hz and range from 195 dB re 1 μPa^2-s at 1 m for fast-moving (greater than 37 km per hour [20 knots]) supertankers to 140 dB re 1 μPa^2-s at 1 m for smaller vessels (NRC 2003b). Although large vessels emit predominantly low-frequency sound, studies report broadband sound from large cargo vessels to about 2 kHz, which may interfere with important biological functions of cetaceans (Blair et al. 2016; Holt 2008a; Holt 2008b; Rolland et al. 2012). Small boats with outboard or inboard engines produce sound that is generally concentrated in the mid-frequency (1–5 kHz) range and at moderate (150–180 dB re 1 μPa at 1 m) sound source levels (Erbe 2002; Gabriele et al. 2003; Kipple and Gabriele 2004). At frequencies below 300 Hz, ambient sound levels are elevated by 15–20 dB when exposed to sounds from vessels at a distance (McKenna et al. 2013).

Much of the increase in sound in the ocean environment over the past several decades is due to increased shipping, as vessels become more numerous and of larger tonnage (Haver et al. 2021; Hildebrand 2009b; McKenna et al. 2012; NRC 2003b; NRC 2003c). Commercial shipping was a major source of low-frequency sound in the ocean, and a driver of increased ambient sound levels (Haver et al. 2021; Hildebrand 2004). Measurements made over the period 1950 through 1970 indicated low-frequency (50 Hz) vessel traffic sound in the western North Atlantic Ocean was increasing by 0.55 dB per year (Ross 1976; Ross 1993; Ross 2005). Whether or not such trends continue today is unclear (e.g., Chapman and Price 2011; Hildebrand 2009a), and in some places, such as the equatorial and South Atlantic Ocean, ambient sound levels are mostly driven by seismic airguns (Haver et al. 2017; Miksis-Olds and Nichols 2016). Efforts are underway to better document changes in ambient sound (Haver et al. 2018), which would help provide a better understanding of current and future impacts of vessel sound on ESA-listed species.

Sonar systems, which can affect cetaceans, are used on commercial, recreational, and military vessels (NRC 2003a). The action area may host many of these vessel types during any time of the year. Although little information is available on potential effects of multiple commercial and recreational sonars to ESA-listed marine mammals and sea turtles, the distribution of these sounds would be small because of their short durations and the fact that the high frequencies of the signals attenuate quickly in seawater (Nowacek et al. 2007). However, military sonar, particularly low and mid-frequency active sonar, often produces intense sounds at high source levels, and these may impact cetacean behavior (Southall et al. 2016). For further discussion on active sonar and anthropogenic sound from military activities on ESA-listed species located within the action area and considered in this consultation, see Sections 5.5.5 and 5.5.6.

5.5.2 Aircraft

Aircraft within the action area may consist of small commercial or recreational airplanes, helicopters, or large commercial airliners. These aircraft produce a variety of sounds that can potentially affect marine mammals and sea turtles. While it is difficult to assess these impacts, several studies have documented minor behavioral disturbances in response to aircraft presence (Nowacek et al. 2007). Erbe et al. (2018) recorded underwater noise from commercial airplanes reaching as high as 36 dB above ambient noise. Sound pressure levels received at depth were comparable to cargo and container ships traveling at distances of 1–3 km away, although the airplane noises ceased as soon as the airplanes left the area, which was quick compared to a cargo vessel. While such noise levels are relatively low and brief, they still have the potential to be heard by cetaceans and sea turtles at certain frequencies. Given the inefficient transfer of sound energy from the air into the water, exposure to aircraft sound would likely occur when marine mammals or sea turtles are at or near the surface.

5.5.3 Seismic Surveys

Seismic survey activities involving towed airgun arrays, similar to the one considered in this opinion, may occur within the action area. Seismic surveys are the primary exploration technique to locate hydrocarbon deposits, fault structure, and other geological hazards. Airguns contribute a large amount of anthropogenic energy to the world's oceans (3.9×10^{13} Joules cumulatively), second only to nuclear explosions (Moore and Angliss 2006). Although most energy is in the low-frequency range, airguns emit a substantial amount of energy up to 150 kHz (Goold and Coates 2006). Seismic airgun noise can propagate substantial distances at low frequencies (e.g., Nieukirk et al. 2004). These activities can produce noise that affects ESA-listed marine mammals and sea turtles within the action area.

In the U.S., seismic surveys involving the use of airguns with the potential to take marine mammals are generally covered by incidental take authorizations under the MMPA, and if they involve ESA-listed species, undergo formal ESA section 7 consultation. In addition, the Bureau of Ocean Energy Management authorizes oil and gas activities in domestic federal waters and the NSF and U.S. Geological Survey funds and/or conducts these seismic survey activities in domestic, international, and foreign waters, and in doing so, consults with NMFS to ensure their actions are not likely to jeopardize the continued existence of ESA-listed species or adversely modify or destroy designated critical habitat. More information on the effects of these activities on ESA-listed species, including authorized takes, can be found in recent biological opinions associated with these consultations.

Previous NSF-funded seismic surveys in the Northwest Atlantic Ocean, in the general vicinity of the action area, occurred on the R/V *Maurice Ewing* in 2003 and on the R/V *Langseth*, from 2014 through 2015, and most recently in 2023 off South Carolina and North Carolina. The USGS funded and conducted seismic surveys in the Northwest Atlantic Ocean on the R/V *Marcus G. Langseth* in 2014 through 2015 and R/V *Hugh R. Sharp* in 2018. In 2018, we issued an opinion on the Bureau of Ocean Energy Management's issuance of five oil and gas permits for geological and geophysical seismic surveys off the U.S. coast of the Atlantic Ocean and NMFS Permits Division's issuance of associated IHAs. Presently, no oil and gas development is planned for the Mid-Atlantic Ocean and South Atlantic Ocean region as leasing considerations for waters off North Carolina, South Carolina, Georgia, and Florida were withdrawn. Each of these seismic surveys includes a MMPA IHA and each is subject to a separate ESA section 7 consultation. The finalized consultations all resulted in a "no jeopardy" opinion.

5.5.4 Marine Construction

Marine construction activities that may occur in the action area include drilling, dredging, pile-driving, cable-laying, and explosions. These activities may cause behavioral disturbance and physical damage to marine mammals (NRC 2003a). While most of these activities are coastal, offshore construction does occur in the Northwest Atlantic Ocean. All or some of these activities may cause effects to ESA-listed species within the action area.

Dredging involves the removal and relocation of submerged sediment in waterways, nearshore areas, and offshore, and supports activities such as maintaining coastal navigation channels, beach nourishment, levee construction, and coastal restoration. Dredging activities can significantly impact aquatic ecosystems through: (1) direct removal/burial of organisms; (2) turbidity/siltation effects; (3) contaminant re-suspension; (4) sound/disturbance; (5) alterations to hydrodynamic regime and physical habitat; and (6) loss of riparian habitat (Chytalo 1996; Winger et al. 2000). Dredging may also harm sea turtles by injuring individuals with the equipment used or may degrade and modify their foraging habitat (such as soft bottom and seagrass beds), affecting available food resources. Although the underwater sounds from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and strongest at low frequencies, they are not believed to have any long-term effects on sea turtles. However, the construction and maintenance of federal navigation channels and dredging in sand mining sites ("borrow areas") have been identified as sources of sea turtle mortality. Hopper dredges can kill sea turtles by entraining them in dredge drag arms and impeller pumps. Hopper dredges in the dredging mode can move relatively quickly and can thus overtake, entrain, and kill sea turtles as the suction draghead(s) of the advancing dredge overtakes a resting or swimming organism.

5.5.5 Active Sonar

Active sonar emits high-intensity acoustic energy and receives reflected and/or scattered energy. A wide range of sonar systems are used for both civilian and military applications. The primary sonar characteristics that vary with application are the frequency band, signal type (pulsed or continuous), rate of repetition, and sound source level. Sonar systems can be divided into categories, depending on their primary frequency of operation; low-frequency (1 kHz or less), mid-frequency (1–10 kHz), high-frequency (10–100 kHz), and very high-frequency (more than 100 kHz; Hildebrand 2004). Low-frequency systems are designed for long-range detection (Popper et al. 2014a). Signal transmissions are emitted in patterned sequences that may last for days or weeks. Mid-frequency military sonars include tactical anti-submarine warfare sonars, designed to detect submarines over several tens of kilometers, depth sounders, and communication sonars. High-frequency military sonars include those incorporated into weapons (e.g., torpedoes and mines) or weapon countermeasures (e.g., mine countermeasures or anti-torpedo devices), as well as side-scan sonar for seafloor mapping. Commercial sonars are designed for fish finding, depth sounds, and sub-bottom profiling. Depth sounders and sub-bottom profilers are operated primarily in nearshore and shallow environments; however, fish finders operate in both deep and shallow areas.

Most sonar (except for military activities, see below) occur closer to shore than the proposed seismic surveys.

5.5.6 Military Activities

The U.S. Navy conducts training, testing, and other military readiness activities on range complexes throughout coastal and offshore areas in the United States and on the high seas. The U.S. Navy's Atlantic Fleet Training and Testing range complex overlaps with the action area for the proposed seismic surveys. During training, existing and established weapon systems and tactics are used in realistic situations to simulate and prepare for combat. Activities include: routine gunnery, missile, surface fire support, amphibious assault and landing, bombing, sinking, torpedo, tracking, and mine exercises. Testing activities are conducted for different purposes and include at-sea research, development, evaluation, and experimentation. The majority of the training and testing and research activities the U.S. Navy conducts in the action area are similar, if not identical to activities that have been occurring in the same locations for decades; therefore, the ESA-listed species located in the action area have been exposed to these military activities often and repeatedly.

The U.S. Navy's activities produce sound and visual disturbance to marine mammals and sea turtles throughout the action area. Anticipated impacts from harassment due to the U.S. Navy's activities include changes from foraging, resting, milling, and other behavioral states that require low energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures. Based on the currently available scientific information, behavioral responses that result from stressors associated with these training and testing and research activities are not expected to affect the reproduction, survival, or recovery of these species. The U.S. Navy's activities constitute a Federal action and take of ESA-listed marine mammals, sea turtles, and designated critical habitat considered for these activities have previously undergone separate ESA section 7 consultation.

In 2025, NMFS issued a biological and conference opinion on the U.S. Navy Atlantic Fleet's military readiness training and testing activities and the promulgation of regulations for incidental take of marine mammals (NMFS 2018a). We concluded that the action is not likely to jeopardize the continued existence of any ESA-listed species or result in destruction or adverse modification of critical habitat. The 2025 AFTT Phase IV opinion includes an ITS with exempted take for ESA-listed marine mammals, sea turtles, fish, and coral (for details see OPR-2024-02209). Through the section 7 consultation process with NMFS, the Navy has implemented monitoring and conservation measures to reduce the potential effects of explosives, sonar, and vessel strikes on ESA-listed species in the Atlantic Ocean and Gulf of America.

5.6 Scientific Research Activities

Regulations for section 10(a)(1)(A) of the ESA allow issuance of permits authorizing take of certain ESA-listed species for the purposes of directed scientific research. Prior to the issuance of such a permit, the proposal must be reviewed for compliance with section 7 of the ESA. Scientific research permits issued by NMFS currently authorize studies of ESA-listed species in the Northwest Atlantic Ocean, some of which extend into portions of the action area for the proposed actions. Marine mammals and sea turtles have been the subject of field studies for decades. The primary objective of most of these field studies has generally been monitoring populations or gathering data for behavioral and ecological studies. Over time, NMFS has issued dozens of permits on an annual basis for various forms of "take" of marine mammals and sea turtles in the action area from a variety of research activities.

Authorized research on ESA-listed marine mammals includes aerial surveys, vessel surveys, close approaches, photography, videography, behavioral observations, active acoustics (i.e., auditory evoked potentials, playbacks, prey mapping, and remote ultrasound), passive acoustic monitoring, biological sampling (i.e., biopsy sampling, breath sampling, fecal sampling, and sloughed skin sampling), and tagging. Research activities involve only non-lethal "takes" of these marine mammals.

Authorized research on ESA-listed sea turtles includes aerial surveys, vessel surveys, close approaches, active acoustics, capture, handling, holding, restraint, transportation, tagging, shell and chemical marking, biological sampling (i.e., biopsy, blood and tissue collection, tear, fecal and urine, and lavage), drilling, pills, imaging, ultrasound, antibiotic (tetracycline) injections, captive experiments, laparoscopy, and mortality (e.g., observed mortalities reported by the researcher, mortalities that occur after the sea turtle is released back into the wild). Sea turtle research activities involve mostly authorized sub-lethal "takes" with a very small level of accidental mortality authorized.

There have been numerous research permits issued since 2009 under the provisions of both the MMPA and ESA authorizing scientific research on marine mammals all over the world, including for research activities in the action area. The consultations that took place on the issuance of these ESA scientific research permits found that the authorized research activities would have no more than short-term effects and were not likely to jeopardize the continued existence of the species or result in adverse modification or destruction of designated critical habitat.

5.7 Space Launch and Reentry Operations

Space activities may affect ESA-listed species, including marine mammals and sea turtles, that inhabit or transit through areas where launch and reentry operations occur. The FAA, National Aeronautics and Space Administration (commonly known as NASA), and the U.S. Space Force (USSF) are involved in space operations such as licensing and regulating U.S. commercial launch and reentry activity and launch sites, leasing launch facilities, and overseeing commercial and Department of Defense launch and reentry activities, such as for government and commercial satellites. As part of these operations, several vehicles are launched from facilities across the U.S. each year, and vehicles, stages, components, or debris may end up in the ocean. These operations often involve the deployment of weather balloons, vessel and aircraft surveillance, and expending or landing a vehicle or component of the vehicle (parachutes, fairings) in the ocean, which can affect marine mammals and sea turtles, their prey, and their habitat.

The programmatic letter of concurrence for launch and reentry vehicle operations in the marine environment (OPR-2025-02196) sets maximum annual limits on space launch and reentry operations in the Northwest Atlantic Ocean. The current maximum annual limits for the Northwest Atlantic Ocean are shown in Table 8.

Table 8. Space launch and reentry programmatic current maximum annual limits in the Northwest Atlantic Ocean

Type of Operation	**Maximum Number of Annual Operations**
Atlantic Ocean	
Launches involving stages and fairings that are expended in the ocean	350
Launches involving attempted recovery of stages and fairings in the ocean	210
Launches involving attempted recovery of stages and expended fairings	40
Spacecraft reentry and landing in the ocean (may involve debris expended in the ocean)	10
Launch abort test	1

6 Analysis of Effects

The ESA section 7 regulations (50 CFR §402.02) define *effects of the action* as "the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration[2] " 50 CFR §402.02 (2018).

To understand the effects of the action on listed species, we employ a stressor-exposure-response analysis. The stressors resulting from this action were identified in Section 2.3 and the stressor analyzed here is the sound generated by the airgun array. The following analysis is structured to separately assess the exposure of listed species, followed by separate assessments of the responses of listed species to that exposure. To conclude this section, we summarize the combination of exposure and response for each species.

6.1 Exposure

In this section, we consider the exposure to the stressor that could cause an effect to ESA-listed species that are likely to co-occur with the action's modifications to the environment in space and time, and identify the nature of that co-occurrence. We describe the timing and location of the stressor to identify the populations, life stages, or sexes of each ESA-listed species likely to be exposed. We also describe the duration, frequency, and intensity of the stressor to quantify the number of exposures that are reasonably certain to occur. We then determine to which populations those exposed individuals belong.

6.1.1 Species Exposure

Our exposure analysis relies on two basic components: (1) information on species distribution (i.e., density or occurrence within the action area [i.e., seismic survey area]), and (2) information on the level of exposure to sound (i.e., acoustic thresholds) at which species are reasonably certain to be affected (i.e., exhibit a significant response). Using this, and information on the high-energy seismic surveys (e.g., area that would be ensonified at certain sound levels, seismic survey tracklines, days of operation), we then estimate the number of instances in which an ESA-listed species may be exposed to sound from the airgun array that are likely to result in adverse effects to inform our response analysis. Estimating the potential exposure of animals to anthropogenic stressors is difficult due to limited information on animal density estimates, overall abundance, the temporal and spatial location of animals, and the proximity and duration of exposure to the sound source in the action area. For these reasons, and by regulation, we evaluate the best available data and information to reduce the level of uncertainty in making our final exposure estimates.

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[2] This definition includes the second sentence of the definition of "effects of the action." That sentence provided the definition of "environmental baseline" in effect as of 2018. In the 2019 rule amending the 50 CFR part 402 regulations, the Services established "environmental baseline" as a stand alone definition. 84 Fed. Reg. 44976, 45016 (August 27, 2019). In the 2024 rule, the Services made minor revisions to the "environmental baseline" definition. 89 Fed. Reg. 24268, 24298 (April 5, 2024). The Court's ruling did not touch upon that definition of "environmental baseline," and it therefore remains valid. The definition is also fully consistent with the definition of "effects of the action" from 2018.

6.1.1.1 Marine Mammal Exposure

The ESA-listed marine mammals that are likely to be adversely affected by sound from the airgun array are blue whale, fin whale, sei whale, and sperm whale. These species' hearing ranges encompass the frequency range within which the airgun array operates (Table 9). Blue whale, fin whale, and sei whale are classified in the low-frequency hearing group, and sperm whales are classified in the high-frequency hearing group in NMFS's Updated Technical Guidance (NMFS 2024a).

Table 9. Marine mammal hearing groups defined in NMFS's Updated Technical Guidance (NMFS 2024a)

Hearing Group	Generalized Hearing Range*
Low-frequency (blue, fin, and sei whale)	7 Hz to 35 kHz
High-frequency (sperm whale)	150 Hz to 160 kHz

*Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), animals are able to detect very loud sounds above and below that "generalized" hearing range

We reviewed and adopted NSF and L-DEO's application of NMFS's acoustic thresholds to determine at what point during exposure to sound from the airgun array marine mammals may be adversely affected. An estimate of the number of marine mammals that will be exposed to sound from the airgun array is included in NSF's draft environmental assessment (LGL 2025). We describe the methods to estimate the number of ESA-listed marine mammals that may be exposed below.

Ensonified Area

As described in Section 2.1.1, there will be 20 days of seismic operations totaling approximately 4,264 km of seismic acquisition (691 km of MCS and 3,573 km of OBS) in waters deeper than 4,000 m. Table 2 and Table 3 describe the radial distances from the airgun array to the 160 dB re 1 μPa (rms) behavioral disturbance onset threshold and AUD INJ onset threshold for low-frequency and high frequency marine mammals in deep water.

The daily ensonified area for the seismic survey based on the 160 dB re 1μPa (rms) threshold is approximately 2,593 square kilometers (km^2) for MCS seismic acquisition using a shot interval of 50 m at 4.1 knots, and approximately 3,132 km^2 for OBS seismic acquisition using a shot interval of 200 m at 5 knots. The daily ensonified areas were calculated using the radial distances from the airgun array to the predicted threshold, along representative seismic tracklines that could be surveyed in one day: approximately 222 km at 5 knots (for OBS) and approximately 182 km at 4.1 knots (for MCS). To calculate the total ensonified area, the daily ensonified area was increased by 25% (equivalent to an additional 25% of seismic acquisition, to account for any delays or re-surveying of areas with poor data quality), and then multiplied by the total number of seismic days (16 days for OBS and four days for MCS). This estimates the total area expected to be ensonified (MCS and OBS) to sound levels corresponding to the onset of behavioral disturbance, which is approximately 75,604 km^2 (Table 10). The same method was used to determine the total area ensonified (MCS and OBS) to the AUD INJ onset threshold, which is approximately 2,086 km^2 for low-frequency cetaceans and approximately 151 km^2 for high-frequency cetaceans (Table 11).

Table 10. Ensonified areas for onset of behavioral disturbance in ESA-listed marine mammals

Type of Seismic Acquisition	Isopleth (m)	Daily Ensonified Area (km^2)	Survey Days	Total Ensonified Area with 25% Increase (km^2)
50-m interval at 4.1 knots (MCS)	6,733	2,593.2	4	12,966.2
200-m interval at 5 knots (OBS)	6,733	3,131.9	16	62,637.4

m = meters, MCS = multichannel seismic; OBS = ocean bottom seismometer; km^2 = square kilometers

AUD INJ is expected at received levels of 183 dB re 1 μPa^2-s (SEL_{cum}) or 222 dB re 1 μPa (SPL_{peak}) from impulsive sound for low-frequency cetaceans and at received levels of 193 dB re 1 μPa^2-s (SEL_{cum}) or 230 dB re 1 μPa (SPL_{peak}) from impulsive sound for high-frequency cetaceans (NMFS 2024a).

Table 11. Ensonified areas for onset of AUD INJ in ESA-listed marine mammals

Criteria and Type of Seismic Acquisition	Isopleth (m)	Daily Ensonified Area (km^2)	Survey Days	Total Ensonified Area with 25% Increase (km^2)
Low-frequency Cetaceans (SEL_{cum}) 50-m interval at 4.1 knots (MCS)	468.7	208.8	4	1,044
Low-frequency Cetaceans (SEL_{cum}) 200-m interval at 5 knots (OBS)	117.2	52.1	16	1,041.6
High-frequency Cetaceans (SPL_{peak})	13.6	6.04	4	30.2

50-m interval at 4.1 knots (MCS)				
High-frequency Cetaceans (SPL_{peak}) 200-m interval at 5 knots (OBS)	13.6	6.04	16	120.8

m = meters, MCS = multichannel seismic; OBS = ocean bottom seismometer; km^2 = square kilometers

Density

We reviewed available marine mammal densities and group sizes with the NSF, L-DEO, and the Permits and Conservation Division and agreed that densities from Roberts et al. (2023) constituted the best available scientific information for each ESA-listed marine mammal species. The Permits and Conservation Division adopted these estimates for their proposed IHA, and we have adopted them for our exposure analysis for blue, fin, sei, and sperm whales.

The habitat-based stratified cetacean densities for the North Atlantic Ocean for the U.S. Navy Atlantic Fleet Testing and Training (AFTT) Area from Roberts et al. (2023) was the best option for calculating exposure of marine mammals during the proposed action. For blue and sperm whales, densities did not change based on season. For fin and sei whales, the highest mean monthly density between July and October were chosen to overlap with the period of the proposed seismic surveys. Table 12 shows the averaged densities in the 10 km by 10 km grid cells for the AFTT area overlapping the proposed seismic survey area for each marine mammal species.

Table 12. ESA-listed marine mammal densities in the proposed seismic survey area

Species	Density (number of individuals/km^2)
Blue Whale	0.00002
Fin Whale	0.000011
Sei Whale	0.000319
Sperm Whale	0.003625

km^2=square kilometers

Exposure Estimates

Blue whales, fin whales, sei whales, and sperm whales of all age classes are likely to be exposed during the seismic survey. Given that the high-energy seismic survey would be conducted in the summer/fall, we expect that most animals would be on their feeding grounds or beginning their migration south. These whales are all expected to be feeding, traveling, or migrating through the seismic survey area. We assume that sex distribution is even for blue whales, fin whales, sei whales, sperm whales, and sexes are exposed at a relatively equal level.

The population abundance estimates of blue, fin, sei, and sperm whales considered in this consultation represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. In this case, we rely on the AFTT modeled abundance, similar to the species densities. The percentage of exposure for each population of blue, fin, sei, and sperm whales in the action area is summarized below. Exposure estimates (Table 13) were derived from multiplying species densities (Table 12) by the largest total ensonified area (Table 10). Note that the largest ensonified area for marine mammals results from the behavioral disturbance acoustic threshold (160 dB re 1 μPa).

The estimated number of individuals exposed is likely higher than the actual number of exposures. Past consultations on NSF-funded seismic surveys, using the same method of estimating marine mammal densities and in a similar but more nearshore area, estimated approximately 419–745 exposed marine mammals (see OPR-2022-02949 [two blue whales exposed, four fin whales exposed, 30 sei whales exposed, and 709 sperm whales exposed] and OPR-2022-02837 [one blue whale exposed, four fin whales exposed, eight sei whales exposed, and 406 sperm whales exposed]). Monitoring and conservation measures during those surveys were the same as those described in Section 2.2 for these proposed seismic surveys. Monitoring reports after the conclusion of the prior seismic surveys stated that no individuals of these species were observed within the ensonified area corresponding to the 160 dB re 1 μPa threshold. While it is possible that monitoring measures missed detecting a marine mammal, it is unlikely given the monitoring and PSO requirements. The density and exposure estimates here still represent the best available information for the action area.

Table 13. Exposure estimates for ESA-listed marine mammals

Species	Total Ensonified Area (km^2)	Density (# animals/km^2)	Estimated Individuals Exposed*
Blue Whale	75,604	0.00002	2
Fin Whale	75,604	0.000011	1
Sei Whale	75,604	0.000319	24
Sperm Whale	75,604	0.003625	274

km^2=square kilometers

* Rounded to the nearest whole number; may account for multiple exposures to a smaller number of individuals (see discussion below)

Blue whale – The estimated exposure of the regional population (approximately 191 animals) of blue whales is two animals, which is approximately 1% of the regional population. This number is likely higher than the actual exposures given the conservation measures that will be implemented, resulting in effects to fewer individuals.

Fin Whale — The estimated exposure of the regional population of fin whales (approximately 11,672 individuals) of fin whales is one animal, which is approximately 0.01% of the regional population.

Sei Whale — The estimated exposure of the regional population (approximately 19,530 individuals) of sei whales is 24 animals, which is approximately 0.1% of the regional population. This is likely higher than the actual exposures given the conservation and monitoring measures that will be implemented, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there will be multiple exposures of a smaller number of individuals that will occur within the action area.

Sperm Whale – The estimated exposure of the regional population (approximately 5,895 individuals) of sperm whales is 274 animals, which is approximately 4.6% of the regional population. This is likely higher than the actual exposures given the conservation and monitoring measures that will be implemented, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there may be multiple exposures of a smaller number of individuals that will occur within the action area.

6.1.1.2 Sea Turtle Exposure

The ESA-listed sea turtles that are likely to be adversely affected by sound from the airgun array are the North Atlantic DPS green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS loggerhead turtle. These species' hearing ranges encompass the frequency range within which the airgun array operates (Section 4.2).

We reviewed and adopted NSF's application of NMFS's acoustic thresholds to determine at what point during exposure to sound from the airgun array sea turtles may be adversely affected. An estimate of the number of sea turtles that will be exposed to sound from the airgun array is included in NSF's draft environmental assessment (LGL 2025). We describe the methods to estimate the number of ESA-listed sea turtles that may be exposed below.*Ensonified Area*

As described in Section 2.1.1, there will be 20 days of seismic operations totaling approximately 4,264 km of seismic acquisition (691 km of MCS and 3,573 km of OBS) in waters deeper than 4,000 m. Table 2 and Table 3 describe the radial distances from the airgun array to the 175 dB re 1 μPa (rms) behavioral disturbance onset threshold and AUD INJ onset threshold for sea turtles in deep water.

The daily ensonified area for the seismic survey based on the 175 dB re 1μPa (rms) threshold is approximately 689 km^2 for MCS seismic acquisition using a shot interval of 50 m at 4.1 knots, and approximately 839 km^2 for OBS seismic acquisition using a shot interval of 200 m at 5 knots. The daily ensonified areas were calculated using the radial distances from the airgun array to the predicted threshold, along representative seismic tracklines that could be surveyed in one day: approximately 222 km at 5 knots (for OBS) and approximately 182 km at 4.1 knots (for MCS). To calculate the total ensonified area, the daily ensonified area was increased by 25% (equivalent to an additional 25% of seismic acquisition, to account for any delays or re-surveying areas with poor data quality), and then multiplied by the total number of seismic days (16 days for OBS and four days for MCS). This estimates the total area expected to be ensonified to sound levels corresponding to the onset of behavioral disturbance. The total ensonified area (MCS and OBS) associated with onset of behavioral disturbance is approximately 20,218 km^2 (Table 14). The same method was used to determine the total area ensonified to the AUD INJ onset threshold. The total ensonified area (MCS and OBS) associated with onset of AUD INJ is approximately 2,871 km^2 (Table 15).

Table 14. Ensonified areas for onset of behavioral disturbance in ESA-listed sea turtles

Type of Seismic Acquisition	Isopleth (m)	Daily Ensonified Area (km^2)	Survey Days	Total Ensonified Area with 25% Increase (km^2)
50-m interval at 4.1 knots (MCS)	1,864	689.4	4	3,447.1
200-m interval at 5 knots (OBS)	1,864	838.5	16	16,770.6

m = meters, MCS = multichannel seismic; OBS = ocean bottom seismometer; km^2 = square kilometers

Table 15. Ensonified areas for onset of AUD INJ in ESA-listed sea turtles

Criteria and Type of Seismic Acquisition	Isopleth (m)	Daily Ensonified Area (km^2)	Survey Days	Total Ensonified Area with 25% Increase (km^2)
Sea Turtles (SEL_{cum}) 50-m interval at 4.1 knots (MCS)	644.9	287.6	4	1,438.2
Sea Turtles (SEL_{cum}) 200-m interval at 5 knots (OBS)	161.2	71.7	16	1,433.1

m = meters, MCS = multichannel seismic; OBS = ocean bottom seismometer; km^2 = square kilometers

Density

We reviewed available sea turtle densities and reviewed NSF's density analysis to determine densities that constituted the best available scientific information for each ESA-listed sea turtle species.

NSF estimated densities using Putman et al. (2020) for Kemp's ridley, green, and loggerhead turtles, and Bovery and Wyneken (2016) for leatherback turtles. Densities for pelagic-stage turtles were derived from model outputs described in Putman et al. (2020), whichmodeled sea turtle dispersal into the Gulf of America, Gulf of Mexico, and wider Atlantic Ocean (including the Sargasso Sea) based on surface currents after sea turtles hatched from nesting sites in the Gulf of America, Gulf of Mexico, and off both Florida coasts. NSF estimated sea turtle densities by using the daily number of estimated turtles in the seismic survey area, for each day July–October between 2005–2016, based on the Putman et al. (2020) modeled data. NSF then calculated the mean daily abundance of Kemp's ridley, green, and loggerhead turtles and divided the abundance by the seismic survey area (approximately 297,906 km^2). Bovery and Wyneken (2016) estimated leatherback densities in the southeast Florida Current.

While the DiMatteo et al. (2024) sea turtle density models are widely regarded as the best available on the U.S. East Coast, the modeled area does not cover the seismic survey area. However, upon our review of available sea turtle densities, the densities at the closest point of the DiMatteo et al. (2024) modeled area to the seismic survey area are similar or less than the densities NSF estimated from Putman et al. (2020) and Bovery and Wyneken (2016) for the seismic survey area. Thus, although there is uncertainty about the representativeness of the density data and the assumptions used to estimate exposures, and densities derived from past surveys or models may not be precisely representative of the densities that would actually be encountered during the seismic survey (e.g., models did not consider *Sargassum*, which is known sea turtle habitat), we adopted NSF's density analysis for sea turtles. Density estimates for each sea turtle species are found in Table 16. The approach used here is based on the best available data.

Table 16. ESA-listed sea turtle densities in the proposed seismic survey area

Species	Density (number of individuals/km^2)
Green Turtle – North Atlantic DPS	0.088569
Kemp's Ridley Turtle	0.000933
Leatherback Turtle	0.00018
Loggerhead Turtle – Northwest Atlantic Ocean DPS	0.221444

km^2=square kilometers

Exposure Estimates

Adults, juveniles, and post-hatchlings of the North Atlantic DPS green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS loggerhead turtle are likely to be exposed during the seismic survey. Given that the high-energy seismic survey will be conducted in the summer/fall, we expect that most animals would be nesting or foraging. All sea turtle species are expected to be feeding or traveling in the action area and some females may occur closer to shore for nesting.

Exposure estimates (Table 17) were derived from multiplying species densities (Table 16) by the largest total ensonified area (Table 15). Note that the largest ensonified area for sea turtles results from the behavioral disturbance acoustic threshold (175 dB re 1 μPa).

The estimated number of individuals exposed is likely higher than the actual number of exposures. Past consultations on NSF-funded seismic surveys using the same method of estimating sea turtle densities and in a similar but more nearshore area, estimated approximately 360–1,300 exposed sea turtles (see OPR-2022-02949 [116 green turtles exposed, two Kemp's ridley turtles exposed, eight leatherback turtles exposed, and 234 loggerhead turtles exposed] and OPR-2022-02837 [251 green turtles exposed, two Kemp's ridley turtles exposed, two leatherback turtles exposed, and 1,047 loggerhead turtles exposed]).

Monitoring and conservation measures during those surveys were the same as those described in Section 2.2 for these proposed seismic surveys. However, monitoring reports after the conclusion of the seismic surveys stated that only one to four sea turtles (green, loggerhead, or unidentified turtle) were observed within the ensonified area corresponding to the 175 dB re 1 μPa threshold. While it is possible that monitoring measures missed detecting a sea turtle, particularly one that is small (i.e., hatchlings and juveniles), it is unlikely given the monitoring and PSO requirements. The density and exposure estimates here still represent the best available information for the action area.

Table 17. Exposure estimates for ESA-listed sea turtles

Species	Total Ensonified Area (km^2)	Density (# animals/km^2)	Estimated Individuals Exposed*
Green Turtle – North Atlantic DPS	20,218	0.088569	1,791
Kemp's Ridley Turtle	20,218	0.000933	19
Leatherback Turtle	20,218	0.00018	4
Loggerhead Turtle – Northwest Atlantic Ocean DPS	20,218	0.221444	4,477

km^2=square kilometers
* Rounded to the nearest whole number; may account for multiple exposures to a smaller number of individuals (see discussion below)

Green Turtle North Atlantic DPS – The estimated exposure of the North Atlantic DPS of green turtle (population abundance unknown) is 1,791 animals, which is an unknown percentage of the regional population. Using DiMatteo et al. (2024) green turtle population estimates along the U.S. East Coast (63,674 turtles), which does not encompass the entire range of the DPS, this is approximately 2.8% of the population. This number is likely higher than the actual exposures given uncertainty regarding the representativeness of the density data and conservation measures that will be implemented, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there will be multiple exposures of a smaller number of individuals that will occur within the action area.

Kemp's Ridley Turtle – The estimated exposure of Kemp's ridley turtle (population abundance unknown) is 19 animals, which is an unknown percentage of the regional population. Using DiMatteo et al. (2024) Kemp's ridley turtle population estimates along the U.S. East Coast (10,762 turtles), which does not encompass the entire range of the species, this is approximately 0.2% of the population. This number is likely higher than the actual exposures given uncertainty regarding the representativeness of the density data and conservation measures that will be implemented, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there will be multiple exposures of a smaller number of individuals that will occur within the action area.

Leatherback Turtle – The estimated exposure of leatherback turtle (population abundance unknown) is four animals, which is an unknown percentage of the regional population. Using DiMatteo et al. (2024) leatherback turtle population estimates along the U.S. East Coast (21,984 turtles), which does not encompass the entire range of the species, this is approximately less than

0.02% of the population. This number is likely higher than the actual exposures given uncertainty regarding the representativeness of the density data and conservation measures that will be implemented, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is possible that there will be multiple exposures of a smaller number of individuals that will occur within the action area.

Loggerhead Turtle Northwest Atlantic Ocean DPS – The estimated exposure of the Northwest Atlantic Ocean DPS of loggerhead turtle (population abundance unknown) is 4,477 animals, which is an unknown percentage of the regional population. Using DiMatteo et al. (2024) loggerhead turtle population estimates along the U.S. East Coast (193,423 turtles), which does not encompass the entire range of the DPS, this is approximately 2.3% of the population. This number is likely higher than the actual exposures given uncertainty regarding the representativeness of the density data and conservation measures that will be implemented, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there may be multiple exposures of a smaller number of individuals that will occur within the action area.

6.2 Response

Given the potential for exposure to sound from the airgun array discussed above, in this section, we describe the probable response or range of responses likely to result from that exposure for ESA-listed species. Our assessment considers the potential lethal, sub-lethal (or physiological), or behavioral responses that might reduce the fitness of individuals.

6.2.1 Species Response

For species, we discuss responses in terms of physiological, physical, or behavioral effects to the species. These responses may rise to the level of take under the ESA. *Take* is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (16 U.S.C. §1532(19)). We evaluate the probable responses to stressors by relying on the best scientific and commercial data available.

A pulse of sound from the airgun array displaces water around the airgun array and creates a wave of pressure, resulting in physical effects on the marine environment that can then affect marine organisms, such as ESA-listed marine mammals and sea turtles considered in this opinion. Possible responses considered in this analysis consist of:

- Hearing threshold shifts.
- Auditory interference (masking).
- Behavioral responses.
- Non-auditory physical or physiological effects.

6.2.1.1 Response of Marine Mammals

Hearing Threshold Shifts

Exposure of marine mammals to very strong impulsive sound sources from airgun arrays can result in auditory damage, such as changes to sensory hairs in the inner ear, which may temporarily or permanently impair hearing by decreasing the range of sound an animal can detect within its normal hearing ranges. Hearing threshold shifts depend upon the duration, frequency, sound pressure, and rise time of the sound. A temporary threshold shift (TTS) is a temporary, reversible increase in hearing threshold at a specified frequency or portion of an animal's hearing range above a previously established reference level (Finneran 2013). PTS is a permanent, irreversible increase in hearing threshold at a specified frequency of a portion of an animal's hearing range above a previously established reference level. AUD INJ acknowledges that auditory injury, such as the loss of cochlear neuron synapses or auditory neuropathy, may occur even if hearing thresholds return to previously established reference levels. In other words, AUD INJ includes PTS, but can occur without resulting in PTS (U.S. Department of the Navy 2024). A study looking at the effects of sound on mice hearing has shown that, although full hearing can be regained from TTS (i.e., the sensory cells actually receiving sound are normal), damage can still occur to the cochlear nerves leading to delayed but permanent hearing damage (Kujawa and Liberman 2009b). At higher received levels, particularly in frequency ranges where animals are more sensitive, AUD INJ (including PTS) can occur, meaning lost auditory sensitivity is unrecoverable. Either of these conditions can result from exposure to a single pulse or from the accumulated effects of multiple pulses, where a single pulse may not be as loud but has the same accumulated effect. Instances of TTS and AUD INJ are generally specific to the frequencies over which exposure occurs but can extend to a half-octave above or below the center frequency of the source in tonal exposures (less evident in broadband noise such as the sound sources associated with the proposed actions (Kastak 2005; Ketten 2012; Schlundt 2000).

Few data are available to precisely define each ESA-listed marine mammal species' hearing range or sensitivity, or the levels necessary to induce TTS or AUD INJ. Blue whales, fin whales, and sei whales have an estimated generalized hearing range of 7 Hz to 36 kHz and sperm whales have an estimated generalized functional hearing frequency range of 150 Hz to 160 kHz (NMFS 2024a).

Thresholds for TTS and AUD INJ are based on the best available information, which are derived from captive studies of marine mammals, our understanding of terrestrial mammal hearing, and extensive modeling. In terms of exposure to the R/V *Langseth*'s airgun array, an individual must be extremely close to the airgun to experience a single pulse greater than the respective SPL_{peak} threshold: 222 dB re 1 µPa for low-frequency cetaceans and 230 dB re 1 µPa for high-frequency cetaceans. If an individual experienced exposure to several airgun pulses at those levels, AUD INJ could occur. Cetaceans must be within certain modeled radial distances specified in Table 2 and Table 3 from the R/V *Langseth*'s 36-airgun array to be within the AUD INJ threshold isopleth, TTS, or other measurable behavioral response.

Though we expect that individuals will move away from the airgun array as it approaches if the sound is adverse, a few individuals, particularly if they are engaged in key life functions such as foraging, may not move away and would be exposed to sound levels that could result in some form of a hearing threshold shift. Ramp-ups likely reduce the probability of exposure to hearing threshold shifts because as acoustic intensity increases and animals detect that increase, they can move away, and avoid exposure to more injurious sound levels. Furthermore, conservation measures will be in place to initiate a shutdown if individuals enter or are about to enter the 500 m shutdown zone during the 36-airgun array operations, which is similar to the distances that potentially cause AUD INJ in ESA-listed marine mammals. As evaluated in the exposure analysis, each individual could be exposed to sound above the 160 dB re 1 μPa (rms) level. We do not expect AUD INJ due to the conservation measures being implemented. We expect that individuals will recover from TTS between each of these short-duration exposures. We expect monitoring to produce some degree of mitigation such that exposures will be reduced, and (as stated above) we expect individuals to show avoidance behaviors (i.e., moving away) as received sound levels increase, reducing the likelihood of exposure at levels that could affect their fitness. In summary, we do not expect animals to be exposed to sound levels that can cause AUD INJ. If animals are exposed to sound levels that can cause TTS, we expect TTS will be temporary, and animals will quickly make a full recovery.

Masking

Masking occurs when a sound is a similar frequency and similar to or louder than the sound an animal is trying to hear (Clark et al. 2009; Erbe et al. 2016). Masking can interfere with an individual's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Richardson 1995). This can result in loss of cues of predatory risk, mating opportunity, or foraging options (Francis and Barber 2013). Low-frequency sounds are broad and tend to have relatively constant bandwidth, whereas higher frequency bandwidths are narrower (NMFS 2006h).

The frequency range of the airgun array overlaps with the frequency range of ESA-listed cetacean vocalizations, particularly those of baleen whales and, to some extent, sperm whales. The seismic survey could mask sperm whale calls at some of the lower frequencies for this species. This could affect communication between individuals, their ability to receive information from their environment, or sperm whale echolocation (Evans 1998; NMFS 2006h). Most of the energy of sperm whale clicks is concentrated at 2–4 kHz and 10–16 kHz and, though the findings by Madsen et al. (2006a) suggest frequencies of pulses from airgun arrays can overlap this range, the dominant frequency component of the R/V *Langseth*'s airgun array is below 200 Hz (2–188 Hz). Any masking that might occur will be temporary because acoustic sources from the seismic surveys are not continuous and the R/V will be in constant motion, transiting through the area. Given the disparity between sperm whale echolocation and communication-related sounds with the dominant frequencies for seismic surveys, masking is not likely to be significant for sperm whales (NMFS 2006h). Nieukirk et al. (2012) analyzed 10 years of recordings from the Mid-Atlantic Ridge. When several surveys were recorded simultaneously, whale sounds were masked (drowned out), and the airgun noise became the dominant component of background noise levels. The R/V *Langseth*'s airgun array will emit an approximately 0.01 second pulse when fired approximately every 24 or 78 seconds during the high-energy seismic surveys, while sperm whale calls last 0.5–1 second. Therefore, pulses will not "cover up" the vocalizations of sperm whales to a significant extent (Madsen et al. 2002b).

The sound localization abilities of cetaceans suggest that, if a signal and potential masking sound come from different directions, masking will not be as severe as typical masking studies suggest (Richardson 1995). The dominant background noise may be directional if it comes from a localized source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these sounds by improving the effective signal-to-sound ratio. Toothed whales, and probably other cetaceans, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background sound. There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with a lot of ambient sound toward frequencies with less noise (Au 1975; Au et al. 1974; Au 1974; Lesage 1999; Moore 1990; Romanenko and Kitain 1992; Romanenko 1992; Thomas 1990). A few marine mammal species increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Au 1993; Dahlheim 1987; Foote 2004; Holt et al. 2009; Lesage 1999; Lesage 1993; Parks 2009a; Parks et al. 2007; Terhune 1999). Parks et al. (2011) documented an increase in the amplitude of North Atlantic right whale calls during periods of increased background noise.

Other studies reported decreased likelihood of calling during periods of high noise, or even complete cessation of calling (e.g., Melcón et al. 2012; Tsujii et al. 2018). In the Beaufort Sea, bowhead whales (*Balaena mysticetus*) recorded at sites near seismic survey airgun activity decreased their call localization rate (the number of localized calls per hour within a specified study area) during and after the seismic survey. In other words, calling was highest before seismic activity. In contrast, call localization rates or bowhead whales recorded at sites further away from the seismic survey activity were either unchanged before, during, and after seismic activity, or were lowest before seismic activity (Blackwell et al. 2013a).

In summary, high levels of sound generated by the seismic survey activities may mask the detection of weaker biologically important sounds for some cetaceans considered in this consultation. This masking is expected to be more prominent for baleen whales (blue whales, fin whales, and sei whales) given their hearing range and frequency range at which they produce vocalizations. For toothed whales (sperm whales) that hear best at frequencies above the predominant ones produced by airguns, there may be modifications to aspects of their vocalizations that allow them to reduce the effects of masking on higher frequency sounds such as echolocation clicks like other toothed whales mentioned above (e.g., belugas, Au et al. 1985). As such, toothed whales are not expected to experience significant masking while the airgun arrays are producing sound.

Behavioral Responses

We expect the most frequent and greatest impact of airgun array sounds on cetaceans to be behavioral. ESA-listed cetaceans may briefly change their behavior or relocate a short distance away from the airgun array, but population-level consequences from these behavioral responses are unlikely. Displacement from important feeding or breeding areas over a prolonged period would be more significant for individuals, and could affect the population depending on the extent of the feeding area and duration of displacement. For example, increased seismic survey activity along the Brazilian coast may have resulted in extended displacement of humpback whales (Parente et al. 2007). Just as aquatic, aerial, and terrestrial animal responses to anthropogenic noise have differing fitness consequences (Costa et al. 2016; Fleishman et al. 2016; Francis and Barber 2013; New et al. 2014; NRC 2005), cetacean responses will vary by species, maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012; Harris et al. 2018).

Several studies help us identify thresholds at which whales may modify or stop their calls in response to sounds from airguns. Whales may continue calling while seismic surveys are operating locally (Greene Jr et al. 1999; Jochens et al. 2006; Madsen et al. 2002a; McDonald et al. 1993; McDonald et al. 1995; Nieukirk et al. 2004; Richardson et al. 1986a; Smultea et al. 2004; Tyack et al. 2003). Some blue whales, fin whales, and sperm whales stopped calling for short and long periods in response to airguns (Bowles et al. 1994; Clark and Gagnon 2006; McDonald et al. 1995). Fin whales (presumably adult males) engaged in singing in the Mediterranean Sea moved out of the area of a seismic survey while airguns were operational and did not return for at least a week (Castellote et al. 2012a). Dunn and Hernandez (2009) tracked blue whales during a seismic survey on the R/V *Maurice Ewing* in 2007 and did not observe changes in call rates or identify anomalous behavior that they could attribute to airgun sound levels of approximately less than 145 dB re 1 μPa (rms). Blue whales may call more frequently during seismic surveys (Iorio and Clark 2009). Bowhead whale calling rates decreased during migration in the Beaufort Sea when seismic surveys were being conducted (Nations et al. 2009). Calling rates decreased when exposed to seismic airguns at estimated received levels of 116–129 dB re 1 μPa (rms), but did not change at received levels of 99–108 dB re 1 μPa (rms; Blackwell et al. 2013b). A more recent study examining cumulative sound exposure found that bowhead whales began to increase call rates as soon as airgun sounds were detectable, but this increase leveled off at approximately 94 dB re 1 μPa^2-s over the course of 10 minutes (Blackwell et al. 2015). Once sound levels exceeded approximately 127 dB re 1 μPa^2-s over 10 minutes, call rates began to decline and, at approximately 160 dB re 1 μPa^2-s over 10 minutes, bowhead whales appeared to cease calling (Blackwell et al. 2015).

One study reported that sperm whales ceased calling when airguns were being fired hundreds of kilometers away (Bowles et al. 1994), yet in other studies sperm whales did not respond to received airgun sound levels up to 146 dB re 1 μPa (peak-to-peak; Madsen et al. 2002a; McCall Howard 1999). Detections of fin whale vocalizations decreased by 52% during active seismic surveys off northwestern Spain, with the most rapid decrease observed one to two days after the surveys began (Edwards et al. 2026). When exposed to seismic airguns, researchers observed a reduction in singing humpback whale song cycle duration by approximately 12.8 seconds for every 1 dB increase in airgun noise over 135 dB re 1 μPa^2-s and a 64% reduction in complex song phrases when exposed to airgun noise (Johnson et al. 2026).

Some exposed ESA-listed whales may cease calling or otherwise alter their vocal behavior in response to the R/V *Langseth*'s airgun array during the seismic survey activities. The effect is expected to be temporary and brief given the R/V is constantly moving when the airgun array is active. Animals may resume or modify calling later or in a location away from the R/V *Langseth*'s airgun array once the acoustic stressor has diminished.

Activity of individuals seems to influence response (Robertson et al. 2013), as feeding individuals respond less than mother and calf pairs and migrating individuals (Harris et al. 2007; Malme and Miles 1985; Malme et al. 1984b; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995b; Richardson et al. 1999). Feeding bowhead whales did not avoid vessels or cease feeding while seismic airgun surveys occurred 10–50 km away, apparently tolerating received sound levels up to 180 dB re 1 μPa (rms; Koski et al. 2008).

Migrating bowhead whales show strong avoidance reactions to received sound levels of 120–130 dB re 1 μPa (rms) at distances of 20–30 km, but only changed dive and respiratory patterns while feeding. Total avoidance was reported for exposures to higher received sound levels (152–178 dB re 1 μPa [rms]; Harris et al. 2007; Ljungblad et al. 1988; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995b; Richardson et al. 1999; Richardson et al. 1986b). Nations et al. (2009) also found that bowhead whales were displaced during migration in the Beaufort Sea during active seismic surveys.

The available data indicate that most, if not all, baleen whale species exhibit avoidance of active seismic airguns (Barkaszi et al. 2012; Castellote et al. 2012b; Gordon et al. 2003; NAS 2017; Potter et al. 2007; Southall et al. 2007; Stone et al. 2017; Stone and Tasker 2006). Despite the above observations and exposure to repeated seismic surveys, bowhead whales continue to return to summer feeding areas and, when displaced, appear to return within a day (Richardson et al. 1986b). We do not know whether the individuals exposed within these ensonified areas are the same individuals returning or whether, though they tolerate repeat exposures, they may still experience a stress response. However, we expect that the action's pre-survey ramp-up, the vigilance of NMFS-approved PSOs, and the shutdown procedures when marine mammals are in the exclusion/shutdown zone will lower the likelihood that marine mammals will be exposed to significant sound levels from the airgun array.

Migrating humpbacks, including females with calves, altered their travel path (at least locally) along Western Australia at received sound levels as low as 140 dB re 1 μPa (rms) and showed an avoidance response at 7–12 km from the acoustic source (McCauley et al. 2000a; McCauley et al. 1998). A startle response occurred as low as 112 dB re 1 μPa (rms). Closest approaches were generally limited to 3–4 km, although some individuals (mainly males) approached to within 100 m on occasion where sound levels were 179 dB re 1 μPa (rms). Changes in course and speed generally occurred at estimated received sound levels of 157–164 dB re 1 μPa (rms). Similarly, on the east coast of Australia, migrating humpback whales appear to avoid seismic airguns at distances of 3 km at levels of 140 dB re 1 μPa^2-second. Humpback whales exhibited no abnormal behaviors in response to a full active 3,130 in^3 airgun array and, while there were detectable changes in respiration and diving, these were similar to those observed when baseline groups (i.e., not exposed to active sound sources) were joined by another humpback whale (Dunlop et al. 2017). While some humpback whales reduced their speed and changed course along their migratory route, overall behavioral responses are unlikely to have significant biological consequences (Dunlop et al. 2017). Feeding humpback whales appeared to be somewhat more tolerant to noise exposure. Humpback whales off the coast of Alaska exhibited startle responses at 150–169 dB re 1 μPa (rms) and no clear evidence of avoidance was apparent at received sound levels up to 172 dB re 1 μPa (rms; Malme et al. 1984b; Malme et al. 1985). Potter et al. (2007) reported localized avoidance of airgun arrays by humpback whales on feeding grounds in the Atlantic Ocean. Among humpback whales on Angolan breeding grounds, no clear difference was observed in encounter rate or point of closest approach during seismic versus non-seismic periods (Weir 2008b).

Behavioral data in response to airguns are sparse for baleen whales on breeding and feeding grounds. Available data support a general avoidance response. Some fin and sei whale sighting data indicate similar sighting rates during seismic versus non-seismic periods, but sightings tended to be further away and individuals remained underwater longer (Stone 2003; Stone et al. 2017; Stone and Tasker 2006). Other studies reported small differences in sighting rates (lower during seismic survey activities), as well as whales being more distant from the seismic vessel during seismic survey activities (Moulton and Miller 2005a). At the average sighting distance, individuals will have likely been exposed to approximately 169 dB re 1 μPa (rms; Moulton and Miller 2005b).

Sperm whale response to airguns has thus far included mild behavioral disturbance (temporarily disrupted foraging, avoidance, cessation of vocal behavior) or no reaction. Several studies have found sperm whales in the Atlantic Ocean to show little or no response (Davis et al. 2000; Madsen et al. 2006b; Miller et al. 2009b; Moulton and Miller 2005a; Stone 2003; Stone et al. 2017; Stone and Tasker 2006; Weir 2008a). In the Gulf of America, Miller et al. (2009a) concluded that sperm whales in their study did not avoid airgun noise, potentially due to habituation to the sound in a highly industrialized Gulf of America, but that sperm whales may delay foraging until airgun noise ceases. Johnson and Miller (2002) noted possible sperm whale avoidance of seismic sound sources at received sound levels of 137 dB re 1 μPa. Other anthropogenic sounds, such as pingers and sonars, disrupt behavior and vocal patterns (Goold 1999; Watkins et al. 1985; Watkins and Schevill 1975). The intensity and frequency of the disturbance created by the airguns influenced the responses of exposed sperm whales. The persistent, high-level disturbance caused by exposure to underwater noise associated with oil and gas activities in the Gulf of America was predicted to cause significant reductions in fitness, especially for reproductive female sperm whales due to lost foraging opportunities, to the point of starvation (Farmer et al. 2018a). An individual sperm whale's resilience to foraging disturbance depends on its size and daily energetic demands with pregnant and nursing sperm whales being most vulnerable (Farmer et al. 2018b). The amount of time between disturbances to foraging behavior matters because sperm whales need time to replenish lost reserves. Thus, intermittent disturbances to foraging behavior, such as those that may occur from the proposed action, are less impactful than continuous disruption.

Winsor and Mate (2013) reported that satellite-tagged sperm whales in the Gulf of America were randomly distributed at and beyond 5 km from airgun arrays, suggesting individuals were not displaced and did not move away from the airgun array at and beyond these distances. However, no tagged whales within 5 km were available to assess whether their distribution was random or suggested non-random avoidance within 5 km (Winsor and Mate 2013). In a follow-up study using additional data, Winsor et al. (2017) found no evidence to suggest sperm whales avoid active airguns within distances of 50 km. The lack of response by this species may, in part, be due to its higher frequency range of hearing and the low-frequency (generally less than 200 Hz) pulses produced by seismic airguns (Richardson et al. 1995b). Sperm whales are exposed to considerable sound energy above 500 Hz during the course of seismic surveys (Goold and Fish 1998), so, even though this species generally hears at higher frequencies, it can still hear airgun sounds. Breitzke et al. 2008 found that source levels were approximately 30 dB re 1 μPa lower at 1 kHz and 60 dB re 1 μPa lower at 80 kHz compared to dominant frequencies during a seismic source calibration. Another odontocete, bottlenose dolphins, progressively reduced their vocalizations as an airgun array came closer and got louder (Woude 2013). Reactions of sperm whales to impulse noise likely vary depending on the activity at the time of exposure. For example, in the presence of abundant food or during breeding encounters, toothed whales can be tolerant of noise pulses (NMFS 2010c).

An animal's prior exposure to sounds from seismic surveys may influence its future response. If prior exposure produces a learned response, then subsequent response, such as moving away and reduced time budget for activities otherwise undertaken, will likely be similar to or less than prior responses to novel stimuli and behavioral responses. ; Andre 1997; André 1997; Gordon et al. 2006). Seismic survey activities can potentially lead cetaceans and pinnipeds to habituate to sounds from airgun arrays, which may lead to additional energetic costs or reductions in foraging success (Nowacek et al. 2015). However, we do not believe habituation will occur based upon the lack of severe responses previously observed in marine mammals exposed to sounds from seismic surveys expected to produce a more intense, frequent, and/or earlier response to subsequent exposures. Additionally, the seismic surveys will take place over approximately 20 days, minimizing the likelihood that habituation will occur. We believe that exposed individuals will move away from the sound source, especially in the open ocean of the action area, where we expect ESA-listed marine mammals to be transiting through.

In summary, ESA-listed marine mammals are expected to exhibit a wide range of behavioral responses when exposed to sound fields from the airgun array. Baleen whales are expected to mostly exhibit avoidance behavior, and may alter their vocalizations. Toothed whales (i.e., sperm whales) are expected to exhibit less overt behavioral changes, but may alter foraging behavior, including echolocation vocalizations. Behavioral reactions will be short-term, likely lasting the duration of the exposure, and long-term consequences for individuals or populations are unlikely. Long-term exposure to individuals or populations are further minimized due to the implementation of conservation measures.

Physical or Physiological Effects

Possible physical or physiological responses to impulsive sound sources like airgun arrays include neurological injury, bubble formation, and other types of organ or tissue damage (Cox et al. 2006; Southall et al. 2007; Tal et al. 2015; Zimmer and Tyack 2007), which are not immediately observable. Importantly, these more severe physical and physiological responses have been associated with explosives and/or mid-frequency tactical sonar, and not seismic airguns. Therefore, we do not expect ESA-listed marine mammals to experience any of these more severe physical and physiological responses because of the seismic survey activities.

Individual whales exposed to airguns (as well as other sound sources) could experience other effects that are not readily observable, such as stress (Romano et al. 2002), which may have adverse consequences. Stress is an adaptive response and does not normally place an animal at risk. It may require the animal to expend energy and resources to cope with stress at the expense of other life processes. Distress involves a stress response resulting in a biological consequence to the individual. The mammalian stress response involves the hypothalamic-pituitary-adrenal axis stimulation by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones cortisol, adrenaline (epinephrine), glucocorticosteroids, and others (Busch and Hayward 2009; Gregory and Schmid 2001; Gulland et al. 1999; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Thomson and Geraci 1986). These hormones can cause short-term weight loss; impairment of the immune and nervous systems; elevated heart rate, body temperature, blood pressure, and alertness; and other responses (Busch and Hayward 2009; Cattet et al. 2003; Costantini et al. 2011; Dickens et al. 2010; Dierauf and Gulland 2001; Elftman et al. 2007; Fonfara et al. 2007; Kaufman and Kaufman 1994; Mancia et al. 2008; Noda et al. 2007; Thomson and Geraci 1986). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer et al. 2005). In highly stressful circumstances, or in species prone to strong "fight-or-flight" responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998; Cowan and Curry 2002; Cowan 2008; Herraez et al. 2007). The most widely recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the hypothalamic-pituitary-adrenal axis may persist for weeks (Dierauf and Gulland 2001). Stress levels can vary by age, sex, season, and health status (Gardiner and Hall 1997; Hunt et al. 2006; Keay et al. 2006; Romero et al. 2008; St. Aubin et al. 1996). For example, stress is lower in immature North Atlantic right whales than adults, and mammals with poor diets or undergoing dietary change tend to have higher fecal cortisol levels (Hunt et al. 2006; Keay et al. 2006).

Loud sounds generally increase stress indicators in mammals (Kight and Swaddle 2011). Romano et al. (2004a) found beluga whales and bottlenose dolphins exposed to a seismic watergun (up to 228 dB re 1 μPa at 1 m peak-to-peak) and single pure tones (up to 201 dB re 1 μPa) had increases in stress chemicals, including catecholamines, which could affect an individual's ability to fight off disease. During the time following September 11, 2001, shipping traffic and associated ocean noise decreased along the northeastern U.S. This decrease in ocean sound was associated with a significant decline in fecal stress hormones in North Atlantic right whales, providing evidence that chronic exposure to increased noise levels, although not acutely injurious, can produce stress (Rolland et al. 2012). These levels returned to baseline after 24 hours of vessel traffic resuming.

Because whales use hearing for communication and as a primary way to gather information about their environment, we assume that limiting these abilities will be stressful. We also assume that some individuals exposed at sound levels above the threshold of 160 dB re 1 μPa (rms) will experience a stress response, which may also be associated with an overt behavioral response. However, because exposure to sounds from the airgun array are expected to be temporary in all cases, we expect stress responses to be brief. Given the available data, animals will be expected to return to baseline state (e.g., baseline cortisol level) within hours to days. The duration of the stress response is expected to depend on the severity of the exposure (i.e., we expect a TTS exposure will result in a longer duration before returning to a baseline state, as compared to exposure to levels below the TTS threshold). Although we do not have a way to determine the health of the animal at the time of exposure, we assume that the stress responses resulting from these exposures could be more significant or exacerbate other factors if an animal is already in a compromised state.

Strandings

There is some concern regarding the coincidence of marine mammal strandings and proximal seismic surveys. No conclusive evidence exists to causally link stranding events to seismic surveys. Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel et al. 2004) were not well founded (Iagc 2004; IWC 2007). In September 2002, two Cuvier's beaked whales (*Ziphius cavirostris*) stranded in the Gulf of California, Mexico. The R/V *Maurice Ewing* had been operating a 20-airgun array (8,490 in^3) 22 km offshore at the time the stranding occurred. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence because the individuals who happened upon the stranding were ill-equipped to perform an adequate necropsy (Taylor et al. 2004). Furthermore, the small numbers of animals involved and the lack of knowledge regarding the spatial and temporal correlation between the beaked whales and the sound source underlies the uncertainty regarding the linkage between sound sources from seismic surveys and beaked whale strandings (Cox et al. 2006). Numerous studies suggest that the physiology, behavior, habitat relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to another phenomenon. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Creel 2005; Fair and Becker 2000; Kerby et al. 2004; Moberg 2000; Romano et al. 2004b). At present, the factors of airgun arrays from seismic surveys that may contribute to marine mammal strandings are unknown and we have no evidence to lead us to believe that aspects of the airgun array proposed for use will cause marine mammal strandings.

We do not expect ESA-listed marine mammals to strand because of the high-energy seismic surveys. If exposed to seismic survey activities, we expect ESA-listed marine mammals will have sufficient space in the open ocean to move away from the sound source and would not be likely to strand given that similar seismic surveys have been conducted by NSF in the past in the Atlantic Ocean with no documented strandings.

6.2.1.2 Response of Sea Turtles

Hearing Threshold Shifts

Although all sea turtle species exhibit the ability to detect low-frequency sound, the potential effects of exposure to loud sounds on sea turtle biology remain largely unknown (Nelms et al. 2016; Samuel et al. 2005). Few data are available to assess sea turtle hearing, let alone the effects of sound sources from seismic surveys on their hearing potential.

Sea turtles are susceptible to hearing threshold shifts when exposed to high levels of sound within their limited hearing range (most sensitive from 100–400 Hz and more limited over 1 kHz). Types of noise-induced threshold shifts include TTS and AUD INJ, similar to marine mammals. AUD INJ has not been directly observed in sea turtles; however, it has been observed in other animals such as mice and guinea pigs (Kujawa and Liberman 2006; Kujawa and Liberman 2009a; Lin et al. 2011). The following discussion summarizes the best available information on hearing threshold shifts in sea turtles or species similar to sea turtles.

Although no studies have directly measured underwater TTS or AUD INJ in ESA-listed sea turtles, recent studies examined underwater TTS in freshwater turtles using broadband sound. Salas et al. (2023) exposed red-eared sliders (*Trachemys scripta elegans*) to sound exposure levels (a measure of the acoustic energy of a sound over a specified time period) between 155–193 dB re 1 μPa^2-s, and auditory sensitivity was measured at 400 Hz using auditory evoked potential methods. The mean predicted TTS onset was 160 dB re 1 μPa^2-s. In a study using Eastern painted turtles (*Chrysemys picta picta),* Salas et al. (2024) reported similar results, with TTS onset occurring at 154 dB re 1 μPa^2 s at 600 Hz and 158 dB re 1 μPa^2 s at 400 Hz. The only study addressing sea turtle TTS was conducted by Moein et al. 1994 in which a loggerhead turtle experienced TTS upon multiple exposures to an airgun in a shallow water enclosure, but recovered full hearing sensitivity within one day.

TTS in sea turtles is expected to last for a few hours to days, depending on the severity. TTS can significantly disrupt a turtle's normal behavior patterns for the duration over which their hearing threshold is altered. However, given TTS is temporary and sea turtles are not known to rely heavily on acoustic cues (Nelms et al. 2016; Popper et al. 2014c), we do not anticipate that TTS exposure would result in long-term fitness impacts to individual turtles. AUD INJ could permanently impair a sea turtle's ability to hear environmental cues, depending on the frequency of the cue and the frequencies affected. Given this, if sea turtles experience AUD INJ, they may have a reduction in fitness either through some slight decrease in survivorship (e.g., decreased ability to hear predators or hazards such as vessels) or reproduction (e.g., minor effects to the animal's navigation that may reduce mating opportunities).

For sea turtles, the thresholds for AUD INJ are 184 dB re 1 μPa^2-second $SEL_{cum;}$ and 230 dB re 1 μPa SPL_{peak}. With a source level at the frequency of greatest energy, which is within the sensitive hearing range of sea turtles, the animal will almost have to be directly under the sound source exactly when it fires. Further, AUD INJ may not be realized at close distances due to near-field interactions. The airgun array will be shut down if a sea turtle is about to enter the 150 m exclusion zone. The calculated isopleth distance to the AUD INJ for sea turtles is 644.9 m (50 m shot interval) and 161.2 m (200 m shot interval). While these distances are further than the shutdown exclusion zone distance, we expect that AUD INJ is unlikely because of the constant movement of both the R/V *Langseth* and the ESA-listed sea turtles in the action area, and the short duration of exposure to loud sound because the R/V is not expected to remain in any area where individual animals may concentrate for an extended period of time. As mentioned previously, we expect that sea turtles are likely to move away from an adverse sound, and given conservation measures (e.g., ramp-up) and the ability of animals to detect sounds from the airgun array, we do not expect sea turtles to be exposed to AUD INJ.

Sea turtles are not known to rely heavily on sound for life functions and instead may rely primarily on senses other than hearing for interacting with their environment, such as vision (Narazaki et al. 2013) and magnetic orientation (Avens and Lohmann 2003; Putman et al. 2015). As such, the likelihood that the loss of hearing in a sea turtle would affect its fitness (i.e., survival or reproduction) is low when compared to marine mammals, which rely heavily on sound for basic life functions. Sea turtles may use acoustic cues such as waves crashing, wind, vessel, and/or predator noise to perceive the environment around them. If such cues increase survivorship (e.g., aid in avoiding predators, navigation), hearing loss may affect individual sea turtle fitness.

Behavioral Responses

As with ESA-listed marine mammals, it is likely that sea turtles will avoid the active airgun array. We do not have specific information on how sea turtles will respond, but we present the available information on the range of possible responses. Some experimental data suggest sea turtles may avoid seismic sound sources (McCauley et al. 2000a; McCauley et al. 2000c; Moein et al. 1994), but monitoring reports from seismic surveys in other regions suggest that some sea turtles do not avoid airguns and were likely exposed to higher levels of pulses from a seismic airgun array (Smultea and Holst 2003). Behavioral responses to human activity have been investigated for green and loggerhead (McCauley et al. 2000b; O'hara and Wilcox 1990), and leatherback, loggerhead, olive ridley, and 160 unidentified sea turtles (hardshell species; Weir 2007). The work by O'Hara and Wilcox 1990 and McCauley et al. 2000b reported behavioral changes of sea turtles in response to seismic airgun arrays. These studies formed the basis for our 175 dB re 1 μPa (rms) threshold for determining when sea turtles will be harassed due to sound exposure because, at and above this level, loggerhead turtles increased swimming speed and erratic behavior. Loggerhead turtles have also been observed moving towards the surface upon exposure to an airgun (Lenhardt 1994; Lenhardt et al. 1983). In contrast, loggerhead turtles resting at the ocean surface were observed to startle and dive as an active seismic source approached them, with the responses decreasing with increasing distance (Deruiter and Larbi Doukara 2012). However, some of these animals may have reacted to the vessel's presence rather than the sound source (Deruiter and Larbi Doukara 2012). A study on leatherbacks off Massachusetts modeled the animals' responses to a seismic sparker and concluded that leatherbacks showed avoidance behaviors such as higher swimming speeds away from the sound source and a decline of approximately 64% in the probability of foraging during periods when exposed to the sparker (Patel et al. 2026). Monitoring reports from seismic surveys show that some sea turtles move away from approaching airgun arrays, although sea turtles may approach active airgun arrays within 10 m with minor behavioral responses (Holst et al. 2006; Holst and Smultea 2008; Holst et al. 2005; NMFS 2006a; NMFS 2006h; Smultea et al. 2005).

Observational evidence suggests that sea turtles are not as sensitive to sound as marine mammals, and that behavioral changes are only expected when sound levels rise above received sound levels of 175 dB re 1 μPa (rms). If exposed at such sound levels, based on the available data, we anticipate some change in swimming patterns. Some sea turtles may approach the active airgun array, but we expect them to eventually turn away. As such, we expect temporary displacement of exposed individuals from some portions of the action area during the seismic survey.

Physical and Physiological Effects

Direct evidence of seismic sound causing stress is lacking for sea turtles. However, animals often respond to anthropogenic stressors in a manner that resembles predator avoidance (Beale and Monaghan 2004; Frid 2003; Frid and Dill 2002; Gill et al. 2001; Harrington and Veitch 1992; Harris et al. 2018; Lima 1998; Romero 2004). As predators generally induce a stress response in their prey (Dwyer 2004; Lopez 2001; Mateo 2007), we assume that sea turtles experience a stress response if exposed to loud sounds from airgun arrays. We expect that breeding adult females may experience a lower stress response. Female green, hawksbill, and loggerhead turtles appear to have a physiological mechanism to reduce or eliminate hormonal responses to stress (predator attack, high temperature, and capture) in order to maintain reproductive capacity at least during their breeding season; a mechanism apparently not shared by males (Jessop 2001; Jessop et al. 2000; Jessop et al. 2004). Individuals may experience a stress response at levels lower than approximately 175 dB re 1 μPa (rms), but data are lacking to evaluate this possibility. Therefore, we follow the best available evidence identifying a behavioral response as the point at which we also expect a significant stress response.

6.2.2 Responses of Prey

Seismic surveys may have indirect, adverse effects on ESA-listed marine mammals and sea turtles by affecting their prey availability (including larval stages) through lethal or sub lethal damage, stress responses, or alterations in their behavior or distribution. Prey of baleen whales (blue, fin, and sei whales) mainly consist of small schooling fishes, such as capelin, herring and sandlance, and euphausiides (krill). Sperm whales prey on squid, octopus, and demersal fish. Prey of sea turtles includes jellyfish, sponges, tunicates, fish, crustaceans, mollusks, and invertebrates. In a comprehensive review, Carroll et al. (2017) summarized the available information on the impacts seismic surveys have on fishes and invertebrates. In many cases, species-specific information on the prey of ESA-listed marine mammals and sea turtles is not available. While information specific to prey of the ESA-listed species considered in this opinion is not available, we expect that prey of ESA-listed species considered in this consultation will react in manners similar to those fish and invertebrates described herein.

Seismic surveys could cause physical and physiological responses, including direct mortality, in fishes and invertebrates. In fishes, such responses appear to be highly variable and depend on the nature of the exposure to seismic survey activities, as well as the species in question. Responses include hearing threshold shifts, barotraumatic ruptures, stress responses, organ damage, and/or mortality. The limited data available for invertebrates suggest that exposure to seismic survey activities can result in anatomical damage and mortality. Some studies suggest that seismic surveys do not result in meaningful physiological and/or physical effects in crustaceans and bivalves while others observed effects under certain circumstances. Furthermore, even within studies not all responses evaluated may be affected by the exposure (e.g., Fitzgibbon et al. 2017). We assume that some ESA-listed species' prey may experience physical and physiological effects, including mortality, but, in most cases, such effects are only expected at relatively close distances to the sound source.

Based on the available data, as reviewed by Carroll et al. (2017), considerable variation exists in how fishes behaviorally respond to seismic survey activities, with some studies indicating no response and others noting startle or alarm responses and/or avoidance behavior. However, no effects to foraging or reproduction have been documented. As with marine mammals, behavioral responses by fish and invertebrate prey species may also be associated with a stress response.

Mortality of fish or invertebrates, prey of marine mammals and sea turtles, may occur from exposure to airguns, but will be limited to close-range exposure to high amplitudes (Bjarti 2002; D'Amelio 1999; Falk and Lawrence 1973; Hassel et al. 2003; Holliday et al. 1987; Kostyuchenko 1973; La Bella et al. 1996; McCauley et al. 2000a; McCauley et al. 2000c; McCauley et al. 2003; Popper et al. 2005; Santulli et al. 1999). Lethal effects, if any, are expected within a few meters of the airgun array (Buchanan et al. 2004; Dalen and Knutsen 1986). If fishes that are not within close range to the airgun array detect the sound and leave the area, it is because the sound is perceived as a threat or it causes some discomfort. We expect these fishes will return to the area once the disturbance abates. For example, a common response by fishes to airgun sound is a startle or distributional response, where fish react by changing orientation or swimming speed, or change their vertical distribution in the water column (Davidsen et al. 2019; Fewtrell 2013a). During airgun studies in which the received sound levels were not reported, Fewtrell (2013a) observed caged *Pelates* spp., pink snapper (*Pagrus auratus*), and trevally (*Caranx ignobilis*) to generally exhibit startle, displacement, and/or grouping responses upon exposure to airguns. This effect generally persisted for several minutes. Subsequent exposures of the same individuals did not necessarily elicit a response (Fewtrell 2013a). Davidsen et al. (2019) performed controlled exposure experiments on Atlantic cod (*Gadus morhua*) and saithe (*Pollachius virens*) to test their response to airgun noise. The cod exhibited reduced heart rate (bradycardia) in response to the particle motion component of the sound from the airgun, indicative of an initial flight response; however, no behavioral startle response to the airgun was observed. Furthermore, both the Atlantic cod and saithe changed swimming depth and horizontal position more frequently during airgun sound production (Davidsen et al. 2019). We expect that, if fish detect a sound and perceive it as a threat, they will move away from the sound source, if it causes them discomfort, and will return to the area and be available as prey for ESA-listed species.

There are reports showing sublethal effects to some fish species, including those that serve as prey to marine mammals in this consultation, from airgun arrays. Several species at various life stages have been exposed to high-intensity sound sources (220–242 dB re 1 μPa) at close distances, with some cases of injury (Booman et al. 1996; McCauley et al. 2003). Effects from TTS were not found in whitefish at received levels of approximately 175 dB re 1 μPa^2-s, but pike did show 10–15 dB of hearing loss with recovery within one day (Popper et al. 2005). Exposure of monkfish (*Lophius* spp.) and capelin eggs at close range to airguns did not produce differences in mortality compared to control groups (Payne 2009). Salmonid swim bladders were reportedly damaged by received sound levels of approximately 230 dB re 1 μPa (Falk and Lawrence 1973).

Startle responses were observed in rockfish at received airgun levels of 200 dB re 1 μPa 0-to-peak and alarm responses at greater than 177 dB re 1 μPa 0-to-peak (Pearson et al. 1992). Fish also tightened schools and shifted their distribution downward. Normal position and behavior resumed 20–60 minutes after firing of the airgun ceased. A downward shift in rockfish was also noted by Skalski et al. 1992 at received seismic sounds of 186–191 dB re 1 μPa 0-to-peak. Caged European sea bass (*Dichentrarchus labrax*) showed elevated stress levels when exposed to airguns, but levels returned to normal after three days (Skalski 1992). These fish also showed a startle response when the seismic survey vessel was as much as 2.5 km away; this response increased in severity as the vessel approached and sound levels increased, but returned to normal after about two hours following cessation of airgun activity.

Whiting (*Merlangius merlangus*) exhibited a downward distributional shift upon exposure to 178 dB re 1 μPa 0-to-peak sound from airguns, but habituated to the sound after one hour and returned to normal depth (sound environments of 185–192 dB re 1 μPa) despite airgun activity (Chapman and Hawkins 1969). Whiting may also flee from sounds from airguns (Dalen and Knutsen 1986). Hake (*Merluccius* spp.) may re-distribute downward (La Bella et al. 1996). Lesser sand eels (*Ammodytes tobianus*) exhibited initial startle responses and upward vertical movements before fleeing from the seismic survey area upon approach of a vessel with an active source (Hassel et al. 2003; Hassel et al. 2004).

McCauley et al. (2000; 2000a) found small fish show startle responses at lower levels than larger fish in a variety of fish species and generally observed responses at received sound levels of 156–161 dB re 1 μPa (rms), but responses tended to decrease over time suggesting habituation. As with previous studies, caged fish showed increases in swimming speeds and downward vertical shifts. Pollock (*Pollachius* spp.) did not respond to sounds from airguns received at 195–218 dB re 1 μPa 0-to-peak, but did exhibit continual startle responses and fled from the acoustic source when visible (Wardle et al. 2001). Blue whiting (*Micromesistius poutassou*) and mesopelagic fishes were found to re-distribute 20–50 m deeper in response to airgun ensonification and a shift away from the seismic survey area was also found (Slotte et al. 2004). Startle responses were infrequently observed in salmonids receiving 142–186 dB re 1 μPa peak-to-peak sound levels from an airgun (Thomsen 2002). Cod (*Gadus* spp.) and haddock (*Melanogrammus aeglefinus*) likely vacate seismic survey areas in response to airgun activity, and estimated catchability decreased starting at received sound levels of 160–180 dB re 1 μPa 0-to-peak (Dalen and Knutsen 1986; Engås et al. 1996; Engås et al. 1993; Løkkeborg 1991; Løkkeborg and Soldal 1993; Turnpenny et al. 1994).

Increased swimming activity in response to airgun exposure in fish, as well as reduced foraging activity, is supported by data collected by Lokkeborg et al. 2012. Yet bass did not appear to vacate during a shallow-water seismic survey with received sound levels of 163–191 dB re 1 μPa

0-to-peak (Turnpenny and Nedwell 1994). Similarly, European sea bass apparently did not leave their inshore habitat during a 4–5 month seismic survey (Pickett et al. 1994). La Bella et al. 1996 found no differences in trawl catch data before and after seismic survey activities and echosurveys of fish occurrence did not reveal differences in pelagic biomass. However, fish kept in cages did show behavioral responses to approaching operating airguns.

Squid, an important prey for sperm whales, exhibited both startle and avoidance responses at received airgun sound levels of 174 dB re 1 µPa (rms) by first ejecting ink and then moving rapidly away from the area (Fewtrell 2013b; McCauley et al. 2000a; McCauley et al. 2000c). The authors also noted some movement upward. Squid did not discharge ink during ramp-up, but alarm responses occurred when received sound levels reached 156–161 dB re 1 µPa (rms). Norris and Mohl (1983) observed lethal effects in squid (*Loligo vulgaris*) at levels of 246–252 dB after 3–11 minutes. André et al. (2011) exposed four cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*) to two hours of continuous sound from 50–400 Hz at 157±5 dB re 1 µPa. They reported lesions to the sensory hair cells of the statocysts of the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low-frequency sound. The received sound pressure level was 157 ± 5 dB re 1 µPa, with peak levels at 175 dB re 1 µPa. Guerra et al. (2004) suggested that giant squid mortalities were associated with seismic surveys based upon coincidence of carcasses with the seismic surveys in time and space, as well as pathological information from the carcasses.

The overall response of fishes and squid is to startle and move vertically and horizontally away from the sound field. Sperm whales regularly feed on squid and some fishes and we expect individuals to feed while in the action area during the seismic survey activities. Based upon the best available information, fishes and squid located within the sound fields corresponding to the approximate 160 dB re 1 µPa (rms) or 175 dB re 1 µPa (rms) isopleths could vacate the area and/or dive to greater depths.

Similarly, data on the behavioral response of invertebrates, including prey species of sea turtles, suggest some species may exhibit a startle response, but most studies do not suggest strong behavioral responses. For example, a recent study by Charifi et al. (2017) found that oysters appear to close their valves in response to low-frequency sinusoidal sounds. Day et al. (2017) recently found that, when exposed to seismic airgun array sounds, scallops exhibit behavioral responses such as flinching, but none of the observed behavioral responses were considered to be energetically costly.

Based on the available data, we anticipate seismic survey activities will result in temporary and minor reduction in the availability of prey for ESA-listed species near the airgun array during and immediately following the use of active seismic sound sources. This may be due to changes in prey distributions (i.e., due to avoidance) or abundance (i.e., due to mortality) or both. We do not expect indirect effects from airgun array operations through reduced feeding opportunities for ESA-listed marine mammals and sea turtles to reach a measurable level. Effects are likely to be temporary and, if displaced, marine mammals, sea turtles, and their prey will re-distribute back into the action area once seismic survey activities have passed or concluded. As described above, we believe that, in most cases, ESA-listed marine mammals and sea turtles will avoid closely approaching the airgun array when it is active and will not be in areas where prey could be temporarily displaced or otherwise affected. In addition, the anticipated quantity of prey that may suffer mortality is extremely low compared to the prey available to ESA-listed species.

6.3 Summary of Effects Analysis

In this section, we combine the exposure analysis and response analysis to produce estimates of the amount and type of take caused directly or indirectly by the proposed action. This summary of the anticipated effects of the action considers all consequences caused by the proposed action. The following subsections state the anticipated effects of the action for each ESA-listed species that will be adversely affected by the proposed actions.

6.3.1 Species Summary

We expect up to two blue whales, one fin whale, 24 sei whales, and 274 sperm whales to be exposed to the airgun array within the 160 dB re 1 μPa (rms) ensonified areas during the seismic survey activities and exhibit responses in the form of ESA behavioral harassment or TTS. We expect up to 1,791 North Atlantic DPS green turtles, 19 Kemp's ridley turtles, four leatherback turtles, and 4,477 Northwest Atlantic Ocean DPS loggerhead turtles to be exposed to the airgun array within the 175 dB re 1 μPa (rms) ensonified areas during the seismic survey activities and exhibit responses in the form of ESA behavioral harassment or TTS.

Because of the requirements in the Permits and Conservation Division's proposed IHA, and the nature of the seismic survey activities, as described above, we do not expect any injury (auditory or non-auditory) or mortality to ESA-listed species from the exposure to the acoustic sources resulting from the proposed actions. As described above, the proposed actions will result in temporary effects, largely behavioral responses (e.g., avoidance, discomfort, loss of foraging opportunities, loss of mating opportunities, masking, alteration of vocalizations, and stress) but with some potential for ESA behavioral harassment or TTS, to blue, fin, sei, or sperm whales. Harassment is not expected to have more than short-term effects on individual ESA-listed marine mammal species (blue, fin, sei, or sperm whales) and is not expected to reduce individual fitness. Additionally, as described above, the proposed actions will result in temporary effects, largely behavioral responses (e.g., avoidance, discomfort, loss of foraging opportunities, and stress) but with some potential for TTS, to the exposed sea turtles (North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS loggerhead turtle). Harassment is not expected to have more than short-term effects on individual ESA-listed marine mammal and sea turtle species.

Because of the large geographic ranges of the affected ESA-listed marine mammals and sea turtles compared to the relatively small size of the portion of the action area where seismic surveys will occur, combined with the relatively short duration of the seismic survey activities, there may be multiple exposures of a small number of individuals in the action area. We do not expect the effects of ESA harassment of these individuals, which will be temporary, will have population-level effects.

7 Cumulative Effects

Cumulative effects are defined in regulations as “those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation” (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7(a)(2) of the ESA.

We assessed the action area of this consultation for any non-Federal activities that are reasonably certain to occur. The past and ongoing impact of existing actions was described in the Environmental Baseline (Section 5). During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than the activities described in the environmental baseline.

8 Integration and Synthesis

This opinion includes a jeopardy analysis for the ESA-listed endangered and threatened species that are likely to be adversely affected by the action. Section 7(a)(2) of the Act and its implementing regulations require every Federal agency, in consultation with and with the assistance of the Secretary (16 U.S.C. §1532(15)), to insure that any action it authorizes, funds, or carries out, in whole or in part, in the United States or upon the high seas, is not likely to jeopardize the continued existence of any listed. The jeopardy analysis, therefore, relies upon the regulatory definitions of *jeopardize the continued existence of*.

Jeopardize the continued existence of means “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR §402.02). *Recovery*, used in that definition, means “improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act” (50 CFR §402.02).

The Integration and Synthesis is the final step in our jeopardy and adverse modification analyses. In this section, we add the effects of the action (Section 6) to the environmental baseline (Section 5) and the cumulative effects (Section 7), taking into account the status of the species, critical habitat, and recovery planning (Section 4), to formulate the agency’s biological opinion as to whether the action agencies can insure their proposed actions are not likely to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution.

8.1 Jeopardy Analysis

The jeopardy analysis assesses the proposed actions' effects on ESA-listed species' survival and recovery. The following sections summarize the relevant information in this opinion for each individual species considered.

8.1.1 Blue Whale

We expect two blue whales are likely to be exposed to sound from the seismic surveys. The individuals may be adults, juveniles, and/or calves. The severity of the animals' response to noise associated with the high-energy seismic survey will depend on the duration and severity of exposure.

The blue whale is endangered because of past commercial whaling. Commercial whaling no longer occurs, but blue whales are threatened by vessel strikes, marine debris and fishing gear ingestion and/or entanglement, anthropogenic noise, and loss of prey base due to changing environmental conditions and ecosystem change.

Current global abundance is estimated to be between 10,000 and 25,000 individuals (Cooke 2018; Hayes et al. 2020a). There is much uncertainty with the abundance estimates for blue whales in the Western Central Atlantic Ocean. The best abundance estimate for the U.S. western North Atlantic stock, acknowledging uncertainty due to low numbers of encountered and photographed individuals, is between 400 and 600 individuals based on the Gulf of St. Lawrence photographic-identification catalog (Hayes et al. 2020b). Overall population growth rates for the species and for the western North Atlantic stock are not available.

No reduction in the distribution of blue whales in the Western Central Atlantic Ocean or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Non-lethal take of two individuals, adults, juveniles, and/or calves, is expected because of the seismic survey activities. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging opportunities, loss of mating opportunities, masking, alteration of vocalizations, and stress) with some potential for TTS, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any impacts to reproduction. Because we do not anticipate a reduction in numbers or reproduction of blue whales due to the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2020 Recovery Plan for the blue whale (NMFS 2020) lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Increase blue whale resiliency and ensure geographic and ecological representation by achieving sufficient and viable populations in all ocean basins and in each recognized subspecies.
- Increase blue whale resiliency by managing or eliminating significant anthropogenic threats.

Because no mortalities or effects on the abundance, distribution, and reproduction of blue whale populations are expected as a result of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division's issuance of an IHA and possible renewal will impede the recovery objectives for blue whales.

In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of blue whales in the wild by reducing the reproduction, numbers, or distribution of the species.

8.1.2 Fin Whale

We expect one fin whale is likely to be exposed to sound from the seismic surveys. The individual may be an adult, juvenile, or calf. The severity of the animal's response to noise associated with the high-energy seismic survey will depend on the duration and severity of exposure.

The fin whale is endangered because of past commercial whaling. Fin whales may be killed under "aboriginal subsistence whaling" in Greenland, under Japan's commercial whaling program, and Iceland's formal objection to the International Whaling Commission's (IWC) ban on commercial whaling. Additional threats include vessel strikes, reduced prey availability due to overfishing or changing environmental conditions, and anthropogenic sound. The species' large population size may provide some resilience to current threats, but trends are largely unknown. The current population abundance estimate for the Western North Atlantic stock is 6,802 individuals (CV=0.24), and N_{min} is 5,573 individuals (Hayes et al. 2022).

No reduction in the distribution of fin whales in the Western Central Atlantic Ocean or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Non-lethal take of one individual, either an adult, juvenile, and/or calf, is expected as a result of the seismic survey activities. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging opportunities, loss of mating opportunities, masking, alteration of vocalizations, and stress) with some potential for TTS, with the individual returning to normal shortly after the exposure has ended, and thus do not anticipate any impacts to reproduction. Given that we do not anticipate a reduction in numbers or reproduction of fin whales because of the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2010 Final Recovery Plan (NMFS 2010d) for the fin whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Achieve sufficient and viable population in all ocean basins.
- Ensure significant threats are addressed.

Because no mortalities or effects on the abundance, distribution, and reproduction of fin whale populations are expected as a result of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division's issuance of an IHA and possible renewal will impede the recovery objectives for fin whales.

In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of fin whales in the wild by reducing the reproduction, numbers, or distribution of the species.

8.1.3 Sei Whale

We expect 24 sei whales are likely to be exposed to sound from the seismic surveys. The individuals may be adults, juveniles, and/or calves. The severity of the animals' response to noise associated with the high-energy seismic survey will depend on the duration and severity of exposure.

The sei whale is endangered because of past commercial whaling. Now, only a few individuals are taken each year by Japan. Current threats include vessel strikes, fisheries interactions (including entanglement), changing environmental conditions (habitat loss and reduced prey availability), and anthropogenic noise. Population abundance trends are largely unknown.

The Nova Scotia stock (Halifax, Nova Scotia to Florida) population is estimated at 6,292 individuals (CV=1.02; N_{min}=3,098 individuals) from surveys conducted in the spring from 2010 through 2013 (March through May, when sei whale density is predicted to be highest; Hayes et al. 2022). Population growth rates for sei whales are not available as there are little to no systematic survey efforts to study sei whales.

No reduction in the distribution of sei whales in the Western Central Atlantic Ocean or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Non-lethal take of 24 individuals, adults, juveniles, and/or calves, is expected because of the seismic survey activities. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging opportunities, loss of mating opportunities, masking, alteration of vocalizations, and stress) with some potential for TTS, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any impacts to reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of sei whales due to the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2011 Final Recovery Plan for the sei whale (NMFS 2011b) lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Achieve sufficient and viable populations in all ocean basins.
- Ensure significant threats are addressed.

Because no mortalities or effects on the abundance, distribution, and reproduction of sei whale populations are expected as a result of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal will impede the recovery objectives for sei whales.

In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of sei whales in the wild by reducing the reproduction, numbers, or distribution of the species.

8.1.4 Sperm Whale

We expect 274 sperm whales are likely to be exposed to sound from the seismic surveys. The individuals may be adults, juveniles, and/or calves. The severity of the animals' response to noise associated with the high-energy seismic survey will depend on the duration and severity of exposure.

The sperm whale is endangered because of past commercial whaling. Although the aggregate abundance worldwide is probably at least several hundred thousand individuals, the extent of depletion and degree of recovery of populations are unknown. Continued threats to sperm whale populations include vessel strikes, entanglement in fishing gear, competition for resources due to overfishing, pollution, loss of prey and habitat degradation due to changing environmental conditions, and anthropogenic noise. This species' large population size shows that it is somewhat resilient to current threats.

The current global sperm whale population abundance estimate is about 850,000 individuals (Whitehead and Shin 2022). There are six recognized sperm whale stocks in U.S. waters: Puerto Rico and the U.S. Virgin Islands, Northern Gulf of Mexico, North Atlantic, North Pacific, California/Oregon/Washington, and Hawaii. There are no reliable estimates for sperm whale abundance across the entire North Atlantic Ocean. The best abundance estimate for the North Atlantic stock, based on 2021 survey data from Central Florida to the lower Bay of Funday is 5,895 (CV=0.29; Hayes et al. 2023). No trend analysis has been conducted for the North Atlantic stock.

No reduction in the distribution of sperm whales in the Western Central Atlantic Ocean or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Non-lethal take of 274 individuals, adults, juveniles, and/or calves, is expected because of the seismic survey activities. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging opportunities, loss of mating opportunities, masking, alteration of vocalizations, and stress) with some potential for TTS, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any impacts to reproduction. Because we do not anticipate a reduction in numbers or reproduction of sperm whales due to the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2010 Final Recovery Plan for the sperm whale (NMFS 2010e) lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Achieve sufficient and viable populations in all ocean basins.
- Ensure significant threats are addressed.

Because no mortalities or effects on the abundance, distribution, and reproduction of sperm whale populations are expected as a result of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal will impede the recovery objectives for sperm whales.

In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of sperm whales in the wild by reducing the reproduction, numbers, or distribution of the species.

8.1.5 Green Turtle – North Atlantic DPS

We expect 1,791 North Atlantic DPS green turtles are likely to be exposed to sound from the seismic surveys. The individuals may be adults, juveniles, and/or post-hatchlings. The severity of the animals' response to noise associated with the high-energy seismic survey will depend on the duration and severity of exposure.

For the North Atlantic DPS of green turtle, the available data indicate an increasing trend in nesting abundance. There are no reliable estimates of population growth rate of the green turtle North Atlantic DPS as a whole; however, increases in nester abundance for the North Atlantic DPS of green turtle in recent years are encouraging. But they must be viewed cautiously, as the datasets represent a fraction of a green turtle generation, up to 50 years. While there is no comprehensive population abundance estimate for the entire DPS, a recent study predicted a mean abundance for the U.S. East Coast of 63,674 (90% CI = 23,381–117,610) green turtles (DiMatteo et al. 2024).

Once abundant in tropical and subtropical waters, green turtles worldwide exist at a fraction of their historical abundance due to over-exploitation. Historically, over-exploitation drove significant populations declines. Current threats include bycatch in fisheries, ingestion and entanglement in marine debris, habitat destruction and degradation, and changing environmental conditions.

No reduction in the distribution of North Atlantic DPS of green turtles in the Western Central Atlantic Ocean or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Non-lethal take of 1,791 individuals, whether adults, juveniles, and/or post-hatchlings, is expected because of the seismic survey activities. We anticipate temporary behavioral responses (e.g., temporary displacement and stress) with some potential for TTS, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any impacts to reproduction. Because we do not anticipate a reduction in numbers or reproduction of the North Atlantic DPS of green turtles due to the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The Recovery Plan (NMFS 1991) for the U.S. Atlantic population of green turtle lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Determine distribution and seasonal movements for all life stages in marine environment.
- Reduce threat to pollution and foraging habitat from marine pollution.

Because no mortalities or effects on the abundance, distribution, and reproduction of the North Atlantic DPS of green turtle are expected as a result of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal will impede the recovery objectives for the North Atlantic DPS of green turtle.

In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of North Atlantic DPS of green turtle in the wild by reducing the reproduction, numbers, or distribution of the species.

8.1.6 Kemp's Ridley Turtle

We expect 19 Kemp's ridley turtles are likely to be exposed to sound from the seismic surveys. The individuals may be adults, juveniles, or post-hatchlings. The severity of the animals' response to noise associated with the high-energy seismic survey will depend on the duration and severity of exposure.

Kemp's ridley turtles face many of the same threats as other sea turtle species, including bycatch in fisheries, ingestion and entanglement in marine debris, habitat destruction and degradation, and changing environmental conditions. The Kemp's ridley turtle was listed as endangered in response to a severe population decline, primarily the result of egg harvesting. The *Deepwater Horizon* oil spill affected Kemp's ridley turtles on land, resulting in reduced nesting abundance and hatchling production, and in water, resulting in large population losses across various age classes. Thus, while the *Deepwater Horizon* oil spill likely had significant population-level effect on the species, we do not understand those impacts on the future trajectory of the species.

The Kemp's ridley turtle nesting population was exponentially increasing (NMFS et al. 2011); however, since 2009 there has been concern over the slowing of recovery (Gallaway et al. 2016a; Gallaway et al. 2016b; Plotkin 2016). While there is no population abundance estimate for the entire species, a recent study predicted a mean abundance for the U.S. East Coast of 10,762 (90% CI = 2,620–19,443) Kemp's ridley turtles (DiMatteo et al. 2024).

No reduction in the distribution of Kemp's ridley turtles in the Western Central Atlantic Ocean or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal.

No reduction in numbers is anticipated from the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Non-lethal take of 19 individuals, adults, juveniles, and/or post-hatchlings, is expected because of the seismic survey activities. We anticipate temporary behavioral responses (e.g., temporary displacement and stress) with some potential for TTS, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any impacts to reproduction Because we do not anticipate a reduction in numbers or reproduction of Kemp's ridley turtles due to the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan (NMFS and USFWS 2011) for the population of Kemp's ridley turtle lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Protect and manage nesting and marine habitats.
- Protect and manage populations on nesting beaches and in the marine environment.
- Maintain, promote awareness of and expand U.S. and Mexican laws.

- Enforce laws.

Because no mortalities or effects on the abundance, distribution, and reproduction of Kemp's ridley turtle populations are expected as a result of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal will impede the recovery objectives for Kemp's ridley turtles.

In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of Kemp's ridley turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

8.1.7 Leatherback Turtle

We expect four leatherback turtles are likely to be exposed to sound from the seismic surveys. The individuals may be adults, juveniles, or post-hatchlings. The severity of the animals' response to noise associated with the high-energy seismic survey will depend on the duration and severity of exposure.

The leatherback turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. Threats to leatherback turtles include fisheries interactions (bycatch), habitat degradation and modification, changing environmental conditions, and marine debris.

The total index of nesting female abundance in the Northwest Atlantic Ocean is 20,659 females (NMFS and USFWS 2020). Leatherback turtles in the Northwest Atlantic Ocean exhibited a decreasing nest trend at nesting beaches with the greatest known nesting female abundance. This decline was more pronounced from 2008–2017, and the available nest data reflect a steady decline for more than a decade (Eckert and Mitchell 2018). There is no population abundance estimate for the entire species; however, a recent study predicted mean abundances for the U.S. East Coast of 21,984 (90% CI = 10,049–33,600) leatherback turtles (DiMatteo et al. 2024).

No reduction in the distribution of leatherback turtles in the Western Central Atlantic Ocean or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Non-lethal take of four individuals, adults, juveniles, and/or post-hatchlings, is expected because of the seismic survey activities. We anticipate temporary behavioral responses (e.g., temporary displacement and stress) with some potential for TTS, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any impacts to reproduction. Because we do not anticipate a reduction in numbers or reproduction of leatherback turtles due to the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 1998 and 1991 Recovery Plans (NMFS 1998) for the U.S. Caribbean, Gulf of Mexico, and Atlantic Ocean for the population of leatherback turtle lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- International cooperation.
- Monitoring and research.

Because no mortalities or effects on the abundance, distribution, and reproduction of leatherback turtle populations are expected as a result of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal will impede the recovery objectives for leatherback turtles.

In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of leatherback turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

8.1.8 Loggerhead Turtle – Northwest Atlantic Ocean DPS

We expect 4,477 Northwest Atlantic Ocean DPS loggerhead turtles are likely to be exposed to sound from the seismic surveys. The individuals may be adults, juveniles, or post-hatchlings. The severity of the animals' response to noise associated with the high-energy seismic survey will depend on the duration and severity of exposure.

The total number of annual U.S. nest counts for the Northwest Atlantic Ocean DPS of loggerhead turtles is over 110,000 (NMFS and USFWS 2023b). In-water population abundance estimates for the entire DPS do not exist. In 2010, NMFS's Northeast Fisheries Science Center and Southeast Fisheries Science Center estimated a regional abundance estimate of 588,000 individuals (approximate inter-quartile range of 382,000–817,000 individuals) based on positively identified loggerhead turtle sightings (NMFS 2011). A recent study predicted a mean abundance for the U.S. East Coast of 193,423 (90% CI = 159,158–227,668) loggerhead turtles (DiMatteo et al. 2024). Based on the current available information, the overall nesting trend of the Northwest Atlantic Ocean DPS of loggerhead turtle appears to be stable for over two decades (NMFS and USFWS 2023b).

Destruction and modification of habitats threaten the Northwest Atlantic Ocean DPS of loggerhead turtle. Changing environmental conditions, artificial lighting, debris and pollution, and fisheries interactions also threaten this DPS (NMFS and USFWS 2023b).

No reduction in the distribution of Northwest Atlantic Ocean DPS loggerhead turtles in the Western Central Atlantic Ocean or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Non-lethal take of 4,477 individuals, adults, juveniles, and/or post-hatchlings, is expected because of the seismic survey activities. We anticipate temporary behavioral responses (e.g., temporary displacement and stress) with some potential for TTS, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any impacts to reproduction. Because we do not anticipate a reduction in numbers or reproduction of Northwest Atlantic Ocean DPS loggerhead turtles due to the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2009 Final Recovery Plan (NMFS 2008) for the Northwest Atlantic Population of loggerhead turtle lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.
- Manage sufficient feeding, migratory, and interesting marine habitats to ensure successful growth and reproduction.
- Develop and implement local, state, Federal, and international legislation to ensure long-term protection of loggerhead turtles and their terrestrial and marine habitats.
- Minimize trophic changes from fishery harvest and habitat alteration.
- Minimize marine debris ingestion and entanglement.
- Minimize vessel strike mortality.

Because no mortalities or effects on the abundance, distribution, and reproduction of Northwest Atlantic Ocean DPS loggerhead turtle populations are expected as a result of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits and Conservation Division's issuance of an IHA and possible renewal will impede the recovery objectives for Northwest Atlantic Ocean DPS of loggerhead turtles.

In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of Northwest Atlantic Ocean DPS of loggerhead turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

9 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the consequences of the proposed actions and associated activities, and cumulative effects, it is NMFS's biological opinion that the proposed actions are not likely to jeopardize the continued existence of the blue whale, fin whale, sei whale, sperm whale, North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle.

Section 4.1.2 determined the likelihood of exposure was discountable or a response would be insignificant and, therefore, this action may affect, but is not likely to adversely affect the following species: North Atlantic right whale; Carolina DPS, Chesapeake Bay DPS, and South Atlantic DPS of Atlantic sturgeon; giant manta ray; Nassau grouper; oceanic whitetip shark; shortnose sturgeon; queen conch; and boulder star coral. Section 4.1.3 determined the proposed actions may affect, but are not likely to adversely affect the following critical habitats: Northwest Atlantic Ocean DPS loggerhead turtle designated critical habitat; Carolina DPS and South Atlantic DPS Atlantic sturgeon designated critical habitat; and North Atlantic DPS green turtle proposed critical habitat. In the event the proposed North Atlantic DPS green turtle critical habitat is finalized and 1) no significant new information is developed (including that developed during the rulemaking process on the proposed listing or critical habitat designation) and 2) no significant changes to the Federal action are made that would alter the content of this opinion; NSF can request, via email, that we adopt this conference opinion to a biological opinion in order to satisfy the requirements of section 7(a)(2) of the ESA.

10 Incidental Take Statement

In those cases where the Service concludes that an action and the resultant incidental take of listed species will not violate section 7(a)(2), and, in the case of marine mammals, where the taking is authorized pursuant to section 101(a)(5) of the Marine Mammal Protection Act of 1972, the Service will provide with the biological opinion a statement concerning incidental take that, among other things, specifies the impact of the incidental take of the affected species, i.e., an incidental take statement.

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. *Take* is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Incidental take* is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR §402.02). Section 7(b)(4) and section 7(o)(2) of the ESA, as well as in regulation at 50 CFR §402.14(i)(6) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of the ITS.

When an action is reasonably certain to result in incidental take of ESA-listed marine mammals, section 7(b)(4) of the ESA requires that such taking be authorized under section 101(a)(5) of the MMPA in order for the Secretary to issue an ITS for ESA-listed marine mammals and that the ITS specify the measures necessary to comply with section 101(a)(5) of the MMPA. As part of the proposed action, the Permits and Conservation Division proposes to issue regulations for the issuance of IHA. Accordingly, the terms of this ITS and the exemption from section 9 of the ESA become effective only upon the issuance of the 101(a)(5) authorization.

10.1 Amount or Extent of Take

In the opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

We anticipate noise from seismic survey activities is reasonably likely to result in the incidental take of ESA-listed marine mammals (adults, juveniles, and/or calves) by TTS or behavioral harassment. Specifically, we anticipate the take of marine mammals in the action area as described in Table 18 below.

Table 18. Estimated amount of incidental take of ESA-listed marine mammals

Species	Estimated Amount of Incidental Take by Harassment
Blue Whale	2
Fin Whale	1
Sei Whale	24
Sperm Whale	274

We anticipate noise from seismic survey activities is reasonably likely to result in the incidental take of ESA-listed sea turtles (adults, juveniles, and/or post-hatchlings) by TTS or behavioral harassment. Specifically, we anticipate the take of sea turtles in the action area as described in Table 19 below.

Table 19. Estimated amount of incidental take of ESA-listed sea turtles

Species	Estimated Amount of Incidental Take by Harassment
Green Turtle – North Atlantic DPS	1,791
Kemp’s Ridley Turtle	19
Leatherback Turtle	4
Loggerhead Turtle – Northwest Atlantic Ocean DPS	4,477

10.2 Reasonable and Prudent Measures

“Reasonable and prudent measures” are measures that are necessary or appropriate to minimize the impact of incidental take on the species (50 CFR §402.02). These measures “cannot alter the basic design, location, scope, duration, or timing of the action and may involve only minor changes” (50 CFR §402.14(i)(2)). NMFS believes the following RPMs are necessary and appropriate:

1. The NMFS Permits and Conservation Division must ensure that the NSF implements a program to mitigate and report on the potential effects of seismic survey activities as well as the effectiveness of the conservation measures incorporated as part of the proposed IHA for the incidental taking of blue, fin, sei, and sperm whales pursuant to section 101(a)(5)(D) of the MMPA and as specified below for sea turtles. In addition, the Permits and Conservation Division must ensure that the provisions of the IHA are carried out, and inform the NMFS ESA Interagency Cooperation Division if take is exceeded.
2. The NSF must implement a program to mitigate and report on the potential effects of seismic survey activities as well as the effectiveness of the conservation measures incorporated as part of the proposed action for the North Atlantic DPS green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS loggerhead turtle.

10.3 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the NSF and NMFS Permits and Conservation Division must comply (or must ensure that any applicant complies) with the following terms and conditions that implement the reasonable and prudent measures. The NSF and NMFS Permits and Conservation Division or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (16 U.S.C. § 1536(b)(4)(iv) and 50 CFR §402.14(i)(4)).

1. The following terms and conditions implement reasonable and prudent measure 1:

   Any reports of injured or dead ESA-listed species must be provided by the Permits and Conservation Division or NSF to the ESA Interagency Cooperation Division within 24 hours to Tanya Dobrzynski, Chief, ESA Interagency Cooperation Division by email at tanya.dobrzynski@noaa.gov and nmfs.hq.esa.consultations@noaa.gov, with the subject line, "OPR-2026-00304 NSF Western Central Atlantic Seismic Survey – Dead/Injured ESA-listed Species Report."

2. The following terms and conditions implement reasonable and prudent measure 2:
   A copy of the draft comprehensive report on all seismic survey activities and monitoring results must be provided to the ESA Interagency Cooperation Division within 90 days of the completion of the seismic survey, or expiration of the IHA, whichever comes sooner. The report will be sent to nmfs.hq.esa.consultations@noaa.gov, with the subject line, "OPR-2026-00304 – NSF Western Central Atlantic Seismic Survey Draft Report."

11 Conservation Recommendations

Conservation recommendations are "suggestions … regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information" (50 CFR §402.02).

The following conservation recommendations should be considered by the NSF and NMFS Permits and Conservation Division to minimize or avoid effects to threatened and endangered species associated with this action or contribute to the development of information:

1. We recommend that the NSF promote and fund research examining the potential effects of seismic surveys on ESA-listed marine mammal and sea turtle prey species, and ESA-listed fishes.
2. We recommend that the NSF develop a more robust propagation model that incorporates environmental variables into estimates of airgun array sound propagation.
3. We recommend that the NSF conduct sound source verification in the study area (and future locations) to validate predicted and modeled isopleth distances to ESA acoustic thresholds and incorporate the results of that study into conservation measures.
4. We recommend the NSF use (and Permits and Conservation Division require in MMPA incidental take authorizations) thermal imaging cameras, in addition to binoculars (Big-Eye and handheld) and the naked eye, for use during daytime and nighttime visual observations and test their effectiveness at detecting ESA-listed species.
5. We recommend the NSF use the Marine Mammal Commission's recommended method for more accurately estimating the number of cetaceans in the vicinity of the R/V during seismic surveys based on more realistic analyses of cetacean detectability from the R/V. This analysis should be included in monitoring reports.
6. We recommend the NSF and Permits and Conservation Division make the data collected as part of the required monitoring and reporting available to the public and scientific community in an easily accessible online database that can be queried to aggregate data across PSO reports (e.g., Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations online database). Access to such data, which may include sightings as well as animal responses to seismic survey activities, will not only help us understand the biology of ESA-listed species (e.g., their range), it will inform future consultations and incidental take authorizations/permits by providing information on the effectiveness of the conservation measures and the impact of seismic survey activities on ESA-listed species.
7. We recommend the NSF and Permits and Conservation Division consider using the potential standards for towed array PAM in the *Towed Array Passive Acoustic Operations for Bioacoustic Applications: ASA/JNCC Workshop summary March 14-18, 2016 Scripps Institution of Oceanography, La Jolla, California, USA* Thode 2017.
8. We recommend the NSF use real-time cetacean sighting services such as the WhaleAlert application. We recognize that the research vessel may not have reliable internet access during operations offshore, but nearshore, where many of the cetaceans considered in this opinion are likely found in greater numbers, we

anticipate internet access may be better. Using such systems will help plan seismic survey activities and transits to avoid areas with recent ESA-listed cetacean sightings, and may also be valuable during other activities to alert others of ESA-listed cetaceans within the area, which they can then avoid.

9. We recommend the vessel operator and other relevant vessel personnel (e.g., crewmembers) on the R/V *Langseth* take the U.S. Navy's marine species awareness training.

In order for NMFS OPR ESA Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on ESA-listed species or their critical habitat, the NSF and NMFS Permits and Conservation Division should notify the ESA Interagency Cooperation Division of any conservation recommendations implemented in the final action. Notice can be provided to nmfs.hq.esa.consultations@noaa.gov with the ECO number for this consultation (from the signature page) in the subject line.

12 Reinitiation of Consultation

This concludes formal consultation on the NSF's proposed funding of seismic surveys and the NMFS Permits and Conservation Division's proposed issuance of an IHA. Consistent with 50 CFR §402.16(a), reinitiation of consultation is required and shall be requested by the Federal agency or the Service, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

1. If the amount or extent of incidental taking specified in the ITS is exceeded;
2. If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered;
3. If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the opinion; or
4. If a new species is listed or critical habitat designated that may be affected by the identified action.

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14 APPENDIX A

INCIDENTAL HARASSMENT AUTHORIZATION

The Lamont-Doherty Earth Observatory of Columbia University (L-DEO) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(D)) to incidentally harass marine mammals, under the following conditions:

1. This incidental harassment authorization (IHA) is effective for 1 year upon written notification from the Holder to NMFS, but not beginning later than 1 year from the date of issuance or extending beyond 2 years from the date of issuance.

2. This IHA is valid only for geophysical survey activity off the Eastern North American Margin in the Western Central Atlantic Ocean, as specified in L-DEO's IHA application.

3. General Conditions

(a) A copy of this IHA must be in the possession of L-DEO, the vessel operator, the lead protected species observer (PSO), and any other relevant designees of LDEO operating under the authority of this IHA.

(b) The species and/or stocks authorized for taking are listed in Table 1. Authorized take, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 1.

(c) The taking by serious injury or death of any of the species listed in Table 1 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized numbers listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) L-DEO must ensure that relevant vessel personnel and the PSO team participate in a joint onboard briefing led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, marine mammal monitoring protocols, operational procedures, and IHA requirements are clearly understood.

4. Mitigation Requirements

a. L-DEO must use independent, dedicated, trained visual and acoustic PSOs, meaning that the PSOs must be employed by a third-party observer provider, must not have tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO

training course appropriate for their designated task (visual or acoustic). Individual PSOs may perform acoustic and visual PSO duties (though not at the same time).

b. At least one visual and two acoustic PSOs must have a minimum of 90 days at-sea experience working in those roles, respectively, during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience.

c. Visual Observation

i. During survey operations (e.g., any day on which use of the airgun array is planned to occur and whenever the airgun array is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset). Visual monitoring of the shutdown and buffer zones must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the airgun array ceases or until 30 minutes past sunset.

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

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

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

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

d. Acoustic Monitoring

i. The Holder must use a towed passive acoustic monitoring system (PAM) which must be monitored by, at a minimum, one on-duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the airgun array.

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

iii. Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties may not exceed 12 hours per 24-hour period for any individual PSO.

iv. Survey activity may continue for 30 minutes when the PAM system malfunctions or is damaged, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional 10 hours without acoustic monitoring during daylight hours only under the following conditions:

1. Sea state is less than or equal to BSS 4;

2. With the exception of delphinids, no marine mammals detected solely by PAM in the applicable shutdown zone in the previous two hours;

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

4. Operations with an active airgun array, but without an operating PAM system, do not exceed a cumulative total of 10 hours in any 24-hour period.

e. Shutdown zones and buffer zones

i. Except as provided in 4(e)(ii), the PSOs must establish and monitor a 500-m shutdown zone and additional 500-m buffer zone (total 1000 m). The 1000-m zone must serve to focus observational effort but not limit such effort; observations of marine mammals beyond this distance shall also be recorded as described in 5(d) below and/or trigger shutdown as described in 4(g)(iii) below, as appropriate. The shutdown zone encompasses the area at and below the sea surface out to a radius of 500 m from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself) (0–500 m). The buffer zone encompasses the area at and below the sea surface from the edge of the shutdown zone, out to a radius of 1000 meters from the edges of the airgun array (500–1000 m). During use of the airgun array, occurrence of marine mammals within the buffer zone (but outside the shutdown zone) must be communicated to the operator to prepare for the potential shutdown of the airgun array. PSOs must monitor the shutdown zone

and buffer zone for a minimum of 30 minutes prior to ramp-up (i.e., pre-start clearance).

ii. An extended 1500 m shutdown zone must be established for all beaked whales, a large whale with a calf, and groups of six or more large whales. No buffer zone is required.

f. Pre-start clearance and Ramp-up

i. A ramp-up procedure must be followed at all times as part of the activation of the airgun array, except as described under 4(f)(viii).

ii. The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO. The notification time should not be less than 60 minutes prior to the planned ramp-up in order to allow the PSOs time to monitor the shutdown and buffer zone for 30 minutes prior to the initiation of ramp-up.

iii. Ramp-ups shall be scheduled so as to minimize the time spent with the source activated prior to reaching the designated run-in.

iv. One of the PSOs conducting the pre-start clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSOs to proceed.

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

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

vii. PSOs must monitor the shutdown and buffer zones during ramp-up, and rampup must cease and the source must be shut down upon visual observation or acoustic detection (other than delphinids) of a marine mammal within the shutdown zone. Once ramp-up has begun, observations of marine mammals within the buffer zone do not require shutdown, but such observation must be communicated to the operator to prepare for the potential shutdown.

viii. Where operational planning cannot reasonably avoid such circumstances ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Airgun array activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances.

ix. If the airgun array is shut down for brief periods (i.e., less than 30 minutes) for reasons other than that described for shutdown (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant observation and no detections of marine mammals have occurred within the applicable shutdown zone. For any longer shutdown, pre-start clearance observation and ramp-up are required.

x. Testing of the airgun array involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-start clearance watch.

g. Shutdown requirements

i. Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the airgun array.

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

iii. When the airgun array is active (i.e., anytime one or more airguns is active, including during ramp-up) and (1) a marine mammal (excluding delphinids of the species described in 4(g)(iv)) appears within or enters the shutdown zone and/or (2) a marine mammal is detected acoustically and localized within the shutdown zone, the airgun array must be shut down.

When shutdown is called for by a PSO, the airgun array must be immediately deactivated. Any dispute regarding a PSO shutdown must be resolved after deactivation.

iv. The shutdown requirement described in 4(g)(iii) may be waived for small dolphins of the following genera: *Delphinus, Lagenodelphis, Stenella,* and *Tursiops.*

1. If a dolphin of these genera is visually and/or acoustically detected and localized within the shutdown zone, no shutdown is required unless the PSO confirms the individual to be of a genus other than those listed above, in which case a shutdown is required.

2. If there is uncertainty regarding identification, visual PSOs may use best professional judgement in making the decision to call for a shutdown.

v. Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable shutdown zone (*i.e*., animal is not required to fully exit the buffer zone where applicable) or following a clearance period (15 minutes for small odontocetes, and 30 minutes for mysticetes and all other odontocetes) with no further observation of the marine mammal(s).

vi. Shutdown of the array is required upon observation of a species for which authorization has not been granted or a species for which authorization has been granted but the authorized number of takes has been met, approaching or observed within any harassment zone (*see* table 2 and table 3).

h. Vessel strike avoidance

i. Vessel operators and crew must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammals. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (separation distances stated below). Visual observers monitoring the vessel strike avoidance zone may be third-party observers (i.e., PSOs) or crew members, but crew members responsible for these duties must be provided sufficient training to 1) distinguish marine mammals from other phenomena and 2) broadly to identify a marine mammal to taxonomic group (i.e., as a large whale, or other marine mammal).

ii. Vessel speeds must be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.

iii. The vessel must maintain a minimum separation distance of 100 m from sperm whales and all baleen whales.

iv. The vessel must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an understanding that at times this may not be possible (e.g., for animals that approach the vessel).

v. When marine mammals are sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

5. Monitoring Requirements

a. The operator must provide PSOs with bigeye reticle binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality solely for PSO use. These must be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel.

b. The operator must work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals. Such equipment, at a minimum, must include:

i. PAM must include a system that has been verified and tested by an experienced acoustic PSO that will be using it during the trip for which monitoring is required.

ii. Reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one per PSO, plus backups).

iii. Global Positioning Unit (GPS) (plus backup).

iv. Digital single-lens reflex cameras of appropriate quality that capture photographs and video (plus backup).

v. Compass (plus backup)

vi. Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups).

vii. Any other tools necessary to adequately perform necessary PSO tasks.

c. Protected Species Observers (PSOs, Visual and Acoustic) Qualifications

i. PSOs must have successfully completed an acceptable PSO training course appropriate for their designated task (visual or acoustic). Acoustic PSOs are required to complete specialized training for operating PAM systems and are encouraged to have familiarity with the vessel with which they will be working.

ii. NMFS must review and approve PSO resumes.

iii. One visual PSO with experience as shown in 4(b) shall be designated as the lead for the PSO team. The lead must coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. (Note that the responsibility of coordinating duty schedules and roles may instead be assigned to a shore-based, third-party monitoring coordinator.) To the maximum extent practicable, the lead PSO must devise the duty schedule

such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

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

v. PSOs must have successfully attained a bachelor’s degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics.

vi. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must be submitted to NMFS and must include written justification. Requests must be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

d. Data Collection

i. PSOs must use standardized electronic data collection forms. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of animals to the airgun array and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the airgun array. If required mitigation was not implemented, PSOs should record a description of the circumstances.

ii. At a minimum, the following information must be recorded:

1. Vessel name, vessel size and type, maximum speed capability of vessel;

2. Dates (MM/DD/YYYY) of departures and returns to port with port

name; 3. PSO names and affiliations, PSO ID (initials or other identifier);

4. Date (MM/DD/YYYY) and participants of PSO briefings (as discussed in General Requirement);

5. Visual monitoring equipment used (description);

6. PSO location on vessel and height (meters) of observation location above water surface;

7. Watch status (description);

8. Dates (MM/DD/YYYY) and times (Greenwich Mean Time/UTC) of survey on/off effort and times (GMC/UTC) corresponding with PSO on/off effort;

9. Vessel location (decimal degrees) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;

10. Vessel location (decimal degrees) at 30-second intervals if obtainable from data collection software, otherwise at a practical regular interval;

11. Vessel heading (compass heading) and speed (knots) at beginning and end of visual PSO duty shifts and upon any change;

12. Water depths (meters) (if obtainable from data collection software);

13. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;

14. Factors that may have contributed to impaired observations during each
PSO shift change or as needed as environmental conditions changed (description) (e.g., vessel traffic, equipment malfunctions); and

15. Vessel/survey activity information (and changes thereof) (description), such as airgun array power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (i.e., pre-start clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.).

iii. Upon visual observation of any marine mammals, the following information must be recorded:

1. Sighting ID (numeric);

2. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);

3. Location of PSO/observer (description);

4. Vessel activity at the time of the sighting (*e.g.*, deploying, recovering, testing, shooting, data acquisition, other);

5. PSO who sighted the animal/ID;

6. Time/date of sighting (GMT/UTC, MM/DD/YYYY);

7. Initial detection method (description);

8. Sighting cue (description);

9. Vessel location at time of sighting (decimal degrees);

10. Water depth (meters);

11. Direction of vessel's travel (compass direction);

12. Speed (knots) of the vessel from which the observation was made;

13. Direction of animal's travel relative to the vessel (description, compass heading);

14. Bearing to sighting (degrees);

15. Identification of the animal (*e.g.*, genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;

16. Species reliability (an indicator of confidence in identification) (1=unsure/possible, 2=probable, 3=definite/sure, 9=unknown/not recorded);

17. Estimated distance to the animal (meters) and method of estimating distance;

18. Estimated number of animals (high/low/best) (numeric);

19. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);

20. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);

21. Detailed behavior observations (*e.g.*, number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);

22. Animal's closest point of approach (CPA) (meters) and/or closest distance from any element of the airgun array;

23. Description of any actions implemented in response to the sighting (*e.g.*, delays, shutdown, ramp-up) and time and location of the action.

24. Photos (Yes/No);

25. Photo Frame Numbers (list of numbers); and

26. Conditions at a time of sighting (*e.g.*. visibility, BSS)

iv. If a marine mammal is detected while using the PAM system, the following information must be recorded:

1. An acoustic encounter identification number, and whether the detection was linked with a visual sighting;

2. Date (MM/DD/YYYY) and time (GMT/UTC) when first and last heard;

3. Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal); and

4. Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

6. Reporting

(a) L-DEO must submit a draft comprehensive report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. A final report must be submitted within 30 days following resolution of any comments on the draft report. If no comments are received from NMFS within 30 calendar days of receipt of the draft report, the report shall be considered final. The draft report must include the following:

(i) Summary of all activities conducted and sightings of marine mammals near the activities;

(ii) Summary of all data required to be collected (see condition 5(d));

(iii) Full documentation of methods, results, and interpretation pertaining to all monitoring;

(iv) Summary of dates and locations of survey operations (including (1) the number of days on which the airgun array was active and (2) the percentage of time and total time the array was active during daylight vs. nighttime hours (including dawn and dusk)) and all marine mammal sightings (dates, times, locations, activities, associated survey activities);

(v) Geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording any change in airgun status (e.g., when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa);

(vi) GIS files in ESRI shapefile format and UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates must be referenced to the WGS84 geographic coordinate system; and

(vii) Raw observational data.

(b) Reporting Injured or Dead Marine Mammals

(i) Discovery of Injured or Dead Marine Mammal – In the event that personnel involved in the survey activities covered by the authorization discover an injured or dead marine mammal, L-DEO must report the incident to the Office of Protected Resources (OPR) (PR.ITP.MonitoringReports@noaa.gov) as soon as feasible. The report must include the following information:

1. Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);

2. Species identification (if known) or description of the animal(s) involved;

3. Condition of the animal(s) (including carcass condition if the animal is dead);

4. Observed behaviors of the animal(s), if alive;

5. If available, photographs or video footage of the animal(s); and

6. General circumstances under which the animal was discovered.

(ii) Vessel Strike – In the event of a ship strike of a marine mammal by any vessel involved in the activities covered by the authorization, L-DEO must report the incident to OPR as soon as feasible. The report must include the following information:

1. Time, date, and location (latitude/longitude) of the incident;

2. Species identification (if known) or description of the animal(s) involved;

3. Vessel's speed during and leading up to the incident;

4. Vessel's course/heading and what operations were being conducted (if applicable);

5. Status of all sound sources in use;

6. Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;

7. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;

8. Estimated size and length of animal that was struck;

9. Description of the behavior of the marine mammal immediately preceding and following the strike;

10. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

11. Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and

12. To the extent practicable, photographs or video footage of the animal(s).

7. This Authorization may be modified, suspended or revoked if the holder fails to abide by the conditions prescribed herein (including, but not limited to, failure to comply with monitoring or reporting requirements), or if NMFS determines: (1) the authorized taking is likely to have or is having more than a negligible impact on the species or stocks of affected marine mammals, or (2) the prescribed measures are likely not or are not effecting the least practicable adverse impact on the affected species or stocks and their habitat.

8. Renewals

On a case-by-case basis, NMFS may issue a one-time, one-year Renewal IHA following notice to the public providing an additional 15 days for public comments when (1) up to another year of identical, or nearly identical, activities are planned or (2) the specified activities would not be completed by the time this IHA expires and a Renewal would allow for completion of the activities, provided all of the following conditions are met:

(a) A request for renewal is received no later than 60 days prior to the needed Renewal IHA effective date (the Renewal IHA expiration date cannot extend beyond one year from expiration of this IHA).

(b) The request for renewal must include the following:

(i) An explanation that the activities to be conducted under the requested Renewal IHA are identical to the activities analyzed for this IHA, are a subset of the activities, or include changes so minor that the changes do not affect the previous analyses, mitigation and monitoring requirements, or take estimates (with the exception of reducing the type or amount of take).

(ii) A preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.

(c) Upon review of the request for Renewal, the status of the affected species or stocks, and any other pertinent information, NMFS determines that there are no more than minor changes in the activities, the mitigation and monitoring measures will remain the same and appropriate, and the findings made in support of this IHA remain valid.

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Kimberly Damon-Randall,

Director, Office of Protected Resources,

National Marine Fisheries Service

Table 1. Authorized take numbers, by species

Species	Authorized Take	
	Level A	Level B
Fin whale	0	1
Blue whale	0	2
Bryde's whale	1	6
Sei whale	1	23
Minke whale	2	57
Humpback whale	0	2
Sperm whale	0	274

Kogia spp.[1]	8	193
Beaked whales[2]	0	285
Rough-toothed dolphin	0	260
Bottlenose dolphin	0	906
Atlantic white-sided dolphin	0	13
Pantropical spotted dolphin	0	2,303
Atlantic spotted dolphin	0	2,208
Spinner dolphin	0	1,266
Clymene dolphin	0	1,636
Striped dolphin	0	1,392
Frasier's dolphin	0	223
Risso's dolphin	0	102
Common dolphin	0	579
Melon-headed whale	0	665
Pygmy killer whale	0	93
False killer whale	0	131
Killer whale	0	4
Pilot whales[3]	0	936
Harbor porpoise	0	3

1 Includes pygmy sperm whale and dwarf sperm whale.
2 Includes goose-beaked whale, Gervais's beaked whale, Blainville's beaked whale, and True's beaked whale.
3 Includes short-finned pilot whale and long-finned pilot whale.

Table 2. Modeled Radial Distances (m) to Isopleths Corresponding to Level A Harassment Thresholds.

Airgun Configuration	Survey type	Level A harassment zone (m)		
		LF cetaceans	HF cetaceans	VHF cetaceans
36 airgun array (6,600 in^3)	MCS	468.7	13.6	268.3
	OBS	117.2	13.6	268.3

Table 3. Modeled Radial Distance (m) to Isopleth Corresponding to Level B Harassment Threshold.

Airgun Configuration	Water Depth (m)	Level B harassment zone (m)
36 airgun array (6,600 in^3)	>1000m	6,733