NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL OPINION

Title:	Biological Opinion on the National Science Foundation's High-Energy Marine Geophysical Survey by the Research Vessel *Marcus G. Langseth* of the Carolina Trough and Blake Plateau in the Northwest Atlantic Ocean and National Marine Fisheries Service Permits and Conservation Division's Issuance of an Incidental Harassment Authorization Pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce
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AIS – Automatic Identification System

C.F.R. – Code of Federal Regulations

CI – Confidence Interval

CV – Coefficient of Variation

dB – decibels

dB re: 1 µPa – decibels referenced to a pressure of 1 microPascal

DDT – dichlorodiphenyltrichloroethane

DNA – Deoxyribonucleic Acid

DPS – Distinct Population Segment

EEZ – Exclusive Economic Zones

ESA – Endangered Species Act

FR – Federal Register

GI – Generator Injector

GIS – Geographic Information Systems

INI – Internote Interval

IHA – Incidental Harassment Authorization

ITS – Incidental Take Statement

IPCC – Intergovernmental Panel on Climate Change

L-DEO – Lamont-Doherty Earth Observatory of Columbia University

LNG – Liquefied Natural Gas

MCS – Multi-Channel Seismic

mtDNA – Mitochondrial Deoxyribonucleic Acid

MMPA – Marine Mammal Protection Act

nDNA – Nuclear Deoxyribonucleic Acid

NEFSC – Northeast Fisheries Science Center

N_{min} – Minimum Population Estimate

NMFS – National Marine Fisheries Service

NOAA – National Oceanic and Atmospheric Administration

NSF – National Science Foundation

OBS – Ocean Bottom Seismometers

OPR – Office of Protected Resources

PAM – Passive Acoustic Monitoring

PBF – Physical and Biological Features

PCBs – polychlorinated biphenyls

PI – Principle Investigator

PSI – Pounds per Square Inch

PSO – Protected Species Observer

PTS – Permanent Threshold Sift

RMS – Root Mean Square

RPM – Reasonable and Prudent Measure

R/V – Research Vessel

SEL – Sound Exposure Level

SEL_{cum} – Cumulative Sound Exposure Level

SEFSC – Southeast Fisheries Science Center

SPL – Sound Pressure Level

TED – Turtle Excluder Device

TTS – Temporary Threshold Shift

UNLOS – University-National Oceanographic Laboratory System

USFWS – U.S. Fish and Wildlife Service

UTIG – University of Texas Institute of Geophysics

1 INTRODUCTION

The ESA of 1973, as amended (16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of threatened or endangered species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with NMFS for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS jurisdiction (50 C.F.R. §402.14(a)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency is able to insure its action is not likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize listed species or destroy or adversely modify 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 an incidental take is expected, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures. NMFS, by regulation, has determined that an incidental take must be identified when take is "reasonably certain to occur" as a result of the proposed action (50 C.F.R. §402.14(g)(7)).

The Federal action agencies for this consultation are the NSF and the NMFS, OPR, Permits and Conservation Division (Permits Division). Two Federal actions are considered in this biological opinion (opinion). The first is the NSF's proposal to sponsor (fund) a marine geophysical (seismic) survey conducted by the L-DEO of the Carolina Trough and Blake Plateau in the Northwest Atlantic Ocean in the summer and fall of 2023. The second is the NMFS Permits Division's proposal to issue an IHA authorizing non-lethal "takes" by Level A and Level B harassment (as defined by the MMPA) of marine mammals incidental to the planned seismic survey, pursuant to section 101(a)(5)(D) of the MMPA. Level A harassment means any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild. Level B harassment refers to acts that have the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by disrupting behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. Note that Level A and/or Level B harassment under the MMPA do not necessarily equate to ESA harassment.

This biological opinion and ITS were prepared by the NMFS OPR ESA Interagency Cooperation Division (hereafter referred to as "we," "us," or "our") in accordance with section 7(a)(2) of the statute, associated implementing regulations (50 C.F.R. §§402.01–402.17), and agency policy and guidance. Amendments to the regulations governing interagency consultation (50 C.F.R. Part 402) became effective on October 28, 2019 (84 FR 44976). On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 C.F.R. part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order 2 days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and ITS would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

This document represents our opinion on the effects of these actions on threatened and endangered species and critical habitat that has been designated for those species (Section 6). A complete record of this consultation is on file at the NMFS OPR in Silver Spring, Maryland.

1.1 Background

The NSF is proposing to sponsor a high-energy marine seismic survey for scientific research purposes and data collection along the Carolina Trough and Blake Plateau in the Northwest Atlantic Ocean in the summer or fall of 2023. The high-energy marine seismic survey will be conducted by L-DEO. In conjunction with this action, the NMFS Permits Division proposes to issue an IHA under the MMPA for incidental takes of marine mammals that could occur during NSF and L-DEO's high-energy seismic survey. Both the NSF and the NMFS Permits Division have conducted similar actions in the past that have been the subject of ESA section 7 consultations that addressed seismic surveys throughout the world, including several in the Northwest Atlantic Ocean. These include 1 survey between Bermuda and Newfoundland (NMFS 2018), 1 off the coast of New Jersey (NMFS 2015b), and 2 off the coast of North Carolina (NMFS 2014b; NMFS 2023). Each of these consultations determined that the authorized activities were not likely to jeopardize the continued existence of proposed or ESA-listed species, or result in the destruction or adverse modification of designated critical habitat.

1.2 Consultation History

This opinion is based on information provided in the NSF's *Revised Draft Environmental Assessment/Analysis of Marine Geophysical Research of the Blake Plateau, Northwest Atlantic Ocean* prepared pursuant to the National Environmental Policy Act (LGL 2023), L-DEO's MMPA IHA application (LGL 2022), a public notice for the proposed IHA and possible renewal prepared pursuant to the requirements of the MMPA, monitoring reports from similar activities, published and unpublished scientific information on threatened and endangered species and their surrogates, scientific and commercial information such as reports from government agencies and peer-reviewed literature, opinions on similar activities, and other sources of information. Our communication with the NSF and NMFS Permits Division regarding this consultation is summarized as follows:

- On November 17, 2022, we received a request from the NSF for ESA section 7 consultation for a proposed high-energy seismic survey of the Carolina Trough and Blake Plateau in the Northwest Atlantic Ocean in summer/fall of 2023. The NSF provided a letter and draft environmental assessment in support of the request.
- On November 18, 2022, the L-DEO submitted an IHA application to the NMFS Permits Division and us. NMFS Permits Division deemed the IHA application adequate and complete on February 1, 2023.
- On December 21, 2022, we provided the NSF with questions on their draft environmental assessment and IHA application. The NSF responded to the questions on January 11, 2023. On January 13 and January 17, 2023, we provided the NSF with additional questions on their draft environmental assessment/analysis and the NSF responded to the questions on January 13 and January 18, 2023.
- On January 11, 2023, we participated in the NMFS Permits Division's Early Review Team meeting to discuss the NSF and L-DEO's high-energy seismic survey on the R/V *Marcus G. Langseth* in the Northwest Atlantic Ocean off the Blake Plateau and Carolina Trough.
- On February 1, 2023, we requested additional conservation measures for the survey during the month of October, which NSF agreed to on the same date.
- On February 1, 2023, we determined there was sufficient information to initiate formal consultation. We provided the NSF with an initiation letter on February 3, 2023.
- On June 1, 2023, we received a request for formal consultation pursuant to section 7 of the ESA from the NMFS Permits Division to authorize the incidental harassment of marine mammal species during the NSF and L-DEO's high-energy seismic survey on the R/V *Marcus G. Langseth* of the Blake Plateau and Carolina Trough in the Northwest Atlantic Ocean. The consultation request package included an initiation memorandum, draft notice of a proposed IHA and request for comments on proposed authorization and possible renewal, and draft IHA.
- On June 7, 2023, NMFS Permits Division published a notice of a proposed IHA and request for comments on proposed authorization and possible renewal in the *Federal Register* soliciting public comment on their intent to issue an IHA for NSF and L-DEO's high-energy marine seismic survey on the R/V *Marcus G. Langseth* of the Blake Plateau and Carolina Trough in the Northwest Atlantic Ocean.
- On June 12, 2023, we provided comments and edits on the draft notice of a proposed IHA and request for comments on proposed authorization and possible renewal and draft IHA to the NMFS Permits Division and NMFS Permits Division responded to the comments and edits on June 20, 2023.
- On June 21, 2023, we determined there was sufficient information to initiate formal consultation with the NMFS Permits Division. We provided the NMFS Permits Division with an initiation memo on June 22, 2023.

- On July 8, 2023, the NMFS Permits Division notified us that they did not receive any public comments on the proposed IHA and possible renewal.

2 The Assessment Framework

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

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

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

The final designations of critical habitat for loggerhead turtles used the term primary constituent element or essential features. The critical habitat regulation revisions (81 FR 7414) have since replaced this term with PBFs. The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified primary constituent elements, PBFs, or essential features. In this opinion, we use the term PBFs to mean primary constituent elements or essential features, as appropriate for the specific designated critical habitat.

An ESA section 7 assessment involves the following steps:

Description of the Proposed Actions (Section 3): We describe the proposed actions and those aspects (or stressors) of the proposed actions that may alter the physical, chemical, and biotic environment. This section also includes the avoidance and minimization measures that have been incorporated into the project to reduce the effects to ESA-listed species.

Potential Stressors (Section 4): We identify and describe the stressors that could occur because of the proposed actions.

Action Area (Section 5): We describe the action area with the spatial extent of those stressors caused by the proposed action.

Endangered Species Act-Listed Species and Designated Critical Habitat Present in the Action Area (Section 6): We identify the ESA-listed species and designated critical habitat that are subject to this consultation because they co-occur with the stressors produced by the proposed actions in space and time.

Species and Critical Habitat Not Likely to be Adversely Affected (Section 6): We identify the ESA-listed species and designated critical habitat that are not likely to be adversely affected by the stressors produced by the proposed actions.

Species and Critical Habitat Likely to be Adversely Affected (Section 8): During the ESA section 7 consultation process, we identify the ESA-listed species and designated critical habitat that are likely be adversely affected and detail our effects analysis for these species. In this section, we examine the status of ESA-listed species that may be adversely affected by the proposed actions throughout the action area.

Environmental Baseline *(*Section 9): We describe the environmental baseline, which refers to the condition of the ESA-listed species and critical habitat in the action area, without the consequences to the ESA-listed species and critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. §402.02).

Effects of the Actions (Section 10): Effects of the action are all consequences to ESA-listed species that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur in time and may include consequences occurring outside the immediate area involved in the action (50 C.F.R. §402.17). To characterize exposure, we identify the number, age (or life stage), and gender of ESA-listed individuals and the PBFs of critical habitat that are likely to be exposed to the stressors and the populations or sub-populations to which individuals belong and units of critical habitat. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species and PBFs of critical habitat are likely to respond given their probable exposure. This is our response analysis.

Cumulative Effects (Section 11): Cumulative effects are the effects to ESA-listed species and designated critical habitat of future state or private activities that are reasonably certain to occur within the action area (50 C.F.R. §402.02). Effects from future Federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integration and Synthesis (Section 12): In this section, we integrate the analyses in the opinion to summarize the consequences to ESA-listed species and designated critical habitat under NMFS's jurisdiction.

With full consideration of the status of the species and the designated critical habitat, we consider the effects of the actions within the action area on populations or subpopulations and on physical and biological features of designated critical habitat when added to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

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

The results of our jeopardy and destruction and adverse modification analyses are summarized in the Conclusion (Section 13). If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (50 C.F.R. §402.14).

In addition, we include an ITS (Section 14), if necessary, that specifies the impact of the take, reasonable and prudent measures to minimize the impact of the take, and terms and conditions to implement the reasonable and prudent measures (ESA section 7(b)(4); 50 C.F.R. §402.14(i)). We also provide discretionary Conservation Recommendations (Section 15) that may be implemented by the action agency (50 C.F.R. §402.14(j)). Finally, we identify the circumstances in which Reinitiation of Consultation is required (Section 16; 50 C.F.R. §402.16).

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

- Information submitted by the NSF and NMFS Permits Division;
- Government reports (including NMFS biological opinions and stock assessment reports);
- NOAA technical memorandums;
- Monitoring reports; and
- Peer-reviewed scientific literature.

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

3 Description of the Proposed Actions

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 C.F.R. §402.02).

Two Federal proposed actions were evaluated during this consultation. The first proposed action is NSF's proposal to sponsor a high-energy marine seismic survey on the R/V *Marcus G. Langseth* of the Carolina Trough and Blake Plateau in the Northwest Atlantic Ocean in the summer and fall of 2023. The high-energy seismic survey will be conducted by researchers from L-DEO, which owns and operates the R/V *Marcus G. Langseth*, and the UTIG. The NSF-funded survey will occur along the Carolina Trough and Blake Plateau. The second proposed action addressed is NMFS Permits Division's proposed issuance of an IHA authorizing non-lethal "takes" by MMPA Level A and Level B harassment and possible renewal pursuant to section 101(a)(5)(D) of the MMPA for the NSF and L-DEO's high-energy marine seismic survey of the Carolina Trough and Blake Plateau in the Northwest Atlantic Ocean.

The NSF-funded action includes a high-resolution, two-dimensional seismic survey in the Northwest Atlantic Ocean within the EEZ of the U.S., but a portion would also occur within the EEZ of the Bahamas and in International Waters. The seismic survey activities will collect data to examine the structure and evolution of the rifted margins of the southeastern U.S., including the rift dynamics during the formation of the Carolina Trough and Blake Plateau. The NSF, as the research funding and action agency, has a mission to "promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" The proposed high-energy seismic survey will collect data in support of a research proposal reviewed under the NSF merit review process and identified as a NSF program priority to meet the agency's critical need to foster an understanding of Earth processes.

The information presented here is based primarily on the draft environmental assessment (LGL 2023), IHA application (LGL 2022), and *Federal Register* notice (88 FR 37390 to 37422) requesting comments on the proposed IHA and possible renewal provided by the NSF and L-DEO, and NMFS Permits Division as part of their initiation packages.

3.1 National Science Foundation and Lamont-Doherty Earth Observatory of Columbia University's Proposed Action

The NSF proposes to fund a high-energy seismic survey of the Carolina Trough and Blake Plateau in the Northwest Atlantic Ocean on the R/V *Marcus G. Langseth*. The high-energy seismic survey will be conducted by researchers from L-DEO and UTIG. An airgun array, sub-bottom profiler, multi-beam echosounder, pingers, and acoustic Doppler current profiler will be deployed as energy sources.

3.1.1 Seismic Survey Overview and Objectives

The NSF was established by Congress with the National Science Foundation Act of 1950 (Public Law 810507, as amended) and is the only Federal agency dedicated to the support of fundamental research and education in all scientific and engineering disciplines. The NSF has a continuing need to fund seismic surveys that enable scientists to collect data essential to understanding the complex Earth processes beneath the ocean floor.

Researchers from the UTIG and L-DEO, with funding from the NSF, propose to conduct marine geophysical research of the Carolina Trough and Blake Plateau, off the southeastern U.S. in the Northwest

Atlantic Ocean in the summer or fall of 2023. The high-energy seismic survey is designed to investigate the structure and evolution of the rifted margins of the southeastern U.S., including the rift dynamics during the formation of the Carolina Trough and Blake Plateau. By imaging the sediments and crystalline crust of the margins, the survey team will better understand the interaction between tectonic and magmatic processes that led to continental breakup and the onset of seafloor spreading in the central Atlantic Ocean 200 million years ago. PI Dr. H. Van Avendonk (UTIG), and co-PIs Drs. N. Bangs (UTIG) and A. Bécel (L-DEO) are particularly interested in the stratigraphy of sediments that formed during and after rifting, the degree of crustal stretching at the continental margins, crustal faults that formed during extension of the margin, and the geometry of lava flows that were placed on the crust before the start of seafloor spreading. To achieve the goals of the project, the PIs will utilize the two-dimensional MCS reflection capabilities of the R/V *Marcus G. Langseth*, as well as OBSs to collect refraction survey data.

The two-dimensional seismic survey will use a towed 36-airgun array with a maximum discharge volume of approximately 6,600 cubic centimeters (402.76 cubic inches) at a depth of 10–12 meters (32.8 to 39.37 feet). The high-energy seismic survey will take place in water depths greater than approximately 100 meters (328 feet). Overall, just over half (55 percent) of all survey effort would occur in intermediate water (100–1000 meters [328 to 3,280 feet] deep), and 45 percent would occur in deep water (>1000 meters [3,280 feet] deep). The survey activities will consist of a total of approximately 61 days spread between 2 operational legs. One leg will include approximately 32 days of MCS reflection survey operations and approximately 4 days of transit time. The other leg would consist of approximately 8 days of seismic refraction survey operations with OBSs, approximately 13 days of OBS deployment and retrieval, and 4 days of transit. One leg would occur before the other with MCS seismic operations likely occurring first.

Seismic survey activities will be conducted along a total of approximately 6,682 kilometers (3,608 nautical miles) of trackline: 5,730 kilometers (3,094 nautical miles) of two-dimensional MCS seismic reflection data and 952 kilometers (513 nautical miles) of OBS refraction data. Refraction surveys would be acquired along 2 lines – a 456 kilometer (246.2 nautical mile) long line across the southern Carolina Trough with 32 OBS drops and a 496 kilometer (267.8 nautical mile) long line across the Blake Plateau with 39 OBS drops. Following refraction shooting of 1 line, OBSs on that line would be recovered, serviced, and redeployed on a subsequent refraction line. During all seismic operations, airguns would be operated 24/7 for multiple days to meet science objectives unless maintenance or conservation measures warranted.

The R/V *Marcus G. Langseth* is tentatively planning to leave out of and return to port in Jacksonville, Florida (approximately 100 kilometers [62 miles] from the survey area) during summer or fall 2023. The schedule for the R/V *Marcus G. Langseth* is available online at: https://www.mfp.us/programme/shipview/marcus%20g.%20langseth. Some minor deviation in the timeframe is possible, depending on logistics and weather. Due to uncertainties associated with the schedule, sail dates were not provided but it is likely to occur in July, August, and/or September.

The proposed action will use conventional seismic survey methodology and the procedures will be similar to those used during previous NSF-funded seismic surveys. Seismic survey protocols generally involve a predetermined set of tracklines. The seismic data acquisition or sound source vessel travels down a linear trackline for some distance until a line of data is acquired, then turns and acquires data on a different trackline (see Figure 1).

The R/V *Marcus G. Langseth* will deploy an airgun array consisting of 36 GI airguns towed on 4 strings, with 1 towed hydrophone streamer behind the R/V *Marcus G. Langseth* to conduct the two-dimensional seismic survey. The location of the tracklines are considered representative and may shift from what is depicted in Figure 1 depending on factors such as science drivers, poor data quality, weather, ice conditions, mechanical issues with the research vessel and/or equipment, etc.

The proposed activities will occur 24 hours per day during the proposed high-energy seismic survey. There will be additional airgun array operations in the seismic survey area associated with start-ups, line changes and turns, airgun array testing, recovery, and repeat coverage of any areas where initial data quality is considered sub-standard by the project scientists. A section of a trackline may need to be repeated for reasons such as when data quality is poor or missing due to equipment failure (e.g., airgun array or towed hydrophone streamer problems, data acquisition system issues, research vessel issues); data degradation due to poor weather; interruption due to shutdowns or ramp-ups; or trackline deviation for protected species, which will tie into good data on the other side of the trackline. To account for these additional airgun array operations in the estimate of incidental takes of marine mammals and sea turtles that will occur as a result of the seismic survey activities, the NSF and L-DEO added 25 percent to the total number of operational days (which is the equivalent to adding 25 percent to the total proposed trackline kilometers) to the high-energy seismic survey for their calculations of marine mammal and sea turtle exposures to sounds exceeding harm and harassment thresholds. All planned seismic data acquisition activities will be conducted by the NSF, L-DEO, and researchers from UTIG, with onboard assistance by technical staff and the marine operations group. The research vessel will be self-contained, and the scientific party and crew will live aboard the R/V *Marcus G. Langseth* for the entire seismic survey. The NSF and L-DEO's draft environmental assessment and IHA application present more detailed information on the project (LGL 2022; LGL 2023).

3.1.2 Research Vessel Specifications

The high-energy seismic survey will involve 1 source vessel, the U.S.-flagged R/V *Marcus G. Langseth* that is owned and operated by L-DEO. The R/V *Marcus G. Langseth* will tow a source airgun array as a sound source along tracklines (not predetermined). The R/V *Marcus G. Langseth* has a length of 72 meters (235 feet), a beam of 17 meters (56 feet), and a maximum draft of 5.9 meters (19.4 feet). Its propulsion system consists of 2 diesel Bergen BRG-6 engines, each producing 3,550 horsepower, and an 800 horsepower bowthruster. The R/V *Marcus G. Langseth*'s design is that of a seismic research vessel, with a particularly quiet propulsion system to avoid interference with the seismic signals. The operating speed during seismic data acquisition would be no more than 9.26 kilometers per hour (5 knots). When not towing seismic survey gear, the maximum speed of the R/V *Marcus G. Langseth* will be 18.5 kilometers per hour (10 knots). The R/V *Marcus G. Langseth* has an operating range of approximately 13,500 kilometers (7,289.4 nautical miles) and an endurance of approximately 30 days. No chase/support vessel will be used during the proposed seismic survey activities. The R/V *Marcus G. Langseth* will also serve as the platform from which vessel-based PSOs will visually watch for animals (e.g., marine mammals, sea turtles, and fishes). See Table 1 for additional details regarding the R/V *Marcus G. Langseth*.

Table 1. Additional Details of the Research Vessel *Marcus G. Langseth*

Research Vessel *Marcus G. Langseth* Specifications	
Owner	Lamont-Doherty Earth Observatory of Columbia University
Operator	Lamont-Doherty Earth Observatory of Columbia University
Flag	United States of America
Date Built or Modified	Built in 1991 Modified in 2004
Gross Tonnage	3,834
Accommodation Capacity	55 including approximately 20 Crew and 35 Scientists/Researchers

3.1.3 Airgun Array and Acoustic Receivers Description

The energy source for the high-energy seismic survey was chosen by the NSF to be the lowest practical source to meet the scientific objectives. During the high-energy seismic survey, marine technicians on the R/V *Marcus G. Langseth* will deploy 4 airgun arrays (i.e., a certain number of airguns of varying sizes in a certain arrangement) as an energy source. An airgun is a device used to emit acoustic energy pulses downward through the water column and into the seafloor, and generally consists of a steel cylinder that is charged with high-pressure air. Release of the compressed air into the water column generates a signal that reflects (or refracts) off the seafloor and/or sub-surface layers having acoustic impedance contrast. When fired, a brief (approximately 0.1 second) pulse of sound is emitted by all airguns nearly simultaneously. The airguns are silent during the intervening periods with the array typically fired on a fixed distance (or shot point) interval. The return signal is recorded by a listening device (e.g., receiving system) and later analyzed with computer interpretation and mapping systems used to depict the sub-surface.

The airgun arrays for the two-dimensional high-energy seismic survey will consist of up to 36 GI airguns (each airgun is 655.4 to 5,899.3 cubic centimeters [40 to 360 cubic inches]) with a total discharge volume of approximately 108,154.6 cubic centimeters (6,600 cubic inches; Table 2). All airguns in the array will be fired simultaneously. The airgun arrays will be towed behind the R/V *Marcus G. Langseth* in 4 strings spaced 8 meters (26.2 feet) apart. The shot interval will be approximately 24 seconds (approximately 50 meters [164 feet] per second) for the two-dimensional high-energy seismic survey and at approximately 78 seconds (approximately 200 meters [656.2 feet]) during OBS seismic refraction surveys. The firing pressure of the airgun arrays will be approximately 1,900 psi. The airgun arrays will be towed approximately 140 meters (459.3 feet) behind the research vessel (depending on Beaufort sea state) at a tow depth of 10–12 meters (32.8 to 39.37 feet). During operations, airguns would be operated 24/7 for multiple days to meet science objectives unless maintenance or conservation measures warranted shutdown. See Table 2 for the specifications of the R/V *Marcus G. Langseth*'s airgun array configurations, source output, position, tow depths, air discharge volume, dominant frequency components, pulse duration, and shot interval associated with the high-energy seismic survey over the Carolina Trough and Blake Plateau in the Northwest Atlantic.

Table 2. Specifications of the Source Airgun Arrays to be Used by the Research Vessel *Marcus G. Langseth* During the Proposed High-Energy Seismic Survey in the Northwest Atlantic Ocean

Source Airgun Array Specifications	
Energy Source – Number of Airguns	36 1900 psi bolt airguns of 40–360 cubic inches in 4 strings each containing 9 operating airguns
Source Output (Downward) of 4 Airgun Arrays	Peak-to-Peak = 177 bar-m (265 dB re: 1 µPa at 1 meter [rms]) 0-to-Peak = 84 bar-m (259 dB re: 1 µPa at 1 meter [rms])
Position	36 GI Airgun Array grouped in 4 strings approximately 16 m (52.5 ft) apart; Approximately 140 m (459.3 ft) astern
Tow Depth	10–12 meters (32.8 to 39.37 feet)
Air Discharge Volume of 4 Airgun Arrays	Approximately 6600 in^3
Dominant Frequency Components	0 to 188 Hz
Pulse Duration	Approximately 0.01 Seconds
Shot Interval	Approximately 50 m (164 ft) or 24 Seconds for 2D MCS; Approximately 200 m (656.2 ft) or 78 seconds for OBS

GI=generator injector, in^3=cubic inches, psi=pounds per square inch, NA=not available, dB=decibel, µPa=micro Pascal, rms=root mean square, m=meters, ft=feet, Hz=Hertz,

The receiving system will consist of a 15 kilometer (8.1 nautical mile) long towed hydrophone streamer during the MCS reflection survey. The towed hydrophone streamer is a solid flexible polymer streamer (i.e., not filled with gel or oil). The turning rate of the R/V *Marcus G. Langseth* with the airgun array and towed hydrophone streamer deployed is slow and the maneuverability of the research vessel will be limited during seismic survey activities. As the airgun arrays are towed along the survey lines, the hydrophone streamer would transfer data to the on-board processing system.

In addition to the hydrophone streamer, approximately 40 short-period OBSs will be deployed and will remain on the seafloor for approximately 8 days during the proposed high-energy survey. The OBSs have a height of approximately 1 meter (3.3 feet), a diameter of approximately 0.5 meters (1.6 feet), and a weight approximately 22 kilograms (48.5 pounds); an attached steel anchor is 30.5 centimeters x 38 centimeters x 2.5 centimeters (12 inches x 15 inches x 1 inch) high and weighs approximately 24 kilograms (53 pounds). As the airgun array is towed along the survey lines, the OBSs would receive and store the returning acoustic signals internally for later analysis. All OBSs would be recovered by the end of the survey. To retrieve the OBSs, the instrument is released to float to the surface via an acoustic release system. For OBS retrieval, an acoustic release transponder (pinger) is used to interrogate the instrument at a frequency of 8–11 kilohertz, and a response is received at a frequency of 11.5–13 kilohertz. The transmitting beam pattern is 55 degrees. The sound source level is approximately 93 dB. The burn-wire release assembly is then activated and the instrument is released to float to the surface from the anchor, which is not retrieved.

3.1.4 Sub-Bottom Profiler, Multi-Beam Echosounder, and Acoustic Doppler Current Profiler

Along with operations of the airgun array, 3 additional acoustical data acquisition systems will operate during the high-energy seismic survey from the R/V *Marcus G. Langseth*. The Knudsen Chirp 3260 sub-bottom profiler at 3.5 kilohertz and Kongsberg EM 122 multi-beam echosounder at 10.5 to 13 kilohertz will map the ocean floor during the high-energy seismic survey. The Teledyne RDI Ocean Surveyor acoustic Doppler current profiler at 75 kilohertz will measure water current velocities. The sub-bottom profiler, multi-beam echosounder, and acoustic Doppler current profiler sound sources will operate continuously from the R/V *Marcus G. Langseth*, including simultaneously with the airgun array as well as during transit to and from the seismic survey area.

3.1.4.1 Sub-Bottom Profiler

The ocean floor will be mapped with a Knudsen Chirp 3260 sub-bottom profiler. The sub-bottom profiler is normally operated to provide information about the near seafloor sedimentary features and the bottom topography that is mapped simultaneously by the multi-beam echosounder. The beam is transmitted as a 27 degree cone, which is directed downward by a 3.5 kilohertz transducer mounted to the hull of the research vessel. The nominal power output is 10 kilowatts, but the actual maximum radiated power is 3 kilowatts or 222 dB re: 1 µPa at 1 meter (rms). The ping duration is up to 64 milliseconds, and the ping interval is 1 second. A common mode of operation is to broadcast 5 pulses at one-second intervals followed by a five-second pause. The sub-bottom profiler is capable of reaching depths of 10,000 meters (32,808.4 feet). A sub-bottom profiler will be operated continuously during the seismic survey activities and transits.

3.1.4.2 Multi-Beam Echosounder

The ocean floor will be mapped with the Kongsberg EM122 multi-beam echosounder. The multi-beam echosounder is a hull-mounted system operating at 10.5 to 13 (usually 12) kilohertz. The transmitting beamwidth is very narrow, 0 or 2 degrees fore-aft and 150 degrees (maximum) athwartship (i.e., perpendicular to the research vessel's line of travel). The maximum sound source level is 242 dB re: 1 μPa at 1 meter (rms). Each ping consists of 8 (in water greater than 1,000 meters [3,280.8 feet] successive fan-shaped transmissions, each ensonifying a sector that extends 1 degree fore-aft. Continuous-wave signals increase from 2 to 15 milliseconds long in water depths up to 2,600 meters (8,530.2 feet) and frequency modulated chirp signals up to 100 milliseconds long are used in water greater than 2,600 meters (8,530.2 feet). The successive transmissions span an overall cross-track angular extent of about 150 degrees, with 2 millisecond gaps between the pings for successive sectors. The multi-beam echosounder emits a series of 0.7 to 200 millisecond pulses. A multi-beam echosounder will be operated continuously during the seismic survey activities and transits.

3.1.4.3 Acoustic Doppler Current Profiler

The Teledyne RDI Ocean Surveyor acoustic Doppler current profilers will be mounted on the hull of the R/V *Marcus G. Langseth* to measure the speed (velocity), direction, and depth of the water currents. The Teledyne RDI Ocean Surveyor acoustic Doppler current profiler will operate at a frequency of 75 kilohertz and a maximum sound source level of 227 dB re: 1 μPa at 1 meter (rms) over a conically shaped 30 degree beam. The transmitting beamwidth is 30 degrees. The acoustic Doppler current profiler emits a series of 11 to 37 millisecond pulses and has a ping rate is 0.7 seconds. An acoustic Doppler current profiler will be operated continuously during the seismic survey activities and transits.

3.2 National Marine Fisheries Service's Proposed Action

On November 22, 2022, NMFS Permits Division received a request from the NSF and L-DEO for an IHA to take marine mammals incidental to conducting a high-energy marine seismic survey in the Northeast Pacific Ocean. On February 1, 2023, NMFS Permits Division deemed the NSF and L-DEO's application for an IHA to be adequate and complete. The NSF and L-DEO's request is for take of a small number of 31 species of marine mammals by MMPA Level A and Level B harassment. The NSF and L-DEO and NMFS Permits Division do not expect serious injury or mortality to result from the proposed seismic survey activities; therefore, an IHA is appropriate. The planned high-energy seismic survey is not expected to exceed 1 year; hence, the NMFS Permits Division does not expect subsequent MMPA IHAs will be issued for this proposed action. The IHA will be valid for a period of 1 year from the date of issuance. The NMFS Permits Division proposes to issue the IHA on or after July 10, 2023, so that the NSF and L-DEO will have the IHA prior to the start of the proposed high-energy seismic survey.

3.2.1 Proposed Incidental Harassment Authorization

The NMFS Permits Division is proposing to issue an IHA authorizing non-lethal "takes" by MMPA Level A and Level B harassment of marine mammals incidental to the planned high-energy seismic survey. The

IHA will authorize the incidental harassment of the following threatened and endangered species: blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), and sperm whale (*Physeter macrocephalus*). The proposed IHA identifies requirements that the NSF and L-DEO must comply with as part of its authorization. The NMFS Permits Division does not expect the NSF and L-DEO's planned high-energy seismic survey to exceed 1 year and do not expect subsequent MMPA IHAs will be issued for this particular specified activity. Nevertheless, NMFS Permits Division recognizes that delays to the specified activity have the potential to occur and as a result, may issue a one-year renewal to the IHA.

On a case-by-case basis, NMFS Permits Division may issue a one-time, one-year IHA renewal following notice to the public providing an additional 15-days for public comment when: (1) up to another year of identical, or nearly identical, activities as described in the description of the proposed activity section of the *Federal Register* notice (88 FR 37390 to 37422) is planned; or (2) the activities as described in the description of the proposed activity section of the *Federal Register* notice (88 FR 37390 to 37422) will not be completed by the time the IHA expires and a second incident harassment authorization (renewal) will allow for completion of the activities beyond the original dates and duration, provided all of the following conditions are met:

- A request for renewal is received no later than 60 days prior to the needed renewal IHA effective date (recognizing that the renewal IHA expiration date cannot extend beyond 1 year from the expiration of the initial IHA);
- The request for renewal must include the following: (1) an explanation that the activities to be conducted under the proposed renewal IHA are identical to the activities analyzed under the initial IHA, are a subset of the activities, or include changes so minor (e.g., reduction in pile size) 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); and (2) 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.
- Upon review of the request for renewal, the status of the affected species or stocks, and any other pertinent information, NMFS Permits Division 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 in the initial IHA remain valid.

On June 7, 2023, NMFS Permits Division published a notice of proposed IHA and request for comments on the proposed IHA and possible renewal in the *Federal Register* (88 FR 37390 to 37422). The public comment period closed on July 7, 2023. The NMFS Permits Division did not receive any public comments. Appendix A (Section 18) contains the NMFS Permits Division's proposed IHA and possible renewal. The text in Appendix A (Section 18) was taken directly from the proposed IHA and possible renewal provided to us in the consultation initiation package.

3.2.2 Overview of Proposed Mitigation, Monitoring, and Reporting in the Incidental Harassment Authorization

In order to issue an IHA under section 101(a)(5)(D) of the MMPA, NMFS Permits Division must set forth permissible methods of taking pursuant to the activity, and other means of effecting the least practicable impact on the species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stock for taking for certain subsistence uses (latter not applicable for the proposed actions). NMFS Permits Division regulations require applicants for incidental take authorizations 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 C.F.R. §216.104(a)(11)).

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, the NMFS Permits Division carefully consider 2 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, NMFS Permits Division has 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 NMFS Permits Division reviewed seismic mitigation protocols required or recommended elsewhere (HESS 1999; JNCC 2017; Kyhn et al. 2011; Nowacek et al. 2013), recommendations received during public comment periods for previous actions, and the available scientific literature. The NMFS Permits Division also considered recommendations given in a number of review articles (Compton et al. 2008; Parsons et al. 2009; Weir and Dolman 2007; Wright and Consentino 2015). This exhaustive review and consideration of public comments regarding previous similar activities has led to development of the protocols included in the section below.

3.3 National Science Foundation, Lamont-Doherty Earth Observatory of Columbia University, and National Marine Fisheries Service's 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) to have their action 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 or adverse effects on their designated critical habitats. Mitigation is a measure that avoids or reduces the severity of the effects of the action on ESA-listed species. Monitoring is used to observe or check 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 indicate that it reviewed monitoring and conservation measures implemented during seismic surveys authorized by NMFS Permits Division under previous IHAs, as well as recommended best practices in Richardson et al. (1995a), Pierson et al. (1998), Weir and Dolman (2007), Nowacek et al. (2013), Wright (2014), and Wright and Consentino (2015), and has incorporated a suite of monitoring and conservation measures into their proposed actions based on the above sources.

Under the MMPA, the NMFS Permits Division requires mitigation, monitoring, and reporting measures that the NSF and L-DEO will implement during the high-energy seismic survey, listed below. Additional detail for each mitigation and monitoring measure is in subsequent sections of this consultation:

- Proposed shutdown and buffer zones;
- Shutdown procedures;
- Pre-start clearance and ramp-up procedures;
- Vessel-based visual monitoring by NMFS-approved PSOs;
- Vessel strike avoidance measures;
- Additional conservation measures considered; and
- Reporting.

We discuss the proposed shutdown and buffer zones in more detail in the next section (see below). Additional details for the other mitigation and monitoring measures (e.g., shutdown and ramp-up procedures) as well as reporting can be found in NMFS Permits Division *Federal Register* notice of proposed IHA and possible renewal (88 FR 37390 to 37422) and Appendix A (Section 18). A summary table of the mitigation and monitoring protocols are in Table 3.

Table 3. Proposed Mitigation and Monitoring Protocols for the High-Energy Airgun Array in the National Marine Fisheries Service Permits and Conservation Division's Proposed Incidental Harassment Authorization and Possible Renewal

Mitigation and Monitoring Protocols	High-Energy Airgun Array (36 Airguns with 108,154.6 cubic centimeters (6,600 cubic inches)
Vessel-Based Visual Mitigation Monitoring	Minimum of 2 NMFS-approved PSOs on duty during daylight hours (30 minutes before sunrise through 30 minutes after sunset); General limit of 2 consecutive hours on watch followed by a break of at least 1 hour; Maximum of 12 hours on watch per 24-hour period.
Passive Acoustic Monitoring	Minimum of 1 NMFS-approved PAM operator on duty from 30 minutes before start of source to 1 hour past the end of source use; Limit of 4 consecutive hours on watch followed by a break of at least 1 hour; Maximum of 12 hours on watch per 24-hour period
Buffer Zones	1,000 m (3280 ft; marine mammals, except North Atlantic right whale) Any distance (North Atlantic right whale) 150 m (492 ft; sea turtles)
Shutdown Zones	500 m (1,640 ft; marine mammals, except North Atlantic right whale and certain large assemblages) 1,500 m (4,921 ft; large whales with calves, and groups of 6 or more large whales) Any distance (North Atlantic right whale) 150 m (492 ft; sea turtles)
Pre-Start Clearance and Ramp-Up Procedures	Required; 30-minute clearance period of the following zones: • 1,000 m (3280 ft; marine mammals, except North Atlantic right whale) • Any distance (North Atlantic right whale) • 150 m (492 ft; sea turtles) Following detection within zone, animal must be observed exiting or additional period of 15 or 30 minutes
Ramp-Up Procedures	Required; duration ≥ 20 minutes

Mitigation and Monitoring Protocols	High-Energy Airgun Array (36 Airguns with 108,154.6 cubic centimeters (6,600 cubic inches)
Shutdown Procedures	Shutdown required for marine mammals and sea turtles detected within defined shutdown zones; Exception for certain delphinids and pinnipeds; Re-start allowed following clearance period of 15 or 30 minutes
Vessel Strike Avoidance Measures	Vigilant watch by PSOs and crew; vessel speeds reduced when assemblages of marine mammals observed near the research vessel; maintain a minimum separation distance between species of concern; avoid vessel course changes in the vicinity of marine mammals.

m=meters; ft=feet

3.3.1 Proposed Shutdown and Buffer Zones

The NMFS Permits Division will require, and the NSF and L-DEO will implement, shutdown and buffer zones around the R/V *Marcus G. Langseth* to minimize any potential adverse effects of the sound from the airgun array on MMPA and ESA-listed species. The NSF and L-DEO included mitigation and monitoring measures for sea turtles as part of its proposed action. The shutdown zones are areas within which occurrence of a marine mammal or sea turtle triggers a shutdown of the airgun array, to reduce exposure of marine mammals or sea turtles to sound levels expected to have adverse effects on the species or habitats. These shutdown zones are based upon modeled sound levels at various distances from the R/V *Marcus G. Langseth*, and correspond to the respective species sound threshold for ESA harm (e.g., injury) and harassment. The buffer zone means an area beyond the shutdown zone monitored for the presence of marine mammals and sea turtles that may enter the shutdown zone.

3.3.1.1 Ensonified Area

Since the NMFS 2018 *Revisions to Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (NOAA 2018), we recognized that ensonified area/volume can be more technically challenging to predict because of the duration component in the new thresholds, we developed a user spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to help predict takes from PTS. Because of some of the assumptions included in the methods used for these tools, we anticipate that isopleths produced are typically going to be overestimates of some degree and this may result PTS overestimates. However, when more sophisticated three-dimensional modeling methods are not available, these tools offer the best way to predict appropriate isopleths. NMFS continues to develop ways to quantitatively refine these tools and will qualitatively address the output where appropriate. For moving sound sources such as seismic surveys, the user spreadsheet predicts the closest distance at which a stationary animal will not incur PTS 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 environmental assessment and L-DEO's IHA application (LGL 2022; LGL 2023) and NMFS Permits Division's proposed IHA and possible renewal (88 FR 37390 to 37422).

For behavioral harassment, the L-DEO conducted modeling on behalf of the NSF and UTIG. 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 the distances shown in Table 4 and

Table 5 for the proposed MCS and OBS refraction surveys. The L-DEO model results are used to determine the 160 dB re: 1 µPa at 1 meter (rms) and 175 dB re: 1 µPa at 1 meter (rms) radii for a single 40 cubic inch airgun array and 36-airgun array within the survey area's intermediate (100 to 1,000 meters deep [328 to 3,280.8 feet]) and deep waters (greater than 1,000 meters [3,280.8 feet]). For Level B harassment under the MMPA, and behavioral responses under the ESA, NMFS has historically relied on an acoustic threshold for 160 dB re: 1 µPa (rms) for impulsive sound sources. These values are based on mysticete behavioral response observations, but are used for all marine mammals species. This constitutes harassment under the ESA. Also, 175 dB re: 1 µPa at 1 meter (rms) corresponds to the behavioral disturbance threshold for sea turtles (constituting harassment under the ESA). This is based on data from McCauley et al. (2000a) which reported an increased swimming speed and increasingly erratic behavior for both green and loggerhead turtles at received levels of 175 dB re: 1 µPa (rms).

Table 4. Predicted Distances to Which Sound Levels of 160 dB re: 1 µPa at 1 meter (rms) for Impulsive Sources will be Received from the Single 40 cubic inch Airgun and the 36-Airgun Array in Intermediate and Deep Water Depths for Marine Mammals during the Proposed MCS and OBS Refraction Surveys of the Blake Plateau

Source	Volume (in^3)	Water Depth (m)	Predicted Distance to Threshold (160 dB re: 1 µPa [rms]) (m)
1 Airgun	40	100 to 1,000	647
		>1,000	431
36 Airguns	6600	100 to 1,000	10,100
		>1,000	6,733

in^3=cubic inches; m=meters

Table 5. Predicted Distances to Which Sound Levels of 175 dB re: 1 μPa at 1 meter (rms) will be Received from the Single 40 cubic inch Airgun and the 36-Airgun Array in Intermediate and Deep Water Depths for Sea Turtles During the Proposed MCS and OBS Refraction Surveys of the Blake Plateau

Source	Volume (in^3)	Water Depth (m)	Predicted Distance to Threshold (175 dB re: 1 μPa at 1 meter [rms]) (m)
1 Airgun	40	100 to 1,000	116
		>1,000	77
36 Airguns	6,600	100 to 1,000	2,796
		>1,000	1,864

in^3=cubic inches; m=meters

3.3.1.2 Establishment of Proposed Shutdown and Buffer Zones

As noted above, a shutdown zone is a defined area within which occurrence of an animal triggers a mitigation action intended to reduce the potential for certain outcomes (e.g., auditory injury and disruption of critical behaviors). In addition, the buffer zone means an area beyond the shutdown zone monitored for the presence of marine mammals and sea turtles that may enter the shutdown zone. Shutdown and buffer zones for marine mammals and sea turtles are in Table 3. The 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). With certain exceptions (described below), if a marine mammal or sea turtle appears within, enters, or appears on course to enter this zone, the airgun array will be powered-down or shutdown, depending on the circumstance.

The shutdown zone for marine mammals is intended to be precautionary meaning it will be expected to contain sound exceeding the injury criteria for all cetacean hearing groups (based on the dual criteria of the SEL_{cum} and peak SPL), while also providing a consistent, reasonably observable zone within which PSOs will typically be able to conduct effective observations. Additionally, a 500 meter (1,640.4 foot) shutdown zone is expected to minimize the likelihood that marine mammals will be exposed to levels likely to result in more severe behavioral responses. Although significantly greater distances may be observed from an elevated platform under good conditions, the Permits Division believes that 500 meters (1,640.4 feet) is likely regularly attainable for PSOs using the naked eye during typical conditions. 150 meters (492.16 feet) is a practicable shutdown zone for PSOs to implement shutdowns for sea turtles. This zone is sufficiently large to prevent sea turtles from exposure to sound levels that could result in the onset of PTS in hearing because of auditory injury and therefore harm under the ESA.

NSF's draft environmental analysis and L-DEO's IHA application have a detailed description of the modeling for the R/V *Marcus G. Langseth*'s airgun arrays, as well as the resulting isopleths to behavioral thresholds for the various marine mammal hearing groups and sea turtles (Table 4 and

Table 5). Predicted distances to PTS threshold isopleths for the proposed MCS and OBS refraction surveys, which vary based on marine mammal hearing group and sea turtle thresholds, were calculated based on modeling performed by L-DEO using the NUCLEUS software program and the NMFS User Spreadsheet (https://www.fisheries.noaa.gov/action/user-manual-optional-spreadsheet-tool-2018-acoustic-technical-guidance; Table 6 and Table 7). For a discussion on how we evaluated and adopted the NSF and L-DEO's analysis, see Section 10.3.

Table 6. PTS Threshold Distances for Different Marine Mammal Hearing Groups and Sea Turtles for the 36-Airgun Array Based on a Speed of 7.6 kilometers per hour (4.1 knots) and a Shot Interval of 50 meters (164 feet) for the MCS Surveys

Threshold	Low Frequency Cetaceans (m)	Mid Frequency Cetaceans (m)	High Frequency Cetaceans (m)	Phocid Pinnipeds (m)	Otariid Pinnipeds (m)	Sea Turtles (m)
Source – 36-Airgun Array, 50-meter shot interval						
SEL_{cum}	**320.2**	0	1.0	10.4	0	**15.4**
Peak SPL_{flat}	38.9	**13.6**	**268.3**	**43.7**	**10.6**	10.6

m=meters

Table 7. PTS Threshold Distances for Different Marine Mammal Hearing Groups and Sea Turtles for the 36-Airgun Array Based on a Speed of 18.5 kilometers per hour (5 knots) and a Shot Interval of 200 meters (656 feet) for the Refraction Surveys with OBSs

Threshold	Low Frequency Cetaceans (m)	Mid Frequency Cetaceans (m)	High Frequency Cetaceans (m)	Phocid Pinnipeds (m)	Otariid Pinnipeds (m)	Sea Turtles (m)
Source – 36-Airgun Array, 50-meter shot interval						
SEL_{cum}	**80.0**	0	0.3	2.6	0	3.8

Peak SPL_{flat}	38.9	**13.6**	**268.3**	**43.7**	**10.6**	**10.6**

m=meters

3.3.2 Shutdown Procedures

The shutdown of the airgun array requires the immediate de-activation of all individual elements of the airgun array. Any PSO on duty would have the authority to delay the start of seismic survey activities or to call for shutdown of the airgun array if a marine mammal is detected within the applicable shutdown zone. 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. When the airgun array is active (i.e., anytime 1 or more airgun is active, including during ramp-up) and a marine mammal (excluding specific non-ESA-listed delphinid species) appears within or enters the shutdown zone and/or a marine mammal is detected acoustically and localized within the shutdown zone, the airgun array must be shutdown. 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 would occur whenever PAM alone (without visual sighting), confirms 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 would not resume until the marine mammal has cleared the shutdown zone. The animal would be considered to have cleared the shutdown zone if:

- It is visually observed to have departed the shutdown zone (i.e., the animal is not required to fully exit the buffer zone where applicable); or
- If it has not been seen within the shutdown zone after a clearance period of
    - 15 minutes in the case of small odontocetes, or
    - 30 minutes in the case of mysticetes and all other odontocetes, with no further observation of the marine mammal(s).

This shutdown procedure requirement would be in place for all marine mammals, with the exception of small delphinids under certain circumstances. As described above, auditory injury is extremely unlikely to occur for mid-frequency cetaceans (e.g., sperm whales and most delphinids), as this group is relatively insensitive to sound produced at the predominant frequencies in an airgun pulse while also having a relatively high threshold for the onset of auditory injury (i.e., PTS).

Visual PSOs would 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 1 of the delphinid genera for which shutdown is waived or 1 of the species with a larger shutdown zone).

Upon implementation of shutdown, the airgun array 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 the applicable clearance period described above with no further visual observation of the marine mammal(s). Shutdown of the airgun array would also be required upon visual observation of a marine mammal species for which authorization has not been granted, or a marine mammal species for which authorization has been granted but the authorized number of takes are met, observed approaching, or observed within MMPA Level A and Level B harassment zones.

In addition to the shutdown procedure described above, the NMFS Permits Division's MMPA IHA would require the airgun array be shutdown at a distance of 1,500 meters (4,921.3 feet) when:

- All beaked whales;
- Dwarf and pygmy sperm whales (*Kogia* spp.);
- 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) is observed at any distance; and
- An aggregation of 6 or more large whales is observed at any distance.

No buffer zone is required for the extended 1,500-meter (4,921.3 feet) zone.

In addition to the shutdown procedure described above, the NMFS Permits Division's MMPA IHA would require the airgun array be shutdown upon detection (acoustic or visual) of a North Atlantic right whale at any distance.

The NSF and L-DEO will implement a shutdown at a distance of 150 meters (492.1 feet) for ESA-listed sea turtles. The airgun array would be shutdown if a sea turtle is seen approaching or within the shutdown zone. Following a shutdown for ESA-listed sea turtles, the airgun array will not resume until the ESA-listed sea turtle has cleared the shutdown zone. The animal is considered to have cleared the shutdown zone if:

- It is visually observed to have left the shutdown zone; and
- It is not seen within the shutdown zone for 15 minutes.

More details on shutdown procedures are in Appendix A, which contains the NMFS Permits Division's proposed IHA and possible renewal (Section 18) of this consultation.

3.3.3 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 shutdown zone (or extended shutdown zone) prior to the beginning of ramp-up. During 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 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. Two PSOs would be required to monitor during ramp-up.

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

- Thirty minutes of pre-start clearance observation of the 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 1 trackline to another). This pre-start clearance period may occur during any vessel activity (e.g., transit).
    - If any marine mammal is observed within or approaching the 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 shutdown zone or until an additional time period has elapsed with no further sightings (i.e., 15 minutes for small odontocetes, 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 shutdown zone and buffer zone for 30 minutes prior to the initiation of ramp-up (pre-start clearance);
    - 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-ups must be scheduled so as to minimize the time spent with the airgun array activated prior to reaching the designated run-in;
- Ramp-up may not be initiated if any marine mammal is within the applicable shutdown zone or buffer zone.
    - If a marine mammal is observed within the applicable 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 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 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 within the applicable shutdown zone.
  - Once ramp-up has begun, detections 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;
  - 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 have occurred within the applicable shutdown zone.
  - For any longer shutdown, pre-start clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (e.g., Beaufort sea state 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-start clearance watch of 30 minutes is not required; and
- 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).

Ramp-up procedures would not be required for ESA-listed sea turtles if they are not observed within the shutdown zone.

More details on pre-start clearance and ramp-up procedures are in Appendix A, which contains the NMFS Permits Division's proposed IHA and possible renewal (Section 18), of this consultation.

3.3.4 Vessel-Based Visual Mitigation Monitoring

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

The NSF and L-DEO must use at least 5 dedicated, trained, NMFS-approved PSOs. The PSOs must have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and sea turtles and mitigation requirements. The PSO resumes shall be provided to NMFS for approval.

At least 1 of the visual and 2 of the 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 per the MMPA IHA and the ITS are met. To the maximum extent practicable, experienced PSOs will be scheduled to be on duty with PSOs that have appropriate training but who have not yet gained relevant 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 2 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) and 30 minutes prior to and during nighttime ramp-ups of the airgun array. Visual monitoring of the shutdown and buffer zones must begin no less than 30 minutes prior to ramp-up and must continue until 1 hour after use of the airgun array ceases or until 30 minutes past sunset. Visual PSOs shall coordinate to ensure 360-degree 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 Big-Eye reticle binoculars (25 x 150), handheld reticle binoculars (e.g., 7 x 50 Fujinon), and with the naked eye. PSOs will also have night vision devices (ITT F500 Series Generation 3 binocular-image intensifier or equivalent) during darkness, if necessary. At a minimum, the night vision device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.

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 and sea turtles by crewmembers 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 4 consecutive hours followed by a break of at least 1 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.

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 sound source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the airgun array. If required mitigation is not implemented, PSOs shall record a description of the circumstances. At a minimum, the following information must be recorded:

- Vessel name and call sign;
- PSO names and affiliations;
- Dates of departures and returns to port with port name;
- Date and participants of PSO briefings;
- Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;
- Vessel location (latitude/longitude) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
- Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;
- Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including Beaufort sea state and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
- Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (e.g., vessel traffic, equipment malfunctions); and
- Survey activity information, such as sound source power output while in operation, number and volume of airguns operating in the airgun array, tow depth of the airgun 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.).

The following information must be recorded upon visual observation of any protected species:

- Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
- PSO who sighted the animal;
- Time of sighting;
- Vessel location at time of sighting;
- Water depth;
- Direction of vessel's travel (compass direction);
- Direction of animal's travel relative to the vessel;
- Pace of the animal;
- Estimated distance to the animal and its heading relative to vessel at initial sighting;
- 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;
- Estimated number of animals (high/low/best);
- Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
- 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);

- 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);
- Animal's closest point of approach and/or closest distance from any element of the sound source;
- Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and
- Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up) and time and location of the action.

Mitigation and monitoring will be recorded in a standardized format and data will be entered into an electronic database. The accuracy of the data entry will be verified by computerized data validity checks as data are entered and by subsequent manual checking of the database. These procedures will allow initial summaries of the data to be prepared during and after the seismic survey activities, and will facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving.

More details on monitoring can be found in Appendix A, which contains NMFS Permits Division's proposed IHA and possible renewal (Section 18), of this consultation.

3.3.5 Passive Acoustic Monitoring

PAM uses trained personnel operators, herein referred to as 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, as localization of animals may not always be possible. PAM is intended to further support visual monitoring (during daylight hours) in maintaining 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 would consist of hardware (i.e., towed hydrophone streamer) and software (i.e., Pamguard). The "wet end" of the PAM system consists of a towed hydrophone streamer connected to the research vessel by a tow cable. The steel reinforced tow cable is approximately 250 meters (820.2 feet) long and the detachable hydrophone array is approximately 25 meters (82 feet) long. The hydrophones are fitted in the last 10 meters (32.8 feet) of towed hydrophone streamer with a depth gauge (with 100 meter [328.1 feet] capacity) is attached to the free end. The hydrophone streamer is typically towed at a depth of less than 20 meters (65.6 feet). The towed hydrophone streamer would be deployed from a winch located on the stern deck; however, the deployment and connection to the research vessel may change depending upon weather conditions and configuration of the airgun array. The "dry end" of the PAM system consists of a cable on deck that would connect the tow cable to the electronics unit in the main computer laboratory where the PAM station would be located. The acoustic signals received by the towed hydrophone streamer are amplified, conditioned, digitized, and processed by Pamguard software. The PAM system can detect marine mammal vocalizations at frequencies from 10 hertz to 250 kilohertz. The hydrophone array would consist of 2 low-frequency hydrophones (10 hertz to 24 kilohertz), 2 mid-frequency hydrophones (200 hertz to 200 kilohertz), and 2 high-frequency hydrophones (2 to 200 kilohertz).

The PAM system must be monitored by a minimum of 1 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. An acoustic PSO may be on watch for a maximum of 4 consecutive hours followed by a break of at least 1 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. All PSOs would be expected to rotate through the acoustic and visual positions, although the most experienced with acoustics would be on duty at the PAM system more frequently.

The R/V *Marcus G. Langseth* will use a towed PAM system, which must be monitored by a minimum of 1 on-duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the airgun array. Acoustic PSOs may be on watch for a maximum of 4 consecutive hours followed by a break of at least 1 hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period for any individual PSO.

At least 2 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 the at-sea experience.

When a vocalizing marine mammal is detected while visual monitoring are in progress, the acoustic PSO would contact the visual PSO immediately to alert them to the presence of marine mammals (if they have not already been visually sighted) and to allow for the implementation of mitigation measures, if necessary. The information regarding the vocalization would be entered into a database. The acoustic detection could also be recorded for further analysis.

The following information must be recorded if any marine mammal is detected while using the PAM system:

- An acoustic encounter identification number, and whether the detection was linked with a visual sighting;
- Date and time when first and last heard;
- Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal);
- 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.

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 2 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.

3.3.6 Vessel Strike Avoidance Measures

Vessel strike avoidance measures are intended to minimize the potential for collisions with marine mammals. NMFS Permits Division notes that 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:

- The vessel operator (R/V *Marcus G. Langseth*) and crew must maintain a vigilant watch for all marine mammals and slow down or stop or alter course of the vessel, as appropriate and regardless of vessel size, to avoid striking any marine mammal during seismic survey activities as well as transits. A single marine mammal at the surface may indicate the presence of submerged animals near the vessel; therefore, precautionary measures should be exercised when an animal is observed. 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 (i.e., as a North Atlantic right whale, large whale, or other marine mammal).
- Vessel speeds must be reduced to 18.5 kilometers 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 *Marcus G. Langseth*) must maintain a minimum separation distance of 500 meters (1,640.4 feet) from North Atlantic right whales. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take appropriate action.
- The vessel (R/V *Marcus G. Langseth*) must maintain a minimum separation distance of 100 meters (1,640.2 feet) from large whales (i.e., all baleen whales and sperm whales). The following vessel avoidance measures would be taken if a large whale is within 100 meters (328.1 feet) of the vessel:

  - The vessel (R/V *Marcus G. Langseth*) would reduce speed and shift the engine to neutral, when feasible, and would not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.
  - If the vessel is stationary, the vessel would not engage engines until the whale(s) has moved out of the vessel's path.
- The vessel must, to the maximum extent practicable, maintain a minimum separation distance of 50 meters (164 feet) 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.
- All vessels, regardless of size, must observe a 18.5 kilometers per hour (ten knots) speed restriction in specific areas designated by NMFS for the protection of North Atlantic right whales from vessel strikes. These include all seasonal management areas established under 50 C.F.R. §224.105 (when in effect), any dynamic management areas (when in effect), and slow zones. More information is available online at: www.fisheries.noaa.gov/national/endangered -species-conservation/reducing-ship-strikes-north-atlantic-right-whales for specific detail regarding these areas.

3.3.7 Additional Mitigation for North Atlantic Right Whale

To prevent exposure of North Atlantic right whales to airguns during a time when they may start to migrate to calving and nursing grounds in coastal and shelf waters adjacent to the survey area, the NSF will not conduct seismic survey activities in the nearshore portions (i.e., survey tracklines) of the action area on or after October 1st. The Permits Division will include this restriction in the final IHA, if issued.

We define "nearshore lines" as those within 100 kilometers (62.13 miles) of the U.S. shore in areas north of 31 degrees North and within 80 kilometers (49.7 miles) from the U.S. shore in areas south of 31 degrees North. Relative to the survey area, these nearshore portions of the survey area overlap with higher density areas for North Atlantic right whale during the month of October as shown in Roberts et al. (2022).

3.3.8 Reporting

In order to issue an IHA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS Permits Division must set forth requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 C.F.R. §216.104(a)(13) indicate that requests for IHAs must include the suggested means of accomplishing 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 of the MMPA IHA as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS Permits Division will contribute improved understanding of 1 or more of the following:

- Occurrence of marine mammal species or stocks in the area in which take is anticipated (e.g., presence, abundance, distribution, density).
- Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) action or environment (e.g., source characterization, propagation, ambient noise); (2) affected species (life history, diver patterns); (3) co-occurrence of marine mammal species with the action; or (4) biological or behavioral context of exposure (e.g., age, calving, or feeding areas).
- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors.
- How anticipated responses to stressors impact either (1) long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks.
- Effects on marine mammal habitat (e.g., marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat).
- Mitigation and monitoring effectiveness.

To support NMFS's goal of improving our understanding of occurrence of marine mammal species or stocks in the action area (e.g., presence, abundance, distribution, density), NSF and L-DEO will immediately report observations of North Atlantic right whale to NMFS OPR. Although the likelihood of encountering the species is considered to be rare and unexpected.

NSF and L-DEO must submit a draft comprehensive report to NMFS Permits Division within 90 days of the completion of the high-energy seismic survey or expiration of the IHA, whichever comes sooner. The report will describe the seismic survey activities that were conducted and sightings of marine mammals near the proposed actions. The report will provide full documentation of methods, results, and interpretation pertaining to all monitoring and will summarize the dates and locations of seismic survey activities, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities). The report will also include estimates of the number and nature of exposures that occurred within estimated harassment zones based on PSO observations and including an estimate of those that were not detected, in consideration of both the characteristics and behaviors of the species of marine mammals that affect detectability as well as the environmental factors that affect detectability.

The draft report shall also include geo-referenced time-stamped vessel tracklines for all periods during which the airgun array were operating. Tracklines shall include points recording any change in the airgun array status (e.g., when the airgun array began operating, when they were turned off, or when they changed from full airgun array to single airgun or vice versa). GIS files shall be provided in Esri (a GIS company) shapefile format and include the coordinated universal time (UTC) date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available to NMFS Permits Division. The report must summarize the data collected as described above and in the IHA. 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, which contains NMFS Permits Division’s proposed IHA and possible renewal (Section 18), of this consultation.

4 Potential Stressors

The proposed action involves multiple activities, each of which can create stressors. Stressors are any physical, chemical, or biological entity that may directly or indirectly induce an adverse response in ESA-listed species or their designated critical habitat. During consultation, we deconstructed the proposed action to identify stressors that are reasonably certain to result from the proposed activities. These can be categorized as pollution (e.g., exhaust, fuel, oil, trash, OBS anchors), vessel strikes, acoustic and visual disturbance (research vessel, multi-beam echosounder, sub-bottom profiler, pingers, acoustic Doppler current profiler, OBSs, and seismic airgun array), and entanglement in towed seismic equipment (hydrophone streamers). Section 4 of OPR-2021-02539 (NMFS 2022b; https://doi.org/10.25923/wetp-dt20) provides a detailed overview of the acoustic stressors. The proposed action includes several conservation measures described in Section 3.3 designed to minimize effects that may result from acoustic stressors and vessel strikes. While we consider all of these measures important and expect them to be effective in minimizing the effects of potential stressors, they do not completely 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 (Section 10).

5 Action Area

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02).

The proposed action will take place between approximately 27.5 to 33.5 degrees North and 74 to 80 degrees West within the EEZ of the U.S. and Bahamas, and in international waters. The proposed action area also includes all areas where stressors from the survey could occur (including all areas ensonified by sound from the proposed activities) and transit routes from ports. The R/V *Marcus G. Langseth* is expected to leave from and return to the port of Jacksonville, Florida, although port locations may be subject to change. Airgun survey activities will occur in water depths ranging from >100 meters (328 feet) to 5,200 meters (17,060 feet) with approximately 69 percent of these activities occurring in U.S. waters, 24 percent occurring within the EEZ of the Bahamas, and 7 percent in international waters. Representative seismic survey tracklines are displayed in Figure 1 below. However, as described earlier, some deviation in actual tracklines, including the order of survey operations, could be necessary for reasons such as science drivers, poor data quality, inclement weather, or mechanical issues with the research vessel and/or equipment. Therefore, the tracklines could occur anywhere within the coordinates of the proposed survey area as shown in Figure 1. The tracklines shown in the proposed survey area have a total length of approximately 6,682 kilometers (3,608 nautical miles). The closest distance from the proposed survey area to the U.S. coast is approximately 90 kilometers (48.6 nautical miles) to Georgia, approximately 98 kilometers (52.9 nautical miles) to Florida, and approximately 107 kilometers (57.8 nautical miles) to South Carolina. The closest distance from the proposed survey area to the Bahamas is approximately 97 kilometers (52.4 nautical miles) to the Bahamas. The survey area will not extend beyond the area shown in Figure 1.

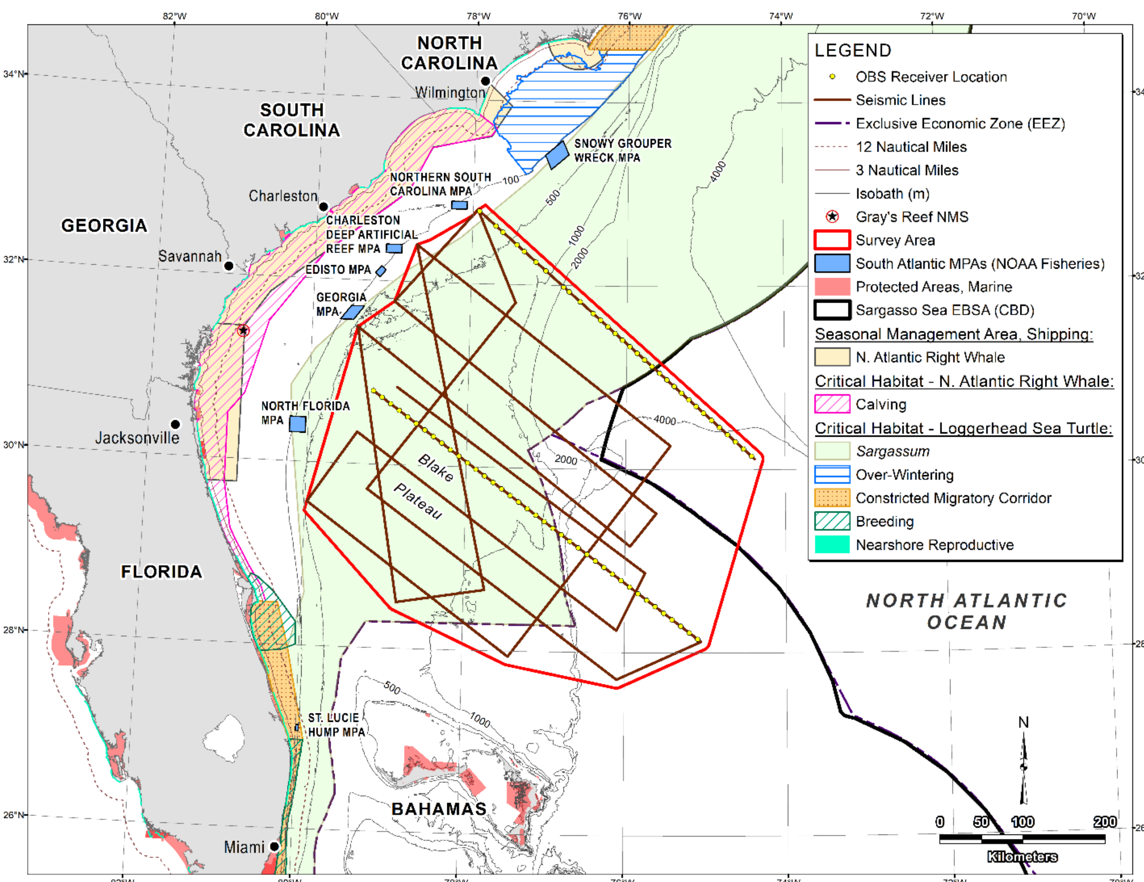

Figure 1. Map of the National Science Foundation and Lamont-Doherty Earth Observatory's high-energy seismic survey of the Carolina Trough and Blake Plateau

6 Endangered Species Act-Listed Species and Designated Critical Habitat Present in the Action Area

This section identifies the ESA-listed species and designated critical habitat that potentially occur within the action area (Section 5) and may be affected by the proposed actions. These ESA-listed species and designated critical habitat are subject in this consultation because they co-occur with the potential stressors produced by the proposed actions in space and time (Section 4).

Table 8. Endangered Species Act-Listed Threatened and Endangered Species and Designated Critical Habitat Potentially Occurring in the Action Area that may be Affected by the National Science Foundation and Lamont-Doherty Earth Observatory's High-Energy Seismic Survey of the Carolina Trough and Blake Plateau in the Northwest Atlantic Ocean and National Marine Fisheries Service Permits Division's Proposed Issuance of an IHA and Possible Renewal

Species	ESA Status	Critical Habitat	Recovery Plan
Marine Mammals – Cetaceans			
Blue Whale (*Balaenoptera musculus*)	E – 35 FR 18319	-- --	07/1998 11/2020
Fin Whale (*Balaenoptera physalus*)	E – 35 FR 18319	-- --	75 FR 47538 07/2010
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	81 FR 4837	70 FR 32293 08/2004
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584 12/2010
Marine Reptiles			
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	not in action area	10/1991 – U.S. Atlantic
Hawksbill Turtle (*Eretmochelys imbricata*)	E – 35 FR 8491	not in action area	57 FR 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	03/2010 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011

Species	ESA Status	Critical Habitat	Recovery Plan
Leatherback Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	not in action area	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 63 FR 28359
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39855	74 FR 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 01/2009 – Northwest Atlantic
Fishes			
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS	E – 77 FR 5913	not in action area	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Chesapeake DPS	E – 77 FR 5879	not in action area	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Gulf of Maine DPS	T – 77 FR 5879	not in action area	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – New York Bight DPS	E – 77 FR 5879	not in action area	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – South Atlantic DPS	E – 77 FR 5913	not in action area	3/2018 (Outline)

Species	ESA Status	Critical Habitat	Recovery Plan
Giant Manta Ray (*Manta birostris*)	T – 83 FR 2916	-- --	-- --
Nassau Grouper (*Epinephelus striatus*)	T – 81 FR 42268	not in action area	8/2018 (Outline)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 FR 4153	-- --	9/2018 (Outline)
Scalloped Hammerhead Shark (*Sphyrna lewini*) – Central and Southwest Atlantic DPS	T – 79 FR 38213	-- --	-- --
Shortnose Sturgeon (*Acipenser brevirostrum*)	E – 32 FR 4001	-- --	63 FR 69613 12/1998
Smalltooth Sawfish (*Pristis pectinata*) – U.S. Portion of Range DPS	E – 68 FR 15674	not in action area	74 FR 3566 01/2009

ESA= Endangered Species Act, FR=*Federal Register*, DPS=Distinct Population Segment, T=Threatened, E=Endangered

7 Species and Critical Habitat Not Likely to be Adversely Affected

This section identifies the proposed ESA-listed species and designated critical habitat under NMFS jurisdiction that may occur within the action area (as described in Section 5) but are not likely to be adversely affected by the proposed actions. This section also identifies potential stressors associated with the proposed actions that are not likely to adversely affect ESA-listed species and designated critical habitat that may occur within the action area.

NMFS uses 2 criteria to identify the ESA-listed species or designated critical habitat that are not likely to be adversely affected by the proposed actions, as well as the effects of activities that are consequences of the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between 1 or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities. The second criterion is the probability of a response given exposure. An ESA-listed species or designated critical habitat that co-occurs with a stressor of the action but is not likely to respond to the stressor is also not likely to be adversely affected by the proposed actions. We applied these criteria to the ESA-listed species and designated critical habitats in Section 6 and we summarize our results below.

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

Insignificant effects relate to the response of the individual or critical habitat and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when a species or critical habitat is likely to be exposed to a stressor, but the response would not rise to the level of constituting an adverse effect.

Discountable effects relate to the exposure of species or critical habitat to a stressor. For an effect to be discountable, we must conclude that the likelihood of exposure is extremely unlikely to occur.

If the effects of an action are determined to be wholly beneficial, insignificant, or discountable, we conclude that the action is not likely to adversely affect ESA-listed species or designated critical habitat. This same decision model applies to individual stressors associated with the proposed actions, such that some stressors may be determined as not likely to adversely affect ESA-listed species or designated critical habitat because any effects associated with the stressors will not rise to the level of take under the ESA.

In Section 7.1, we evaluate the proposed action's stressors (Section 4) that are not likely to adversely affect ESA-listed species and designated critical habitat. We also identify ESA-listed species and designated critical habitat that are not likely to be adversely affected by all stressors from the proposed action (Section 7.2 to 7.7)

7.1 Stressors Not Likely to Adversely Affect ESA-Listed Species or Designated Critical Habitat

Stressors that may affect, but are not likely to adversely affect the ESA-listed cetaceans, sea turtles, fishes, and designated critical habitat considered in this opinion (see Table 8) include pollution, vessel strike, vessel noise and visual disturbance, gear entanglement and interaction, and acoustic noise from a sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pinger. The following sections describe how we reached our effects determinations for these stressors.

7.1.1 Pollution

Pollution in the form of exhaust, fuel or oil spills or leaks, and trash or other debris resulting from the use of research vessels as part of the proposed action could result in impacts to ESA-listed cetaceans, sea turtles, fishes, and PBFs for North Atlantic right whale and loggerhead sea turtle designated critical habitat.

Exhaust (i.e., air pollution, including carbon dioxide, nitrogen oxides, and sulfur oxides) from the research vessel would occur during the entirety of the proposed actions, during all transit and operations, and could affect air-breathing ESA-listed species such as cetaceans and sea turtles. The R/V *Marcus G. Langseth* uses marine fuel oil, which is considered a low sulfur fuel oil because its sulfur content is between 0.10 and 1.50 percent mass concentration (https://www.marineinsight.com/guidelines/a-guide-to-marine-gas-oil-and-lsfo-used-on-ships/#Sulfur_Content_in_Marine_Gas_Oil). It is unlikely that exhaust resulting from the operation of the R/V *Marcus G. Langseth* would have a measurable effect on ESA-listed cetaceans or sea turtles given the relatively short duration of the proposed actions (approximately 61 days), the brief amount of time that cetaceans and sea turtles spend at the water's surface, and the various regulations to minimize air pollution from exhaust, such as NSF and L-DEO's compliance with the Act to Prevent Pollution from Ships (33 U.S.C. §§ 1901-1905). In addition, due to the relatively large size of the action area, adherence to relevant requirements, and the overall small contribution of air emissions from the R/V *Marcus G. Langseth* compared to all the ocean-going vessels in the action area, we believe that potential effect to ESA-listed species from vessel exhaust from the R/V *Marcus G. Langseth* during the proposed action is immeasurable. For these reasons, the effects that may result from exhaust on ESA-listed cetaceans and sea turtles are considered insignificant.

Discharges into the water from the research vessel in the form of wastewater or leakages of fuel or oil are unlikely, though effects of any spills to ESA-listed cetaceans, sea turtles, fishes, and designated critical habitat for North Atlantic right whale and loggerhead sea turtles will be minimal, if they occur at all. The potential for fuel or oil leakages is extremely unlikely. As stated in Section 7.1.1, the NSF proposes to include guidance on the handling and disposal of marine trash and debris during the high-energy seismic survey. The research vessel used during the NSF-funded high-energy seismic survey has spill-prevention plans, which will allow a rapid response to a spill in the event one occurs. In addition to this, NSF has not yet had a fuel or oil spill. The R/V *Marcus G. Langseth* is a UNLOS-designated vessel, meaning that it must adhere to UNLOS Research Vessel Safety Standards, which include requirements for pollution prevention (UNLOS 2021). Further, given the experience of the researchers and vessel operators in conducting activities in the action area, it is unlikely that spills or discharges of pollutants will occur. Thus, we find that the risk from this potential stressor on ESA-listed cetaceans, sea turtles, fishes, and designated critical habitat for North Atlantic right whale and loggerhead sea turtle is discountable.

Wastewater from the research vessel will be treated in accordance with U.S. Coast Guard standards (33 C.F.R. §151 and §159). In addition, given the large size of the action area, the dilution of discharged wastewater, and oceanographic conditions that promote mixing, ESA-listed species are not likely to be exposed to concentrations of contaminants that could lead to adverse responses.

Trash or other debris resulting from the proposed actions may affect ESA-listed cetaceans, sea turtles, and fishes. Any marine debris (e.g., plastic, paper, wood, metal, glass) that might be released would be accidental. The NSF and L-DEO follow standard, established guidance on the handling and disposal of marine trash and debris during the high-energy seismic survey (UNLOS 2021). The gear used in the proposed actions may also result in marine debris. Because the potential for accidental release of trash is extremely unlikely to occur, we find that the effects from this potential stressor on ESA-listed cetaceans, sea turtles, fishes, and designated critical habitat for North Atlantic right whale and loggerhead sea turtle are discountable.

For the reasons stated above, we conclude that pollution by vessel exhaust, wastewater, fuel or spills or leaks, and trash or other debris may affect, but is not likely to adversely affect ESA-listed species and designated critical habitat in the action area.

7.1.2 Vessel Strike

While vessel strikes of cetaceans, sea turtles, and fishes during seismic survey activities are possible, we are not aware of any definitive case of a cetacean, sea turtle, or fish being struck by a vessel associated with seismic surveys. The R/V *Marcus G. Langseth* will be traveling at generally low speeds with a maximum speed ≤ 18.5 kilometers per hour (10 knots) reducing the amount of noise produced by the propulsion system and the probability of a vessel strike (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Vessel strikes are rare events offshore and the risk of a vessel strike resulting from the proposed actions is considered extremely low. Our expectation of vessel strike for a cetacean, sea turtle, and fish is extremely small due to the hundreds of thousands of kilometers the R/V *Marcus G. Langseth* has traveled without a vessel strike, the general expected movement of cetaceans, sea turtles, and fish away from or parallel to the R/V *Marcus G. Langseth*, as well as the generally slow movement of the R/V *Marcus G. Langseth* during most of its travels (Hauser and Holst 2009; Holst 2010; Holst and Smultea 2008b). The R/V *Marcus G. Langseth* will have an operating speed of ≤ 9.26 kilometers per hour (5 knots) during seismic data acquisition. When not towing seismic survey gear, the R/V *Marcus G. Langseth* typically transits at 18.5 kilometers per hour (10 knots). Vessel strike is a less pronounced threat for fishes, as fish are mostly expected to be able to sense and maneuver away from vessels. Sturgeon have been known to be struck and killed by vessels or by the blades of vessel propellers, but we are not aware of reports of vessel strike for shortnose sturgeon and Carolina DPS, Chesapeake DPS, Gulf of Maine DPS, New York Bight DPS, and South Atlantic DPS of Atlantic sturgeon in the action area given that the vessel will operate offshore and strikes occur in rivers and shallow water. Nevertheless, sturgeon have been struck and killed by large commercial vessels as well as smaller recreational vessels. However, the majority of the survey will occur in depths outside of the range for Atlantic sturgeon. The risk of injury and mortality could be high in areas with high vessel traffic navigating channels dredged to the depth of the vessels and is an emerging threat in the Savannah River, Cooper River, and Cape Fear River. It is not known how many sturgeon are struck by vessels and survive their injuries. Balazik et al. (2012) states that Atlantic sturgeon spend the majority of the time in deeper, cooler waters within 1 meter (3.3 feet) of the bottom. Vessel strike is generally considered as a low-risk threat to shortnose sturgeon and the Carolina DPS, Chesapeake DPS, Gulf of Maine DPS, New York Bight DPS, and South Atlantic DPS of Atlantic sturgeon (NMFS 2018), as they generally are not at the water's surface, preferring to rest over sandy bottoms when not migrating.

In addition to the rationale provided above, adherence to observation and avoidance procedures is expected to avoid vessel strikes of cetaceans, sea turtles, and fishes. All factors considered, we have concluded that vessel strikes affecting ESA-listed cetaceans, sea turtles, and fishes in the action area are extremely unlikely to occur, and is therefore discountable. Therefore, we conclude that vessel strike may affect, but is not likely to adversely affect ESA-listed species.

7.1.3 Acoustic Noise from Sub-Bottom Profiler, Multi-Beam Echosounder, and Acoustic Doppler Current Profiler, and Pingers

Sounds emitted by the sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pingers have the potential to affect ESA-listed cetaceans, sea turtles, and fishes. Also, these sources may affect loggerhead sea turtle PBFs consisting of available prey and other material in *Sargassum* habitat which include populations of macroinvertebrates (e.g., copepods). We do not expect masking of communication will occur to an appreciable extent in cetaceans, sea turtles, and fishes due to the sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pinger's signal directionality, low duty cycle, and brief period when an individual could be within their beam. These factors were considered when Burkhardt et al. (2013) estimated the risk of injury from multi-beam echosounders was less than 3 percent that of vessel strike. Behavioral responses to the sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pinger are likely to be similar to airgun noise if received at the same levels. However, given the movement and speed of the research vessel and remote location of OBSs, the intermittent and narrow downward-directed nature of the sounds emitted by the sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pingers would result in no more than 1 or 2 brief ping exposures of any individual cetacean, sea turtle, fish, or prey species if any exposure were to occur. Boebel et al. (2006) and Lurton and DeRuiter (2011) concluded that sub-bottom profilers, multi-beam echosounders, acoustic Doppler current profilers, and pingers similar to those to be used during the proposed seismic survey activities presented a low risk for auditory damage or any other injury. In addition, we do not expect hearing impairment such as TTS and other physical effects if the animal is in the area, as it will have to pass the transducers at close range and match the research vessel's speed and direction in order to be subjected to sound levels that can cause these effects. Sea turtles generally do not possess a hearing range that includes frequencies emitted by the sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pinger; therefore, ESA-listed sea turtles are not expected to detect these sounds even if they are exposed and are not expected to respond to them. We find the probability of adverse effects to ESA-listed cetaceans, sea turtles, fishes, and PBFs for loggerhead sea turtle from this potential stressor to be extremely unlikely to occur. We are unable to quantify the level of exposure to these sound sources, but do not expect any exposure at levels sufficient to cause more than behavioral responses (e.g., avoidance of the sound source) in some species capable of hearing frequencies produced by the sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pinger. In addition, these sources are regularly used in prey mapping zooplankton species (Parra et al. 2019). Studies of adverse effects on zooplankton from these sources have not been documented.

We find that the risk from this potential stressor on ESA-listed cetaceans, sea turtles, fishes, and PBFs for loggerhead sea turtle is insignificant. Therefore, we conclude that the sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pingers may affect, but are not likely to adversely affect ESA-listed species and designated critical habitat.

7.1.4 Vessel Noise and Visual Disturbance

The research vessels associated with the proposed action may cause visual or auditory disturbances to ESA-listed species that spend time near the surface or in the upper parts of the water column, such as cetaceans, sea turtles, and fishes, which may generally disrupt their behavior. In addition, visual and auditory disturbance of loggerhead sea turtle PBFs consisting of available prey and other material in *Sargassum* habitat may also be affected, including populations of macroinvertebrates (e.g., copepods). Assessing whether these sounds may adversely affect ESA-listed species or loggerhead critical habitat PBFs involves understanding the characteristics of the acoustic sources, the species that may be present near the sound source, and the effects the sound may have on the physiology and behavior of those species. Although it is known that sound is important for cetacean communication, navigation, and foraging (NRC 2003b; NRC 2005), there are many unknowns in assessing impacts of sound, such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007a). Other ESA-listed species such as sea turtles and fishes are often considered less sensitive to anthropogenic sound, but given that much less is known about how they use sound, the impacts of anthropogenic sound are difficult to assess (Nelms et al. 2016; Popper et al. 2014b). Limited information on the effects of vessel noise on loggerhead critical habitat PBFs exist, however studies have shown that marine copepods can detect water vibrations (Gassie et al. 1993), and some studies have shown that vessel noise can affect certain copepod life stages (e.g., larval development; Aspirault 2019) as discussed below.

Studies have shown that vessel operations can result in changes in the behavior of cetaceans, sea turtles, and fishes (Hazel et al. 2007; Holt et al. 2009; Luksenburg and Parsons 2009; Noren et al. 2009; Patenaude et al. 2002; Richter et al. 2003; Smultea et al. 2008a). In many cases, particularly when responses are observed at great distances, it is thought that animals are likely responding to sound more than the visual presence of vessels (Blane and Jaakson 1994; Evans et al. 1992; Evans et al. 1994). At close distances, animals may not even differentiate between visual and acoustic disturbances created by vessels and simply respond to the combined disturbance. Nonetheless, it is generally not possible to distinguish responses to the visual presence of vessels from those associated with vessel noise. We consider the effects to cetaceans, sea turtles, and fishes from the visual presence of vessels associated with the proposed action to be insignificant.

Sounds emitted by large vessels can be characterized as low frequency, continuous, or tonal and sound pressure levels at a source will vary according to speed, burden, capacity, and length (Kipple and Gabriele 2007; McKenna et al. 2012; Richardson et al. 1995a). Source levels for 593 container ship transits were estimated from long-term acoustic recording received levels in the Santa Barbara shipping channel, and a simple transmission loss model using Automatic Identification System data for source-receiver range (McKenna et al. 2013). Vessel noise levels could vary 5 to 10 dB depending on transit conditions. Given the sound propagation of low frequency sounds, a large vessel in this sound range can be heard 139 to 463 kilometers (75.1 to 250 nautical miles) away (Polefka 2004). Hatch et al. (2008) measured commercial ship underwater noise levels and reported average source level estimates (71 to 141 hertz, re: 1 µPa at 1 meter [rms] ± standard error) for individual vessels ranged from 158 ± 2 dB (research vessel) to 186 ± 2 dB (oil tanker). McKenna et al. (2012), in a study off Southern California, documented different acoustic levels and spectral shapes observed from different modern vessel-types, illustrating the variety of possible noise levels created by the diversity of vessels that may be present.

The functional hearing ranges of ESA-listed sea turtles are not well understood and vary by species. Piniak et al. (2016) found juvenile green and hawksbill sea turtles capable of hearing underwater sounds at frequencies of 50 hertz to 1,600 hertz (maximum sensitivity at 200 to 400 hertz). Existing information about sea turtle sensory biology suggests that sea turtles rely more heavily on visual cues, rather than auditory signals, to initiate threat avoidance (Hazel et al. 2007). Research also suggests that sea turtles cannot be expected to consistently notice and avoid vessels that are traveling faster than 2 knots (Hazel et al. 2007). Regardless of the specific stressor associated with vessels to which turtles are responding, they only appear to show responses (i.e., avoidance behavior) at approximately 10 meters (32.8 feet) or closer (Hazel et al. 2007). Therefore, the noise from vessels is not likely to affect sea turtles from further distances, and disturbance may only occur if a sea turtle hears a vessel nearby or sees it as it approaches.

All fish species can detect vessel noise due to its low-frequency content and their hearing capabilities. Data for elasmobranch fishes suggest they are capable of detecting sounds from approximately 20 hertz to 1 kilohertz with the highest sensitivity to sounds at lower ranges (Casper et al. 2012; Casper et al. 2003; Casper and Mann 2006; Casper and Mann 2009; Ladich and Fay 2013; Myrberg 2001). Therefore, ESA-listed fishes could be exposed to a range of vessel noises, depending on the source and context of the exposure. In the near field, fish are able to detect water motion as well as visually locate an oncoming vessel. In these cases, most fishes located in close proximity that detect the vessel either visually, via sound and motion in the water would be capable of avoiding the vessel or move away from the area affected by vessel sound. Thus, fish are more likely to react to vessel noise at close range than to vessel noise emanating from a greater distance away.

In addition to effects to ESA-listed species, important species for *Sargassum* (i.e., copepods) that make up PBFs for loggerhead critical habitat may also be affected by vessel noise. Impacts of vessel noise on prey species such as copepods is less known but some studies have shown a reduction in egg production and size with exposure to vessel noise (Aspirault 2019). Additionally, an important zooplankton predator (*Chaoborus flavicans*) increased anti-predatory defense behavior when exposed to short-term exposure to boat noise (Rojas et al. 2021). These works highlight that noise could affect both fitness and behavior of zooplankton species; however, they studied only an acute noise exposure. In addition, the results from these studies are contrasted by other research showing a lack of response in zooplankton from chronic boat noise (Prosnier et al. 2022; Sabet et al. 2019).

The contribution of vessel noise by the R/V *Marcus G. Langseth* is likely small in the overall regional sound field. Brief interruptions in communication via masking are possible, but unlikely given the habits of cetaceans and fish to move away from vessels, either as a result of engine noise, the physical presence of the vessel, or both (Lusseau 2006; Mitson and Knudsen 2003). Also, as stated, sea turtles are most likely to habituate and are shown to be less effected by vessel noise from vessels traveling greater than 3.7 kilometers per hour (two knots) at distances greater than 10 meters (32.8 feet; Hazel et al. 2007). In addition, during research operations, the R/V *Marcus G. Langseth* will be traveling at slow speeds, reducing the amount of noise produced by the propulsions system (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). The distance between the research vessel and observed cetaceans and sea turtles, per avoidance protocols, will also minimize the potential for acoustic disturbance from engine noise. Because the potential acoustic interference from engine noise will be undetectable or so minor that it cannot be meaningfully evaluated, we find that the effects from this potential stressor are insignificant. Therefore, we conclude that acoustic interference from engine noise may affect, but is not likely to adversely affect ESA-listed cetaceans, sea turtles, fishes, or PBF for loggerhead sea turtle critical habitat.

7.1.5 Gear Entanglement and Interaction

There is a variety of gear proposed for use during the proposed action that might entangle, strike, or otherwise interact with ESA-listed species in the action area. Gear entanglement and interaction will have no effect on PBFs for North Atlantic right whale and loggerhead designated critical habitat.

Towed gear from the seismic survey activities pose a risk of entanglement to ESA-listed cetaceans and sea turtles. The towed hydrophone streamer could come in direct contact with ESA-listed species and sea turtle entanglements have occurred in towed gear from seismic survey vessels. We are not aware of any cases of leatherback sea turtles entanglement. However, an NSF-funded seismic survey off the coast of Costa Rica during 2011 recovered a dead olive ridley turtle (*Lepidochelys olivacea*) in the foil of towed seismic equipment; it is unclear whether the sea turtle became lodged in the foil pre- or post mortem (Spring 2011). Entanglement is highly unlikely due to the towed hydrophone streamer design, as well as observations of sea turtles investigating the towed hydrophone streamer and not becoming entangled or operating in regions of high sea turtle density and entanglements not occurring (Hauser 2008; Holst and Smultea 2008a; Holst et al. 2005a; Holst et al. 2005b). The towed hydrophone streamer is rigid and as such will not encircle, wrap around, or in any other way entangle any of the cetaceans considered during this consultation. We expect the taut cables will prevent entanglement. Furthermore, cetaceans are expected to avoid areas where the airgun array is actively being used, meaning they will also avoid towed gear. We are not aware of any entanglement events with ESA-listed cetaceans or sea turtles with the towed gear proposed for use in this action.

We do not expect ESA-listed cetaceans or sea turtles to be at depths where the survey will occur, so the concerns about equipment strike from OBSs would primarily be as they are being deployed, and dropping to the ocean floor. We expect ESA-listed cetaceans or sea turtles to perceive the disturbance and be able to detect the ocean bottom seismometers, exhibit avoidance behavior, and move out of the way.

ESA-listed fish species in the action area (giant manta rays, scalloped hammerheads, and oceanic whitetip sharks) could be entangled or struck by equipment used during the seismic survey. Because the use of these equipment will only occur in waters >100 meters (328 feet) at a distance of ≥ 90 kilometers from the U.S. and Bahamian shore, Atlantic and shortnose sturgeon, Nassau grouper, and smalltooth sawfish (U.S. population) are not expected to overlap with the use of these equipment as these species are not known to travel this far offshore in the proposed action area (Haulsee et al. 2020; NMFS 2010b; NMFS 2013b; NMFS 2022a; OBIS 2023; Wiley and Brame 2018). More information on the distribution of Atlantic and shortnose sturgeon, Nassau grouper, and smalltooth sawfish is provided in Sections 7.3 and 7.5. ESA-listed giant manta rays can occur near the surface when feeding (ten meters [32.8 feet]), but can also dive to depths of between 200 and 450 meters (656.17 to 1,476.4 feet), and even up to 1,000 meters (3280.8 feet). ESA-listed scalloped hammerheads occur over continental and insular shelves, as well as adjacent deep waters. The ocean bottom seismometers will operate at or near the ocean floor. The towed hydrophone array, the PAM hydrophone (both towed near the surface), and the towed airgun array (towed at 12 meters below the surface) pose similar risks to ESA-listed fishes. However, we consider the possibility of equipment entanglement or strike to be remote because of fishes' ability to detect the equipment moving through the water and move out of the way.

Although the towed hydrophone streamer or PAM array could come in direct contact with an ESA-listed species, entanglements are extremely unlikely and considered discountable. Based upon extensive deployment of this type of equipment with no reported entanglement and the nature of the gear that is likely to prevent it from occurring, we find the probability of adverse effects to ESA-listed species to be discountable; therefore, gear interactions may affect, but are not likely to adversely affect any ESA-listed species in the action area.

7.1.6 Potential Stressors Considered Further

The only potential stressor that is likely to adversely affect ESA-listed species within the action area is the sound field produced by the seismic airgun array. This stressor is likely to adversely affect certain ESA-listed species, which are further analyzed and evaluated in Section 10. A discussion on ESA-listed species and designated critical habitat that are not likely to be adversely affected by the airgun array during the proposed action is below.

7.2 North Atlantic Right Whale

North Atlantic right whales are typically found in coastal or shelf waters. As noted in Section 5, the proposed seismic survey activities will take place in the Northwest Atlantic Ocean in offshore waters within the U.S. EEZ adjacent to South Carolina, Georgia, and Florida within water depths ranging from >100 meters (328 feet) to 5,200 meters (17,060 feet). 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 kilometers (13.5 nautical miles) or less from shore (Gowan and Ortega-Ortiz 2014). The closest distance from the proposed seismic survey area to the U.S. coast is approximately 90 kilometers (48.6 nautical miles). No sightings of North Atlantic right whale have been documented within the proposed seismic survey area.

During the proposed survey months of May through October, there are a limited number of sightings (approximately less than 5) of North Atlantic right whale in coastal and shelf waters adjacent to the survey area (OBIS 2023). During the months of September and October, most North Atlantic right whales have not begun or completed their southern migration to winter calving areas off the coast of the North and South Carolina, Georgia, and Florida from their feeding and mating grounds off the coast of Canada and New England (Gowan and Ortega-Ortiz 2014). Furthermore, during the month of October when North Atlantic right whales may start to migrate to calving and nursing grounds in coastal and shelf waters adjacent to the survey area based on recent density information (Roberts et al. 2022), the NSF will not conduct seismic survey activities in nearshore portions of the survey area on or after October 1st as defined in Section 3.3.7. Given the time of year the proposed action will occur, the conservation measures implemented by NSF, and the fact that no sightings of North Atlantic right whales have been observed in the survey area, exposure of North Atlantic right whales to the stressors produced by the proposed airgun survey would be extremely unlikely to occur and thus discountable.

We conclude that the proposed use of the airgun array in the action area may affect, but is not likely to adversely affect North Atlantic right whales.

7.3 Hawksbill Sea Turtle

While the hawksbill turtle can be found in coastal and pelagic habitats within the action area, it is unlikely that hawksbill turtles will be adversely affected by stressors associated with the airgun array because they are not expected to occur in the portion of the action area where airgun array operations will occur.

Hawksbill sea turtles are considered very rare and possibly extralimital in the Northwest Atlantic (Eckert 1995; Lazell 1980). In addition, the species is rarely sighted farther north than the southern tip of Florida (Meylan 2006). There is only 1 record of hawksbill sea turtle occurring in the seismic survey area during the months of July through October in the OBIS database (OBIS 2023). This sighting occurred in late October of 1992 in waters approximately 100 kilometers (62.13 miles) from shore in areas north of 31 degrees north. Based on NSF's conservation measures to not conduct seismic survey activities in nearshore portions of the survey area on or after October 1st as defined in Section 3.3.7, it is unlikely that the proposed survey will overlap with hawksbill sea turtles during the survey months. Due to the lack of sighting or bycatch data, as well as the rarity of strandings in the survey area (Epperly et al. 2002; Epperly et al. 1996; NMFS 2010a; NMFS 2011a; NMFS 2012a; NMFS 2013a; NMFS 2014a; NMFS 2015a; NMFS 2016), we believe that hawksbill turtles are unlikely to be exposed to airgun noise during the high-energy seismic survey. Because of the low probability of occurrence of hawksbill turtles in the action area, the potential adverse effects from the acoustic noise from the airgun array are discountable. Therefore, we conclude that the NSF and L-DEO's high-energy seismic survey may affect, but is not likely to adversely affect ESA-listed hawksbill turtles.

7.4 Elasmobranchs

Smalltooth sawfish are an ESA-listed elasmobranch that overlaps with the action area; however, they are expected to occur in shallower waters outside of where airgun activities will occur. Sawfish inhabit shallow coastal waters, estuaries, and rivers of the tropics and subtropics, down to a maximum depth rarely exceeding 100 meters (328 feet) and are associated with mangrove and seagrass habitats (Dulvy et al. 2016). Adult smalltooth sawfish may occasionally be found in marine waters out to 76.2-167.6 meters (250-550 feet); however, these occurrences are confined to areas closer to shore off the southern Florida coast (e.g., Fort Lauderdale), outside of the airgun survey area. Based on the species' distribution, exposure of smalltooth sawfish to NSF's proposed airgun survey would be extremely unlikely and thus discountable. As a result, we conclude that the proposed seismic survey activities in the action area are not likely to adversely affect smalltooth sawfish.

Other ESA-listed elasmobranchs in the action area, including giant manta ray, oceanic whitetip shark, and Central & Southwest Atlantic DPS scalloped hammerhead shark, may overlap with sound fields generated by airguns during the proposed action. Elasmobranchs, like all fish, have an inner ear capable of detecting sound and a lateral line capable of detecting water motion caused by sound (Hastings and Popper 2005; Popper and Schilt 2009). Data for elasmobranch fishes suggest they are capable of detecting sounds from approximately 20 hertz to 1 kilohertz with the highest sensitivity to sounds at lower ranges (Casper et al. 2012; Casper et al. 2003; Casper and Mann 2006; Casper and Mann 2009; Ladich and Fay 2013; Myrberg 2001). However, unlike most teleost fish, elasmobranchs do not have swim bladders (or any other air-filled cavity), and thus are unable to detect sound pressure (Casper et al. 2012). Particle motion is presumably the only sound stimulus that can be detected by elasmobranchs (Casper et al. 2012). Given their assumed hearing range, elasmobranchs are anticipated to be able to detect the low frequency (10 to 500 Hertz; Hildebrand 2009a) sound from an airgun array, if exposed. However, the limited duration of the proposed action's low-frequency acoustic stressor in a single location will likely minimize the effect this stressor has on elasmobranchs. Furthermore, although some elasmobranchs have been known to respond to anthropogenic sound, in general, elasmobranchs are not considered particularly sensitive to sound (Casper et al. 2012).

There have been no studies examining the direct effects of exposure to specific anthropogenic sound sources in any species of elasmobranchs (Casper et al. 2012). However, several elasmobranch species, including 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). Lemon sharks exhibited withdrawal responses to pulsed low to mid-frequency sounds (500 hertz to 4 kilohertz) raised 18 dB re: 1 μPa at 1 meter (rms) an onset rate of 96 dB re: 1 μPa at 1 meter (rms) per second to a peak amplitude of 123 dB re: 1 μPa at 1 meter (rms) received level from a continuous level, just masking broadband ambient sound (Klimley and Myrberg 1979). In the same study, lemon sharks withdrew from artificial sounds that included 10 pulses per second and 15 to 7.5 decreasing pulses per second.

In contrast, other elasmobranch species are attracted to pulsing low frequency sounds. Myrberg (2001) stated that sharks have demonstrated highest sensitivity to low frequency sound (40 to 800 hertz). Free-ranging sharks are attracted to sounds possessing specific characteristics including irregular pulsed, broadband frequencies below 80 hertz and transmitted suddenly without an increase in intensity, thus resembling struggling fish.

These signals, some "pulsed," are not substantially different from the airgun array signals. Myrberg et al. (1978) reported that silky shark withdrew 10 meters (32.8 feet) from a speaker broadcasting a 150 to 600 hertz sound with a sudden onset and peak source level of 154 dB re: 1 µPa at 1 meter (rms). These sharks avoided a pulsed low frequency attractive sound when its sound level was abruptly increased by more than 20 dB re: 1 µPa at 1 meter (rms). Other factors enhancing withdrawal were sudden changes in the spectral or temporal qualities of the transmitted sound. The pelagic oceanic whitetip shark also showed a withdrawal response during limited tests, but less so than other species (Myrberg et al. 1978). These results do not rule out that such sounds may have been harmful to the fish after habituation; the tests were not designed to examine that point.

Popper et al. (2014b) concluded that the relative risk of fishes with no swim bladders exhibiting a behavioral response 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, but concluded that, if it were to occur, masking will result in a narrow range of frequencies being masked (Popper et al. 2014b). Popper et al. (2014b) also concluded that injury for fish with no swim bladders exposed to low frequency active sonar is unlikely because no damage was found after exposure to higher intensity impulsive signals.

A study on the behavioral responses of sharks to sensory deterrent devices tested the sharks' attraction to bait while being exposed to auditory and visual stimuli. Ryan et al. (2017) used a strobe light and sound sources within a range thought to be audible to sharks (20 to 2,000 hertz) on captive Port Jackson (*Heterodontus portusjacksoni*) and epaulette (*Hemiscyllium ocelltum*) sharks, and wild great white sharks (*Carcharodon carcharius*). The strobe lights alone (and the lights with sound) reduced the number of times bait was taken by Port Jackson and epaulette sharks. The strobe lights alone did not change white shark behavior, but the sound and the strobe light together led to great white sharks spending less time near bait. Sound alone did not have an effect on great white shark behavior (Ryan et al. 2017). The sound sources used in this study are different than the airguns used in the proposed action, but are still somewhat similar as they are both fairly low frequency sounds.

The precise expected response of ESA-listed elasmobranchs to low-frequency acoustic energy is not completely understood due to a lack of sufficient experiment and observational data for these species. However, given the signal type and level of exposure to the low-frequency signals used in the seismic survey activities, we do not expect a measurable response. The most likely response of ESA-listed elasmobranchs 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. Therefore, the potential effect of the seismic survey activities on ESA-listed elasmobranchs is considered insignificant. Thus, we conclude that the proposed seismic survey activities in the action area may affect, but are not likely to adversely affect ESA-listed elasmobranchs and these species will not be considered further in this opinion.

7.5 Sturgeon and Nassau Grouper

As noted in Section 7.1.5, the distributions of Atlantic and shortnose sturgeon, and Nassau grouper are outside of the survey area where use of the airgun array will occur. Based on species observation data from OBIS (2023), there are no recorded sightings of these species in the survey area where the airgun array will operate.

In the marine portion or their range, Atlantic sturgeon are mostly confined to the 50-meter (164-foot) depth contour in waters adjacent to the southeast U.S. coastline. Based on fisheries-dependent data for incidental captures of Atlantic sturgeon, Stein et al. (2004) described that the greatest number of sturgeon captures along the U.S. coast occurred within the 10- to 50-meter (32.8- to 164-foot) isobaths. Dunton et al. (2010), examining both fisheries-dependent and fisheries-independent data of incidental Atlantic sturgeon captures determined that Atlantic sturgeon were mostly found in water depths less than 20 meters (65.6 feet). Erickson et al. (2011), using location data of tagged Atlantic sturgeon, described the mean range of marine waters where Atlantic sturgeon occurred as 9.9 to 24.4 meter (32.4 to 80 feet) deep depending on time of year. Erickson et al. (2011) also noted differences between fish, with some sturgeon using more shallow waters (5 to 15 meters [16.4 to 49.21 feet]) and some using deeper waters (35 to70 meters [114.8 to 229.7 feet]) compared to the other tagged Atlantic sturgeon. Haulsee et al. (2020) conducted a glider survey of the coastal ocean in waters adjacent to the proposed survey area in waters within 6- to 42-meter (19.7- to 137.8-foot) depths with all detections occurring in waters 10 to 20 meters (32.8 to 65.6 feet) deep. Furthermore, multiple detections of adult Atlantic sturgeon in marine waters out to the 80-meter (262.46-foot) depth isobath have occurred (J. Kahn, NOAA Fisheries Office of Protected Resources, pers. comm. to J. Molineaux, NOAA Fisheries Office of Protected Resources, March, 2, 2023). However, no data exists of Atlantic sturgeon going to the 100-meter isobath in areas of the proposed survey area.

In addition to Atlantic sturgeon, shortnose sturgeon are found even closer to shore in the marine environment, with the majority of individuals present in estuaries and rivers (NMFS 2010b). Contrasting with the life history of Atlantic sturgeon, shortnose sturgeon are mostly contained to nearshore coastal marine environments where they migrate to adjacent river systems (NMFS 2010b). Therefore, shortnose sturgeon are not expected to overlap with the proposed seismic survey area.

The northern range of Nassau grouper within the U.S. EEZ is in the waters surrounding Florida, specifically waters south of Cape Canaveral. Smaller fish are found in shallow inshore waters and larger individuals more common on deeper offshore reefs out to 130 meters; however, groupers are most common at depths less than 100 meters outside of the survey area (NMFS 2013b). Per OBIS (2023), there are no documented sightings of Nassau grouper in the survey area.

Based on the distributions of Atlantic and shortnose sturgeon, and Nassau grouper, exposure of these species to NSF's proposed airgun survey would be extremely unlikely and thus discountable. We conclude that the proposed seismic survey in the action area may affect, but is not likely to adversely affect Atlantic and shortnose sturgeon, and Nassau grouper.

7.6 North Atlantic Right Whale Critical Habitat

On January 27, 2016, NMFS issued a final rule expanding North Atlantic right whale critical habitat (81 FR 4837). This expansion included areas in the Gulf of Maine (near Maine, New Hampshire, and Massachusetts) and Georges Bank Foraging Area and off the Southeast U.S. Coast Calving Area, from southern North Carolina to central Florida (Figure 2). The Southeast U.S. Coast Calving Area unit was designated to provide support to the North Atlantic right whale calving and nursing season, which typically occurs from November 15 to April 15 annually.

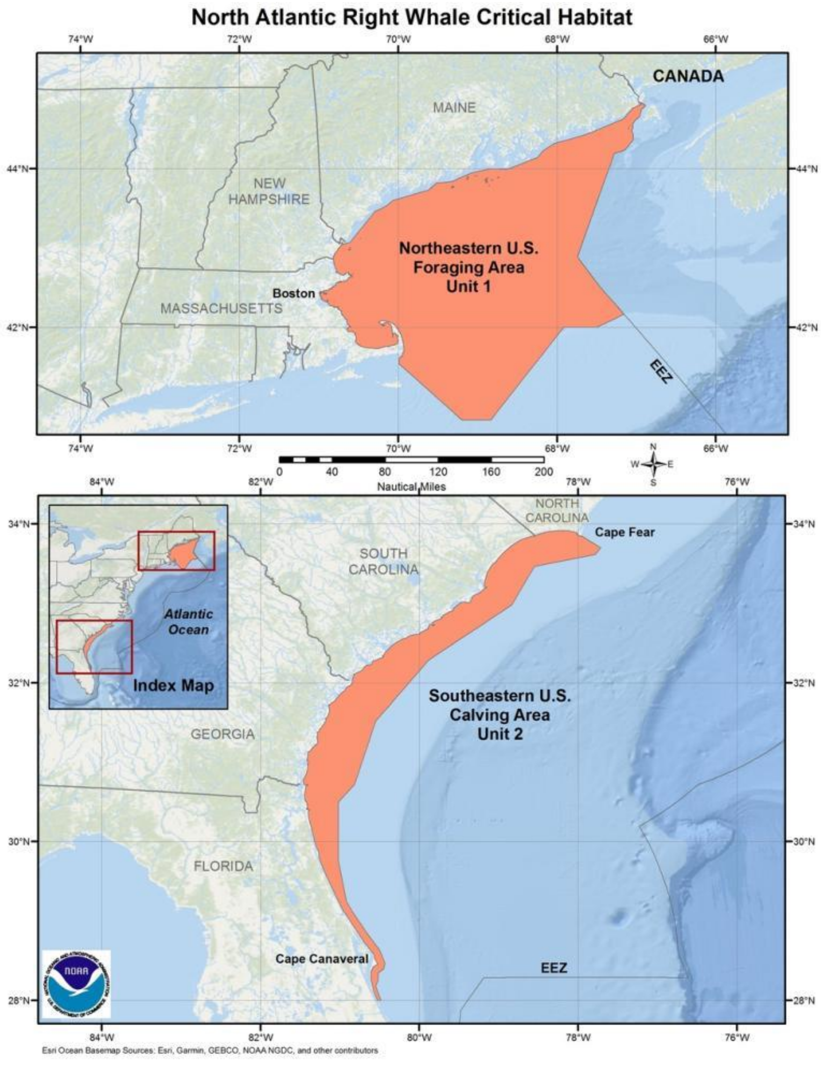

Figure 2. Designated critical habitat for North Atlantic right whale

The proposed action will only overlap with the Southeast U.S. Coast Calving Area unit of North Atlantic right whale critical habitat. The PBFs of the North Atlantic right whale Calving Area unit are:

1. Sea surface conditions associated with Force 4 or less on the Beaufort scale.
2. Sea surface temperatures of 7 to 17 degrees Celsius.

3. Water depths of 6 to 28 meters (19.68 to 91.86 feet) where these features simultaneously co-occur over contiguous areas of at least 792.3 square kilometers (231 square nautical miles) of ocean waters during the months of November through April. When these features are available, they are selected by right whale cows and calves in dynamic combinations that are suitable for calving, nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves.

Only vessel transit will occur in this area outside of the months of November through April when calving and nursing occurs. The airgun survey area would not overlap with any portion of the critical habitat. As a result, seismic survey activities will not affect any of the PBFs associated with the North Atlantic right whale Calving Area unit. Furthermore, vessel transit will only have insignificant effects on the sea surface conditions, temperatures, or water depths of the North Atlantic right whale Calving Area unit. Sea surface conditions, temperatures, or water depths will not be altered or if slightly changed, will immediately return to normal once the R/V *Marcus G. Langseth* has sailed past a specific location in the critical habitat unit. Therefore, we conclude that the proposed action may affect, but is not likely to adversely affect North Atlantic right whale critical habitat.

7.7 Loggerhead Sea Turtle Critical Habitat

On July 10, 2014, NMFS and the USFWS designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtles along the U.S. Atlantic and Gulf of Mexico coasts, from North Carolina to Mississippi (79 FR 39856; Figure 3). The Final Rule designated 5 different units of critical habitat, each supporting PBFs for loggerhead sea turtles. These units include nearshore reproductive habitat, winter area, *Sargassum*, breeding areas, and migratory corridors. In total, the critical habitat is composed of 38 occupied marine areas and 1,102.4 kilometers (685 miles) of nesting beaches. Loggerhead designated critical habitat occurs within the action area; however, only the *Sargassum* unit overlaps with the action area. PBFs for *Sargassum* habitat include: 1) areas where there are concentrated components of the *Sargassum* community in water temperatures suitable for optimal growth of *Sargassum* and loggerhead inhabitance; 2) *Sargassum* in concentrations that support adequate prey abundance and cover; 3) available prey and other material associated with *Sargassum* habitat; and 4) sufficient water depth and proximity to available currents for offshore transport, foraging, and cover for post-hatchling loggerheads.

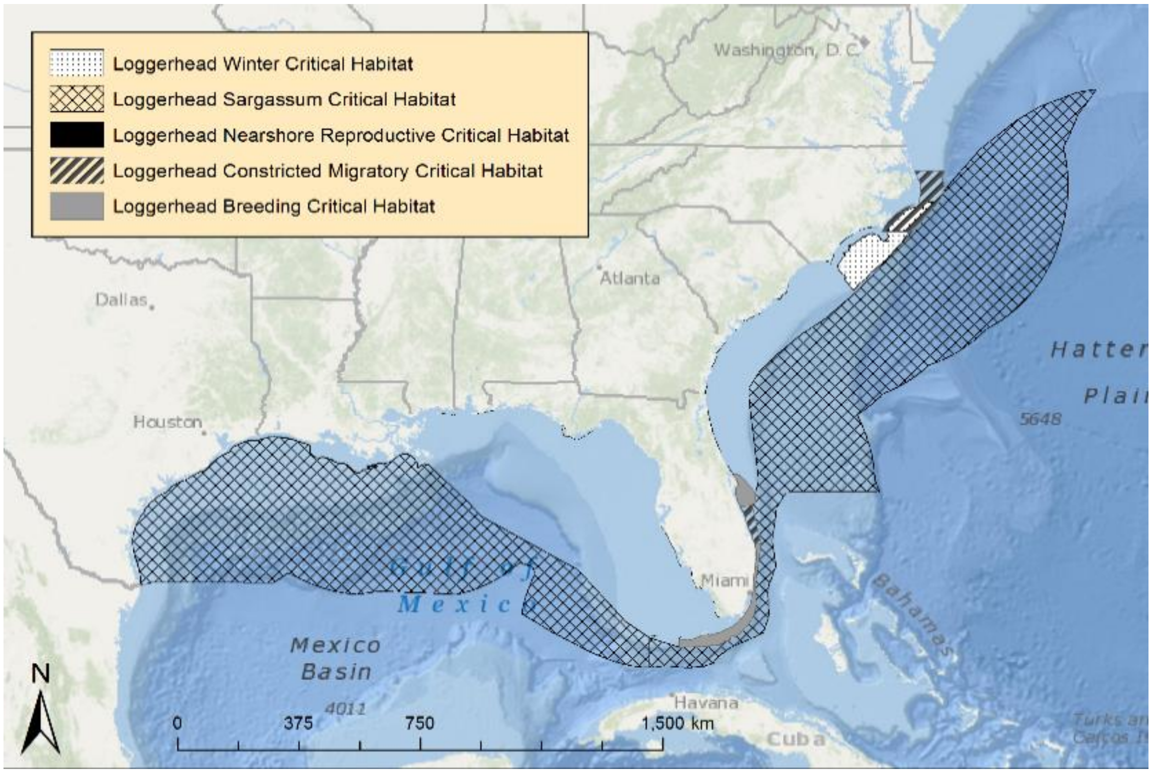

Figure 3. Designated critical habitat for the Northwest Atlantic Ocean Distinct Population Segment of loggerhead sea turtles

Sargassum habitat overlaps with approximately 124,869 square kilometers (48,212 square miles) of the proposed airgun survey area. The proposed airgun survey may affect available prey and other material associated with *Sargassum* habitat. For example, evidence indicates that seismic airguns may lead to a significant reduction in zooplankton, including copepods. McCauley et al. (2017) found that the use of a single airgun (approximately 2,458.1 cubic centimeters [150 cubic inches]) led to a decrease in zooplankton abundance by over 50 percent and a two- to three-fold increase in dead adult and larval zooplankton when compared to control scenarios. In addition, effects were found out to 1.2 kilometers (0.75 miles), the maximum distance to which the sonar equipment used in the study was able to detect changes in abundance. McCauley et al. (2017) noted that, for seismic activities to have a significant impact on zooplankton at an ecological scale, the spatial or temporal scale of the seismic activity must be large in comparison to the ecosystem in question. In particular, 3-D seismic surveys, which involve the use of multiple overlapping tracklines to extensively and intensively survey a particular area, are of concern (McCauley et al. 2017). In part, this is because, for such activities to have a measurable effect, they need to outweigh the naturally fast turnover rate of zooplankton (McCauley et al. 2017).

In contrast to McCauley et al. (2017), Fields et al. (2019b) observed lower rates of mortality to zooplankton in an experiment using 2 airguns, each with a chamber volume of 4,260.6 cubic centimeters (260 cubic inches). Fields et al. (2019b) noted that immediate mortality of copepods was significantly different from controls at distances of 5 meters (16.4 feet) or less from the airguns. Mortality 1 week after the airgun blast was 9 percent higher than controls in copepods placed 10 meters (32.8 feet) from the airgun blast but was not significantly different from the controls at a distance of 20 meters (65.6 feet) from the airgun blast. The increase in mortality relative to controls did not exceed 30 percent at any distance from the airgun blast.

Given the results from each of these studies, it is difficult to assess the exact effect seismic airgun arrays may have on the instantaneous or long-term survivability of zooplankton that are exposed. The majority of copepod prey available to loggerhead sea turtles in *Sargassum* habitat are expected to be near the surface (Witherington et al. 2012), but results of McCauley et al. (2017) provide little information on the effects to copepods at the 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 action would be towed at depths between 10 to 12 meters (32.8 to 39.4 feet), we expect that sounds from seismic airguns would be relatively low at the surface and, as such, would affect copepod prey in *Sargassum* critical habitat less than that reported in McCauley et al. (2017). We also anticipate that seismic survey operators would actively avoid *Sargassum* patches within the action area because coming near or in contact with any *Sargassum* may destroy the towed seismic equipment, and, at the very least, could cause a loss in data while the crew disentangle *Sargassum* from the seismic equipment. Nevertheless, because effects to zooplankton have been observed out to 1.2 kilometers (0.75 miles; McCauley et al. 2017), the avoidance of *Sargassum* patches may not entirely prevent effects to copepods in nearby *Sargassum* patches. However, in contrast to the intensive 3-D seismic surveys discussed in McCauley et al. (2017), the proposed seismic survey is 2-D, and is designed as exploratory, covering a large area in a relatively short amount of time. The proposed survey is less likely to have significant effects on zooplankton given the high turnover rate of zooplankton and the currents in the North Atlantic gyre and the Gulf Stream, which would circulate *Sargassum* into designated loggerhead *Sargassum* critical habitat 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 reduce the impact of seismic surveys on zooplankton at the population level)

In summary, while the proposed seismic survey may temporarily alter copepod abundance in designated loggerhead *Sargassum* critical habitat, we expect such effects to be insignificant because 1) most copepods would be near the surface where sound from seismic airguns is expected to be relatively low, 2) seismic survey operators would actively avoid *Sargassum* patches, and 3) the high turnover rate of zooplankton and ocean circulation would to minimize any effects. Therefore, we find that the proposed action may affect, but is not likely to adversely affect designated loggerhead *Sargassum* critical habitat.

8 STATUS OF SPECIES LIKELY TO BE ADVERSELY AFFECTED

This section identifies and examines the status of ESA-listed cetaceans and sea turtles that are expected to be adversely affected by acoustic stressors from the proposed action's seismic survey activities. The determinations for the effects of stressors that are not likely to adversely affect these same ESA-listed cetaceans and sea turtles during the proposed high-energy seismic survey are discussed in Section 7.1. The effects of stressors resulting from acoustic noise from the airgun array are discussed in more detail in Section 10. The status includes the existing level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and ESA-listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the *Federal Register*, status reviews, recovery plans, and on these NMFS websites: https://www.fisheries.noaa.gov/species-directory/threatened-endangered. The proposed action only overlaps with critical habitat for North Atlantic right whale and loggerhead sea turtles. As noted in Sections 7.6 and 7.7, these designated critical habitats are not likely to be adversely affected. Therefore, only the status of species likely to be adversely affected will be discussed in this section. One factor affecting the range-wide status of cetaceans and sea turtles, and aquatic habitat at large is climate change. The localized effects of climate change in the action area are discussed in the Environmental Baseline (Section 9).

8.1 Blue Whale

The blue whale is a widely distributed baleen whale found in all major oceans (Figure 4).

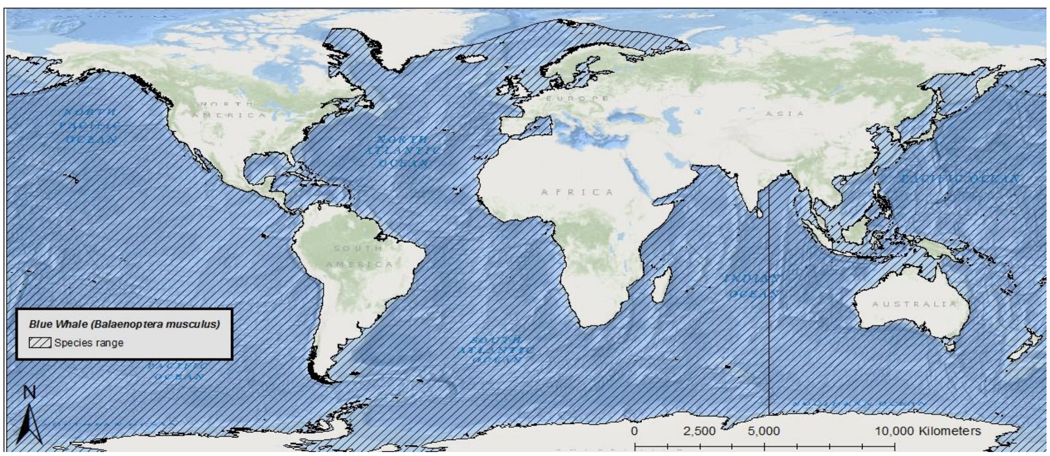

Figure 4. Map identifying the range of the endangered blue whale

There are currently 4 accepted subspecies of blue whale, *B. m. musculus*, which occurs in the Northern Hemisphere, *B. m. intermedia*, which occurs in the Southern Ocean, *B. m. indica* that occurs in the Northern Indian Ocean, and *B. m. brevicauda*, a pygmy species found in the Indian Ocean and South Pacific. A 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). The blue whale was originally listed as endangered on December 2, 1970.

8.1.1 Population Dynamics

The International Whaling Commission (IWC) recognizes 3 blue whale stocks that correspond to the 3 major ocean basins (North Atlantic, North Pacific, and Southern Hemisphere). In the Southern

Hemisphere, where blue whales feed, there are 6 recognized management areas. In U.S. waters, NMFS recognizes 3 stocks: the eastern North Pacific Ocean, central North Pacific Ocean, and western North Atlantic Ocean. Blue whale abundance for the eastern North Pacific stock is estimated at 1,898 individuals (lower [N_{min}] and upper 20th percentile: 1,767 to 2,038 individuals; Calambokidis and Barlow 2020). Abundance estimates for the central North Pacific stock (around the Hawaiian Islands) is 137 individuals (95 percent CI = 23–796 individuals; Bradford et al. 2021). 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 photo ID catalog (Nmin 402 individualsHayes et al. 2020). In the Southern Hemisphere, the abundance estimate for Antarctic blue whales is 2,280 individuals based on surveys from 1991/92 through 2003/04 (95 percent CI = 1,160–4,500 individuals; Branch 2007). While no range-wide estimate for pygmy blue whales exists (Thomas et al. 2016), the latest estimate for pygmy blue whales off the west coast of Australia is 662 to 1,559 individuals based on PAM (McCauley and Jenner 2010), or 712 to 1,754 individuals based on photographic mark-recapture (Jenner 2008). The abundance estimate for pygmy blue whales off New Zealand based on a closed capture-recapture model is 718 individuals (95 percent CI = 279–1,926 individuals; Barlow et al. 2018). There are no current abundance estimates for the Chilean (unnamed subspecies) blue whale across its entire range; however, based on line transect surveys conducted off central Chile December 1997 to January 1998, estimated abundance is 303 individuals (95 percent CI = 176–625 individuals; Williams et al. 2011). Estimated abundance based on capture-recapture for central and southern Chile from 2004 to 2011 is between 570–760 individuals (95 percent CI for right and left flank photographs: 475–705 individuals and 638–933 individuals, respectively; Galletti Vernazzani et al. 2017).

The current population trend for the Eastern North Pacific stock is unknown, though a study modeled that eastern Pacific blue whales were at 97 percent carrying capacity in 2013, which may account for the lack of population size increase (Monnahan et al. 2015). Current population trends for the 2 other U.S. stocks (central North Pacific and western North Atlantic) are not available at this time. In the Southern Hemisphere, it is estimated that whaling reduced the population from 239,000 individuals (95 percent CI = 202,000–311,000 individuals) in 1904 to just 360 individuals (95 percent CI = 150–840 individuals) in the early 1970’s. Currently, the Antarctic blue whale population estimate is 2,280 individuals (CV = 0.36; NMFS 2020b). Currently, the population appears to be increasing at a rate of 8.2 percent per year (95 percent CI = 1.6–14.8 percent; (Branch 2007). Population trends are largely unknown for the pygmy blue whale, though it is estimated that the current population represents less than 23 percent of the historical pre-whaling population (NMFS 2020b).

Little genetic data exist on blue whales globally. Data from Australia and Antarctica indicate that populations in these regions experienced a genetic bottleneck, likely the result of commercial whaling. However, in Australia, genetic diversity levels appear to be similar to other, non-threatened mammal species (Attard et al. 2010). In Antarctica, blue whale mtDNA haplotype diversity is relatively high, though haplotype richness is lower relative to other Antarctic marine mammal species (likely due to the bottleneck; Sremba et al. 2012). Data on genetic diversity of blue whales in the Northern Hemisphere are currently unavailable. However, genetic diversity information for similar cetacean population sizes can be applied. Stocks that have a total population of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Stock populations at low densities (less than 100) are more likely to suffer from the 'Allee' effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density. There is little genetic data to differentiate breeding populations for pygmy blue whales. However, based on acoustic and genetic data, there appear to be 3 distinct populations: Indo-Australian, New Zealand, and Madagascar (Möller et al. 2020). Pygmy blue whales off Australia have relatively low genetic diversity compared to other blue whale populations, likely due to historical climate change (Attard et al. 2015). For Chilean blue whales, though the population estimate is small, (Torres-Florez et al. 2014) found that the genetic diversity (mtDNA and nDNA) off southern Chile feeding grounds was similar to that of other Southern Hemisphere blue whale feeding grounds. Blue and fin whale genetic hybrids have also been documented in the North Pacific, North Atlantic, and Mediterranean Sea.

8.1.2 Vocalization and Hearing

Blue whale vocalizations tend to be long (greater than 20 seconds), low frequency (less than 100 hertz) signals (Thomson and Richardson 1995), with a range of 12 to 400 hertz and dominant energy in the infrasonic range of 12 to 25 hertz (Ketten 1998; McDonald et al. 2001; McDonald et al. 1995; Mellinger and Clark 2003). Vocalizations are predominantly songs and calls.

Calls are short-duration sounds (2 to 5 seconds) that are transient and frequency-modulated, having a higher frequency range and shorter duration than song units and often sweeping down in frequency (80 to 20 hertz), with seasonally variable occurrence. Blue whale calls have high acoustic energy, with reports of source levels ranging from 180 to 195 dB re: 1 µPa at 1 meter (Aburto et al. 1997; Berchok et al. 2006; Clark and Gagnon 2004; Cummings and Thompson 1971; Ketten 1998; McDonald et al. 2001; Samaran et al. 2010). Calling rates of blue whales tend to vary based on feeding behavior. For example, blue whales make seasonal migrations to areas of high productivity to feed, and vocalize less at the feeding grounds then during migration (Burtenshaw et al. 2004). Stafford et al. (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration. Wiggins et al. (2005) reported the same trend of reduced vocalization during daytime foraging followed by an increase at dusk as prey moved up into the water column and dispersed. Oleson et al. (2007c) reported higher calling rates in shallow diving whales (less than 30 meters [98.4 feet]), while deeper diving whales (greater than 50 meters [164 feet]) were likely feeding and calling less.

Although general characteristics of blue whale calls are shared in distinct regions (McDonald et al. 2001; Mellinger and Clark 2003; Rankin et al. 2005; Thompson et al. 1996), some variability appears to exist among different geographic areas (Rivers 1997). Sounds in the North Atlantic Ocean have been confirmed to have different characteristics (i.e., frequency, duration, and repetition) than those recorded in other parts of the world (Berchok et al. 2006; Mellinger and Clark 2003; Samaran et al. 2010). Clear differences in call structure suggestive of separate populations for the western and eastern regions of the North Pacific Ocean have also been reported (Stafford et al. 2001); however, some overlap in calls from the geographically distinct regions have been observed, indicating that the whales may have the ability to mimic calls (Stafford and Moore 2005). In Southern California, blue whales produce 3 known call types: Type A, B, and D. B calls are stereotypic of blue whale population found in the eastern North Pacific (McDonald et al. 2006) and are produced exclusively by males and associated with mating behavior (Oleson et al. 2007a). These calls have long durations (20 seconds) and low frequencies (10 to 100 hertz); they are produced either as repetitive sequences (song) or as singular calls. The B call has a set of harmonic tonals, and may be paired with a pulsed Type A call. D calls are produced in highest numbers during the late spring and early summer and in diminished numbers during the fall, when A-B song dominates blue whale calling (Hildebrand et al. 2011; Hildebrand et al. 2012; Oleson et al. 2007c).

Blue whale songs consist of repetitively patterned vocalizations produced over time spans of minutes to hours or even days (Cummings and Thompson 1971; McDonald et al. 2001). The songs are divided into pulsed/tonal units, which are continuous segments of sound, and phrases, repeated in combinations of 1 to 5 units (Mellinger and Clark 2003; Payne and McVay 1971). Songs can be detected for hundreds, and even thousands of kilometers (Stafford et al. 1998), and have only been attributed to males (McDonald et al. 2001; Oleson et al. 2007a). Off California, blue whale song B calls have decreased in frequency and are now sung at a frequency 31 percent lower than calls recorded in the 1960's (McDonald et al. 2009). Further, there has been a document decrease in call frequency in blue whale populations worldwide. Recently, this decrease in frequency has also been observed in Northeast Pacific (in the Southern California Bight) A calls (Rice et al. 2022). Between 2006 and 2019, A calls decreased at a rate of 0.32 hertz a year, and B calls decreased further at a rate of 0.27 hertz a year. A call pulse rate has also declined in this Southern California and other blue whale populations. There are many theories for this observed 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. Recently, a new blue whale song type have been documented in the Arabian Sea and western Indian Ocean, suggesting a distinct population, and potential separate subspecies, that has previously been conflated with other more widespread populations in the area (Cerchio et al. 2020). In the Northeast Pacific, at least 2 geographically distinct song variants have been observed, suggesting that there are vocally distinct subpopulation within the Northeast Pacific (currently managed as a single stock) and possible finer-scale population structure (Carbaugh-Rutland et al. 2021). In the Indian Ocean, pygmy blue whale song off the Chagos Islands are likely produced by a distinct pygmy blue whale population that migrates from the Chagos Islands to Western Australia and possibly up to Sri Lanka (Leroy et al. 2021).

Because blue whale song has only been documented as being produced by males, it is thought that song functions in a reproductive context (i.e., sexual selection, breeding display, competition for mates). Intense bouts of long, patterned sounds are common from fall through spring in low latitudes (i.e., during the winter breeding season) but these also occur less frequently while in summer high-latitude feeding areas.

Singular calls are thought to be produced when feeding, resting or in social contexts, and both males and females produce D calls.

Direct studies of blue whale hearing have not been conducted, but it is assumed that blue whales can hear the same frequencies that they produce (low frequency) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995a). Based on vocalizations and anatomy, blue whales are assumed to predominantly hear low-frequency sounds below 400 hertz (Croll et al. 2001b; Oleson et al. 2007c; Stafford and Moore 2005). In terms of functional hearing capability, blue whales belong to the low frequency group, which have a hearing range of 7 hertz to 35 kilohertz (NOAA 2018). Recently, Southall et al. (2019) revised their marine mammal hearing groups, and suspect that blue whales, along with a few other mysticete species, are sensitive to very low frequencies and should be treated separately, as a very low-frequency, from the low frequency group.

8.1.3 Status

The blue whale is endangered because of past commercial whaling. In the North Atlantic Ocean, at least 11,000 blue whales were harvested from the late 19th to mid-20th centuries. In the North Pacific Ocean, at least 9,500 blue whales were killed between 1910 and 1965. In the Southern Hemisphere, it is estimated that about 360,000 blue whales were killed in the last century, reducing the population of Antarctic blue whales from 239,000 individuals (95 percent CI = 202,000 to 311,000 individuals) in 1904 to just 360 individuals (95 percent CI = 150 to 840 individuals) in the early 1970's. Currently, the Antarctic blue whale population estimate is 2,280 individuals (CV = 0.36) (NMFS 2020b). 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 climate and ecosystem change. Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats; however, most population trends are unknown and the species has not recovered to pre-exploitation levels.

8.1.4 Status in the Action Area

In the western North Atlantic Ocean, higher densities of blue whales are typically found north of 40 degrees North especially during summer, with lower densities south of 40 degrees North (DoN 2008a; DoN 2008b). Several sightings were reported during summer surveys by the NMFS NEFSC and SEFSC off the northeastern U.S. coast and in particular Canada, but none were reported in waters adjacent South Carolina, Georgia, and Florida (Hayes et al. 2020). Hayes et al. (2020) suggested that the blue whale is an occasional visitor in the U.S. EEZ of the Atlantic Ocean. There are acoustic detections of blue whales that are adjacent to the northern portion of the action area from summer to fall with the highest number of detections occurring in fall and winter (Davis et al. 2020; Palka et al. 2021). Blue whales have also been detected acoustically in the deep waters of Blake Plateau from summer through winter in waters adjacent to South Carolina, Georgia, and Florida (Kowarski et al. 2023; Palka et al. 2021).

8.2 Fin Whale

The fin whale is a large, widely distributed baleen whale found in all major oceans (Figure 5) and is currently comprised of 3 recognized subspecies (recognized by the Society for Marine Mammalogy's Committee on Taxonomy): *B. p. physalus* in the North Atlantic, *B. p. velifera* in the North Pacific, and *B. p. quoyi* in the Southern Hemisphere. Previously, another subspecies, *B. p. patachonica* (a pygmy form), was identified in the Southern Hemisphere; however, a recent genetic study found no support for this differentiation between fin whales in the Southern Hemisphere (further discussed in Section 8.2.1). The fin whale was listed as endangered on December 2, 1970.

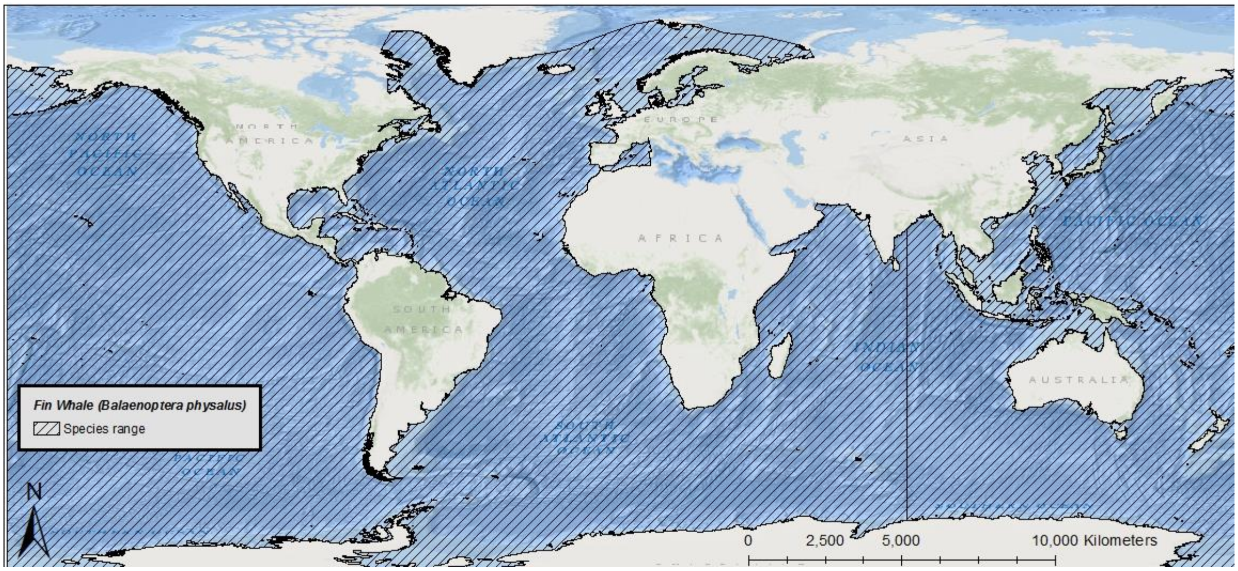

Figure 5. Map identifying the range of the endangered fin whale

8.2.1 Population Dynamics

The pre-exploitation estimate for the fin whale population in the North Pacific Ocean was 42,000 to 45,000 (Ohsumi and Wada 1974). In the North Atlantic Ocean, at least 55,000 fin whales were killed between 1910 and 1989. Approximately 704,000 fin whales were killed in the Southern Hemisphere from 1904 through 1975. NMFS currently manages 4 stocks of fin whale: 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). While there are no reliable estimates of abundance (current or historical) for the entire Northeast Pacific stock, studies have estimated abundance for specific surveyed areas: eastern Bering Sea (in 2002: 419 individuals [CV = 0.33]; in 2008: 1,368 individuals [CV = 0.34]; in 2010: 1,061 individuals [CV = 0.38]); western Alaska and the eastern and central Aleutian Islands (between 2001 and 2003: 1,652 individuals (95 percent CI = 1,142–2,389 individuals); offshore waters of the Gulf of Alaska (in 2013: 3,168 individuals [CV = 0.26] and in 2015: 916 individuals [CV = 0.39]). The minimum population estimate for the Northeast Pacific stock is 2,554 individuals (Muto et al. 2021). For the California/Oregon/Washington and Hawaii stocks, the current population estimate is 11,065 individuals (CV = 0.405) in 2018 (N_{min} = 7,970 individuals) and 203 individuals (CV = 0.99) in 2017 (N_{min} = 101 individuals), respectively (Carretta et al. 2022). The most current population estimate for fin whales in the Antarctic south of 60 degrees South is 5,445 individuals (95 percent CI = 2,000–14,500 individuals) between 1991 and 2004 (Leaper and Miller 2011). For apparent resident populations (Mediterranean and East China Sea), population estimates for the western Mediterranean, Corsican-Ligurian-Provençal Basin, and Pelagos Sanctuary are 3,583 individuals (95 percent CI = 2,130–6,027 individuals) in 1991, 901 individuals (95 percent CI = 591–1,374 individuals) in 1992, and 539 individuals (95 percent CI = 345–732 individuals), respectively (NMFS 2019).

Population trends for the Western North Atlantic, Hawaii, Southern Hemisphere, Mediterranean, and East China Sea stocks are not currently available. For the Northeast Pacific stock, there was an increasing trend by 4.8 percent (95 percent CI = 4.1–5.4 percent) between 1987 and 2003 (Carretta et al. 2022). For the California/Oregon/Washington stock, there is strong evidence that population abundance is increasing; with a fivefold increase between 1991 and 2014 (Nadeem et al. 2016), though it is unknown how much of that rate could be attributed to immigration rather than birth and death processes (Carretta 2019).

(Archer et al. 2019) recently re-examined the genetic structure and diversity of fin whales globally (with the exception of East China Sea/Sea of Japan fin whales). In Archer et al. (2013), full sequencing of the mitochondrial deoxyribonucleic acid (mtDNA) genome for 154 fin whales sampled in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere, resulted in 136 haplotypes, none of which were shared among ocean basins suggesting differentiation at least at this geographic scale. This more recent study conducted analyses on a larger mtDNA control region dataset and on 23 single nucleotide polymorphisms from 144 of the 154 samples. (Archer et al. 2019) concluded with 99 percent accuracy that North Pacific and North Atlantic fin whales are distinct, with very low rates of gene flow between ocean basins (thus separating North Pacific fin whales as subspecies *B. p. velifera*). Pygmy fin whales were thought to be a separate subspecies occurring in the low- to mid-latitudes of the Southern Hemisphere since 2004 based on morphological features (Clarke 2004). However, scientists in 2021 determined that there was an absence of genetic structure within the Southern Hemisphere, suggesting that all fin whales in the Southern Hemisphere are of the *B. p. quoyi* subspecies (Pérez-Alvarez et al. 2021). Haplotype diversity was high in all ocean basins (North Pacific, North Atlantic, Southern Hemisphere [southeastern Pacific and Southern Ocean]) except in the Gulf of California, where haplotype diversity was nearly 3 times lower (Pérez-Alvarez et al. 2021). High genetic diversity may indicate that, despite some populations having small abundance estimates, the species may persist long-term and be somewhat protected from substantial environmental variance and catastrophes.

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

8.2.2 Vocalization and Hearing

Fin whales produce a variety of low frequency sounds in the 10 to 200 hertz range (Edds 1988; Thompson et al. 1992a; Thompson et al. 1992b; Watkins 1981; Watkins et al. 1987a; Watkins et al. 1987b). Fin whales primarily produce 2 types of calls: a 20-hertz call and a 40-hertz call.

The most common fin whale vocalization is what is called a 20 hertz pulse (or 20 hertz note), which is a downswept pulse (30–15 hertz) that lasts about 1 second, and can reach source levels of 189 ± 4 dB re: 1 μPa at 1 meter and can be detected 10s of kilometers away (Charif et al. 2002; Clark et al. 2002; Edds 1988; Garcia et al. 2018; Richardson et al. 1995a; Sirovic et al. 2007; Watkins 1981; Watkins et al. 1987b). 20-hertz pulses can occur as a single pulse, in a doublet, or a triplet, and frequently occur in long sequenced patterns known as 'song', which can be repeated over the course of many hours to days (Watkins et al. 1987b). Fin whale songs are produced by males, and singing generally peaks during the breeding season; thus, songs are thought to have a reproductive function (Croll et al. 2002). Geographic variations in fin whale song may indicate some level of population structure, though variations may also change within a single region seasonally. Variations in fin whale song can be identified by the presence of a higher frequency component after the 20-hertz pulse, by the presence of doublets or triplets, or by the INI, or time between 20-hertz pulses. For example, in Massachusetts Bay and the New York Bight, INI varies throughout the year: a "short INI" season between September and January, and a "long INI" season between March and May, where months in between these seasons are transitional-INI months (Morano et al. 2012). Because these INI patterns are not different between Massachusetts Bay and the New York Bight, it is thought that these changes in INI, which may be associated with changes in behavioral contexts, are occurring within the same population of fin whales (Morano et al. 2012). However, when comparing fin whale song from the Gulf of St. Lawrence and the Gulf of Maine, (Delarue et al. 2009) found that song INIs were significantly different, indicating 2 subpopulations. Recordings of fin whale song off Southern California and in the Gulf of California revealed 4 song types based on the total INI durations of the song and patterns of INIs within the repeated series (Širović et al. 2017). (Širović et al. 2017) found that different song types were dominant in Southern California and the Gulf of California, suggesting that each song type is unique to a population and that any change or overlap in song indicated a change in the primary population in the area or some exchange among populations, respectively.

Another less common fin whale vocalization is the 40 hertz pulse (75–40 hertz), which is also a downsweep lasting less than 1 second. Fin whale 40-hertz pulses have a similar, but slightly lower, source level as 20-hertz pulses (Wiggins and Hildebrand 2020). Croll et al. (2001a) noted that fin whale 40 hertz pulses were generally produced by animals in groups, in foraging contexts such as surface feeding or foraging dives. In the eastern North Pacific (Bering Sea, Southern California, and northern Gulf of California), the presence of 40 hertz pulses peaked in early summer (Širović et al. 2013). This is similar to blue whale D calls off Southern California (Oleson et al. 2007b) which is associated with feeding whales

(Edds-Walton 1997; Oleson et al. 2007a; Thompson et al. 1992b). Additionally, fin whale 40-hertz pulses were strongly influenced by prey biomass (unlike season for the reproductive-context 20-hertz pulses; Romagosa et al. 2021). Thus, fin whale 40-hertz pulses are thought to be produced in a foraging context.

Some researchers have also recorded moans of 14 to 118 hertz, with a dominant frequency of 20 hertz, tonal and upsweep vocalizations of 34 to 150 hertz, and songs of 17 to 25 hertz (Cummings and Thompson 1994; Edds 1988; Garcia et al. 2018; Watkins 1981). In general, source levels for fin whale vocalizations are 140 to 200 dB re 1 µPa at 1 meter (as compiled by Erbe 2002; see also Clark and Gagnon 2004). The source depth of calling fin whales has been reported to be about 50 meters (164 feet; Watkins et al. 1987b).

Direct studies of fin whale hearing have not been conducted, but it is assumed that fin whales can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995a). This suggests fin whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than mid- to high-frequencies (Ketten 1997). In a study using computer tomography scans of a fin whale calf skull, Cranford and Krysl (2015) identified a ‘best hearing’ range between 10 hertz and 10 kilohertz. In the examined fin whale calf skull a maximum sensitivity to sounds in the 1 to 2 kilohertz range was observed; however, it is likely that an adult fin whale’s frequency with the best sensitivity would be lower given the increase in skull size. In terms of functional hearing capability, fin whales belong to the low-frequency group, which have a hearing range of 7 hertz to 35 kiolhertz (NOAA 2018), though (Southall et al. 2019) has suggested that it may be more appropriate to group fin whales in a very low-frequency group (two hertz to 20 kilohertz).

8.2.3 Status

The fin whale is endangered because of past commercial whaling. Prior to commercial whaling, hundreds of thousands of fin whales existed. 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 ban on commercial whaling. Additional threats include vessel strikes, reduced prey availability due to overfishing or climate change, and anthropogenic sound. The species’ overall large population size may provide some resilience to current threats, but trends are largely unknown.

8.2.4 Status in the Action Area

Fin whales occur off the eastern U.S. year-round, but generally north of Cape Hatteras (Davis et al. 2020; Hayes et al. 2022). Very few fin whales were sighted by Conley et al. (2017) off the southeastern U.S.; all sightings were made during winter. No sightings were made during NEFSC and SEFSC summer surveys off the southeastern U.S. (Hayes et al. 2022). Fin whales have only been detected acoustically on the shelf of the southeastern U.S. during fall and winter (Davis et al. 2020; Kowarski et al. 2023; Palka et al. 2021), and in the offshore waters of the Blake Plateau from fall through spring (Kowarski et al. 2023; Palka et al. 2021); there were no detections south of Cape Hatteras during summer (Davis et al. 2020; Kowarski et al. 2023; Palka et al. 2021).

8.3 Sei Whale

The sei whale is a widely distributed baleen whale found in all major oceans (Figure 6) and was listed as endangered on December 2, 1970. Sei whales are distributed worldwide, occurring in the North Atlantic Ocean. Sei whales generally undertake seasonal migrations from low-latitude winter breeding grounds to high-latitude summer feeding grounds. However, winter breeding areas are currently unknown and feeding areas can change substantially between years and seasons. Sei whales are mainly seen offshore, in deep ocean basins or along the continental slope.

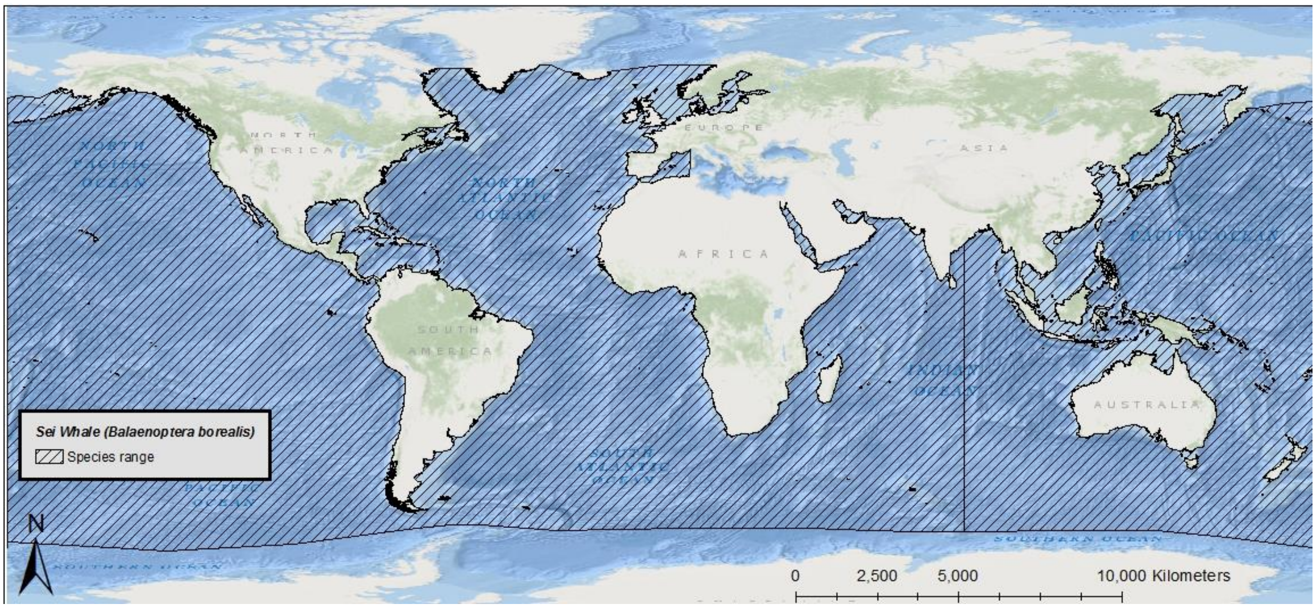

Figure 6. Map identifying the range of the endangered sei whale

8.3.1 Population Dynamics

Two sub-species 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. Models indicate that total abundance declined from 42,000 to 8,600 individuals between 1963 and 1974 in the North Pacific Ocean. More recently, the central and eastern North Pacific Ocean population was estimated to be 29,632 individuals (95 percent CI =18,576–47,267 individuals) between 2010 and 2012 (IWC 2016; Thomas et al. 2016). Surveys of the western North Pacific Ocean were estimated to be 5,086 individuals (CV = 0.38) in 2008 (Hakamada and Matsuoka 2016). In the Southern Hemisphere, pre-exploitation abundance is estimated at 65,000 individuals, with recent abundance estimated at 9,800 to 12,000 individuals. Three relatively small stocks occur in U.S. waters: Nova Scotia, Hawaii, and Eastern North Pacific. The Nova Scotia stock (Halifx, Nova Scotia to Florida) population is estimated at 6,292 individuals (CV = 1.02; N_{min} = 3,098 individuals) from surveys conducted 2010–2013 in the spring (March–May, when sei whale density is predicted to be highest; Hayes et al. 2022). The population estimate for the Hawaii stock of sei whales is 391 individuals (CV = 0.9) based on a survey of the Hawaiian Islands EEZ from August–December 2010 (Bradford et al. 2017). This is the best estimate even though a majority of sei whales would be expected to be in higher-latitude feeding grounds during that time of the year (Carretta et al. 2022). N_{min} for the Hawaii stock is 204 sei whales. In the eastern North Pacific, the sei whale population is estimated at 311 individuals (CV = 0.76) based on surveys in 2008 and 864 individuals (CV = 0.4) based on surveys in 2014; the best estimate is the mean of these 2 estimates, or 519 individuals (CV = 0.4; N_{min} = 374 individuals; (Barlow 2016). 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. The apparent increase in Eastern North Pacific sei whales from 2008 to 2014 may be partially due to recovery from commercial whaling, but may also be due to distributional shifts (Barlow 2016).

Based on genetic analyses, there appears to be some differentiation between sei whale populations in different ocean basins. An early study of allozyme variation at 45 loci found some genetic differences between Southern Ocean and the North Pacific Ocean sei whales (Wada and Numachi 1991). However, more recent analyses of mtDNA control region variation show no significant differentiation between Southern Ocean and the North Pacific Ocean sei whales, though both appear to be genetically distinct from sei whales in the North Atlantic Ocean (Baker and Clapham 2004; Huijser et al. 2018). Taguchi et al. (2021) also found that Southern Hemisphere sei whales were genetically closer to North Pacific sei whales compared to North Atlantic sei whales based on microsatellite DNA. Though haplotype frequency in sei whales was significantly different among the 3 ocean basins (North Pacific, North Atlantic, and Southern Hemisphere), suggesting these populations are genetically distinct (Taguchi et al. 2021). Within an ocean basin, there appears to be intermediate to high genetic diversity and little genetic differentiation despite there being different managed stocks (Danielsdottir et al. 1991; Huijser et al. 2018; Kanda et al. 2011; Kanda et al. 2006; Kanda et al. 2015; Kanda et al. 2013; Pastene et al. 2016)

8.3.2 Vocalization and Hearing

Data on sei whale vocal behavior is limited compared to other baleen whale species and the extent of their vocal repertoire is not well understood. In general, documented sei whale calls include upsweeps, downsweeps, tonal and broadband calls.

Upsweeps, tonal, and broadband calls have generally only been documented in the Southern Hemisphere, near or in the Southern Ocean. (McDonald et al. 2005) documented 6 categories: 1) multi-part frequency stepping tonals, 2) upsweep, 3) tonal, 4) downsweep, 5) upsweep stepping up, and 6) broadband calls. Tonal call components were on average 0.45 ± 0.3 seconds long and 433 ± 192 hertz, whereas the frequency swept calls (downsweeps and upsweeps) were on average 1.1 ± 0.6 seconds long and had an average frequency sweep of 178 ± 141 hertz. (Calderan et al. 2014) also documented downsweep and upsweep calls in the Southern Ocean: all calls were between 34 and 87 hertz and lasted on average 1.1 seconds. Off the Falkland Islands, 5 categories of calls were described including downsweeps (100–30 hertz or 160–30 hertz, some occurring in doublets or with a short initial upsweep “hook”), upsweeps (roughly 20–70 hertz over 2 seconds), and other frequency-modulated calls (Cerchio and Weir 2022). (Cerchio and Weir 2022) also documented mid-frequency sei whale song consisting of patterned broadband calls and low-frequency calls.

The most commonly documented sei whale call in the North Pacific and North Atlantic Oceans are downsweep calls. There are 2 types of downsweeps that have been recorded, 1 that is generally 100–30 hertz and are just over 1 second long, and 1 that is generally lower-frequency (40 or 50 hertz to 20 or 30 hertz) also around 1 second long (e.g., Rankin and Barlow 2007; Tremblay et al. 2019). There is also variation in the occurrence of downsweeps, as some downsweeps have been documented to occur as singles, doublets, or even triplets (e.g., Español-Jiménez et al. 2019; Tremblay et al. 2019). These variations in frequencies and of downsweep calls are documented; for example, off Hawaii where (Rankin and Barlow 2007) recorded downsweeps 100–44 hertz over 1 second, and downsweeps 39–21 hertz over 1.3 seconds. In the south-eastern Pacific (downsweeps 93–42 hertz and 1.6 seconds long occurring mostly in pairs but also tripets and singlets (Español-Jiménez et al. 2019), in the mid-Atlantic (downsweeps 100–37 hertz and 1.2 seconds (Romagosa et al. 2015), and in the western North Atlantic (downsweeps 82–34 hertz and 1.4s long occurring mostly as a single call with some pairs and rare triplets; and downsweeps 50–30 hertz occurring as triplets and singlets (Baumgartner et al. 2008; Tremblay et al. 2019). Tremblay et al. (2019) also suggested the presence of sei whale song in the western North Atlantic based on the repetition of certain patterns of calls. Source levels for downsweeps recorded in the mid-Atlantic were 177 dB re 1 µPa at 1 meter (Romagosa et al. 2015).

Direct studies of sei whale hearing have not been conducted, but it is assumed that they can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995a). This suggests sei whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than mid- to high-frequencies (Ketten 1997). In terms of functional hearing capability, sei whales belong to the low-frequency group, which have a hearing range of 7 hertz to 35 kilohertz (NOAA 2018).

8.3.3 Status

The sei whale is endangered because of past commercial whaling. No estimates of pre-exploitation population size are available and the total number of sei whales in the North Atlantic Ocean is not known (Waring and et al. 2009). Now, only a few individuals are taken each year by Japan; however, Iceland has expressed an interest in targeting sei whales. Current threats include vessel strikes, fisheries interactions (including entanglement), climate change (habitat loss and reduced prey availability), and anthropogenic noise. Given the species’ overall abundance, they may be somewhat resilient to current threats. However, trends are largely unknown, especially for individual stocks, many of which have relatively low abundance estimates.

8.3.4 Status in the Action Area

Acoustic detections of sei whales have been detected off North Carolina and in the deep waters of the Blake Plateau (mostly during winter), with no detections during summer (Davis et al. 2020; Kowarski et al. 2023; Palka et al. 2021). PAM 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. 2018b). There have been no sightings off the southeastern U.S. during summer surveys conducted by NEFSC and SEFSC (Hayes et al. 2022). There are no records of sei whale in the OBIS database for the proposed survey area (OBIS 2023).

8.4 Sperm Whale

The sperm whale is widely distributed and found in all major oceans Figure 7 and was listed as endangered on December 2, 1970.

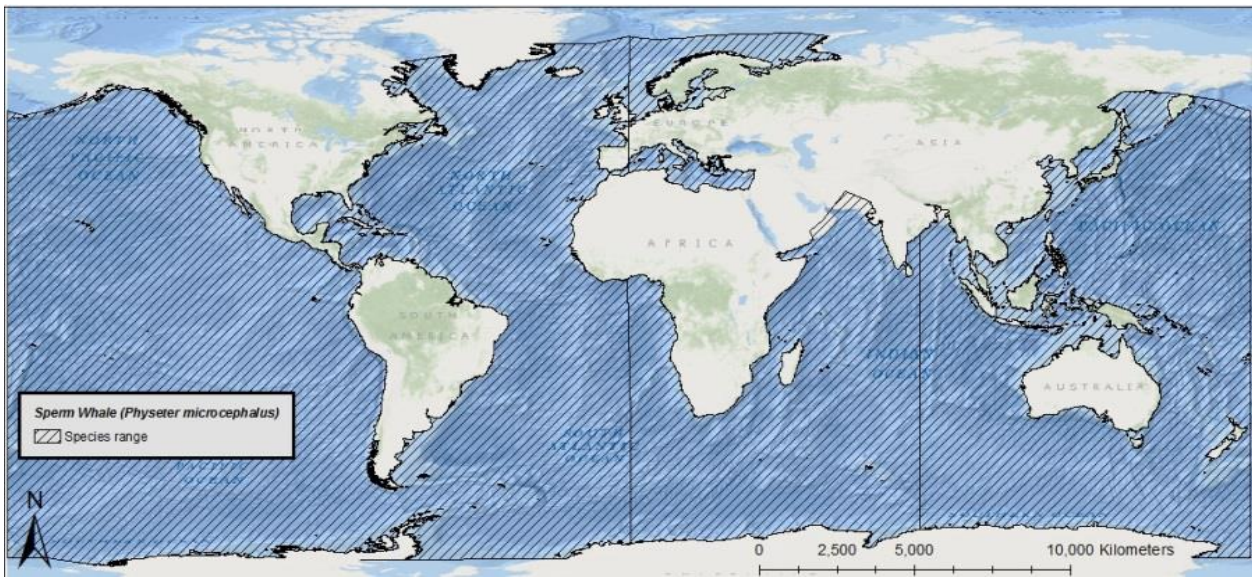

Figure 7. Map identifying the range of the endangered sperm whale

8.4.1 Population Dynamics

The most recent estimate indicated a global population of between 300,000 and 450,000 individuals (Whitehead 2009). It is estimated that well over 1,000,000 sperm whales were killed between the 1950's to 1999 (NMFS 2015c). There are 6 recognized sperm whale stocks in U.S. waters: Puerto Rico and 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 western North Atlantic Ocean. The population estimate for Puerto Rico and U.S. Virgin Islands stock is unknown. The best population estimate for the Northern Gulf of Mexico stock is 1,180 individuals (CV = 0.22) from 2017 and 2018 summer/fall surveys (N_{min} = 983 individuals; (Garrison et al. 2020). For the North Atlantic stock, the best recent abundance estimate is 4,349 individuals (CV = 0.28), which is the sum of abundance estimates from Central Florida to the lower Bay of Funday in 2016 (N_{min} = 3,451 individuals; Garrison 2020; Palka 2020). No trend analysis has been conducted for the North Atlantic stock. In the North Pacific Ocean, the abundance of sperm whales was estimated to be 1,260,000 individuals prior to commercial whaling. In 1997, population estimates in the northeastern temperate North Pacific were 26,300 individuals (CV = 0.81) and 32,100 individuals (CV = 0.36) based on visual and acoustic surveys, respectively (NMFS 2015c). In the eastern tropical Pacific Ocean, the abundance of sperm whales was estimated to be 22,700 individuals (95 percent CI = 14,800–34,600 individuals) in 1993 (NMFS 2015c). There are insufficient data to reliably estimate the population abundance of the North Pacific stock; however, N_{min} is estimated at 244 sperm whales in the Gulf of Alaska (Rone et al. 2017). The best population estimate for the California/Oregon/Washington stock is 1,997 individuals (CV = 0.57) in 2014 (Nmin = 1,270 individuals; Moore and Barlow 2014). The population estimate for the Hawaii stock is 5,707 individuals (CV = 0.23) in 2017 (Nmin = 4,486 individuals; Becker et al. 2021). There are currently no reliable population estimates for sperm whales in the South Pacific Ocean. There is insufficient data to evaluate trends in abundance and growth rates of sperm whale populations at this time. An attempt to determine trends for the Northern Gulf of Mexico stock showed no significant differences in abundance estimates between 2003 and 2018; however, there is little statistical power to detect a trend because of the relatively imprecise estimates and limited survey area (Garrison et al. 2020). Additionally, it has been reported that the California/Oregon/Washington stock abundance appeared stable, but the estimated growth rate include high uncertainty levels.

Ocean-wide genetic studies indicate sperm whales have low genetic diversity, suggesting a recent bottleneck/expansion or selective sweep (Alexander et al. 2016; Lyrholm and Gyllensten 1998; Morin et al. 2018). Consistent with this, 2 studies of sperm whales in the Pacific Ocean indicate low genetic diversity (Mesnick et al. 2011; Rendell et al. 2012). Furthermore, sperm whales from the Gulf of Mexico, the western North Atlantic Ocean, the North Sea, and the Mediterranean Sea all have been shown to have low levels of genetic diversity (Engelhaupt et al. 2009). As none of the stocks for which data are available have high levels of genetic diversity, the species may be at some risk to inbreeding and ‘Allee’ effects, although the extent to which is currently unknown. Despite low overall genetic diversity, there is strong differentiation between matrilineally related groups and ocean basins, suggesting that both geographic and social philopatry influence sperm whale genetic structure (Lyrholm and Gyllensten 1998; Alexander et al. 2016). Sperm whales sampled off southeastern and southwestern Australia belong to the same population, but are distinct from sperm whales from other regions of the Pacific and Indian Oceans, based on nuclear and mtDNA (Day et al. 2021). Off New Zealand, a recent genetic study of stranded male sperm whales showed the presence of rare haplotypes suggesting genetic linkages within New Zealand and the Southwest Pacific (Palmer et al. 2022). Sperm whales in the Mediterranean appear to be genetically isolated from other eastern North Atlantic populations based on mtDNA analysis (Drouot et al. 2004). Similarly, genetic samples from sperm whales off the Azores show that individuals visiting the Azores are a single population (Pinela et al. 2009).

Sperm whales have a global distribution and can be found in relatively deep waters in all ocean basins. While both males and females can be found in latitudes less than 40 degrees, only adult males venture into the higher latitudes near the poles. Males appear to range more broadly than females (Mizroch and Rice 2013).

8.4.2 Vocalization and Hearing

Sound production and reception by sperm whales are better understood than in most cetaceans. Recordings of sperm whale vocalizations reveal that they produce a variety of sounds, such as clicks, gunshots, chirps, creaks, short trumpets, pips, squeals, and clangs (Goold 1999). Sperm whales typically produce short duration repetitive broadband clicks with frequencies below 100 hertz to greater than 30 kilohertz (Watkins 1977) and dominant frequencies between 1 to 6 kilohertz and 10 to 16 kilohertz. Another class of sound, “squeals,” are produced with frequencies of 100 hertz to 20 kilohertz (e.g., Weir et al. 2007). The source levels of clicks can reach 236 dB re: 1 µPa at 1 meter, although lower source level energy has been suggested at around 171 dB re: 1 µPa at 1 meter (Goold and Jones 1995; Mohl et al. 2003; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). Most of the energy in sperm whale clicks is concentrated at around 2 to 4 kilohertz and 10 to 16 kilohertz (Goold and Jones 1995; Weilgart and Whitehead 1993). The clicks of neonate sperm whales are very different from typical clicks of adults in that they are of low directionality, long duration, and low frequency (between 300 hertz and 1.7 kilohertz) with estimated source levels between 140 to 162 dB re: 1 µPa at 1 meter (Madsen et al. 2003). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Norris and Harvey 1972).

Long, repeated clicks are associated with feeding and echolocation (Goold and Jones 1995; Miller et al. 2004; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997; Whitehead and Weilgart 1991). Creaks (rapid sets of clicks) are heard most frequently when sperm whales are foraging and engaged in the deepest portion of their dives, with inter-click intervals and source levels being altered during these behaviors (Laplanche et al. 2005; Miller et al. 2004). Maturing or mature male sperm whales are also thought to produce trumpet sounds on feeding grounds (Pace et al. 2021). Clicks are also used during social behavior and intragroup interactions (Weilgart and Whitehead 1993). When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals in a social unit and are considered to be primarily for intragroup communication (Rendell and Whitehead 2004; Weilgart and Whitehead 1997). Research in the South Pacific Ocean suggests that in breeding areas the majority of codas are produced by mature females (Marcoux et al. 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects (Pavan et al. 2000; Weilgart and Whitehead 1997). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean Sea and those in the Pacific Ocean (Weilgart and Whitehead 1997). In the South Pacific Ocean and Caribbean Sea, 6 acoustic “clans” were identified based on coda repertoires. These “clans” are likely an example of sympatric cultural variation in sperm whales, as smaller units of sperm whales are more likely to form groups with other units within their own clan (Rendell and Whitehead 2003). Three coda types used by male sperm whales have been described from data collected over multiple years: these codas are associated with dive cycles, socializing, and alarm (Frantzis and Alexiadou 2008). A study analyzed mtDNA variation among sympatric vocal clans in the Pacific Ocean and found that variation in mtDNA cannot account for behavioral variation between vocal clans. This suggests that there is parent-offspring vocal transmission and that vocal clans may be more appropriate management units for the species (Rendell et al. 2012).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potential (AEP) tests were recorded (Carder and Ridgway 1990). From this sperm whale, responses support a hearing range of 2.5 to 60 kilohertz and highest sensitivity to frequencies between 5 to 20 kilohertz. Other hearing information consists of indirect data. For example, the anatomy of the sperm whale’s inner and middle ear indicates an ability to best hear high-frequency to ultrasonic hearing (Ketten 1992). The sperm whale may also possess better low-frequency hearing than other odontocetes, although not as low as many baleen whales (Ketten 1992). Reactions to anthropogenic sounds can provide indirect evidence of hearing capability, and several studies have made note of changes seen in sperm whale behavior in conjunction with these sounds. For example, sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins et al. 1985; Watkins and Schevill 1975). In the Caribbean Sea, Watkins et al. (1985) observed that sperm whales exposed to 3.25 to 8.4 kilohertz pulses (presumed to be from submarine sonar) interrupted their activities and left the area. Similar reactions were observed from artificial sound generated by banging on a boat hull (Watkins et al. 1985). André et al. (1997) reported that foraging whales exposed to a 10 kilohertz pulsed signal did not ultimately exhibit any general avoidance reactions: when resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al. 1997). A study compared sperm whale reactions to continuous active sonar and traditional pulsed active sonar. Continuous active sonar may be used at a lower amplitude than traditional pulsed active sonar, but has a higher cumulative sound energy. Sperm whales reduced their time spent foraging during high sound exposure levels compared to high sound pressure levels (Isojunno et al. 2020). This suggests that cumulative sound energy may be an important driver of sperm whales behavioral responses to active sonar. Thode et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel’s propeller (110 dB re: 1 μPa^2 second at 1 meter between 250 hertz and 1 kilohertz) interrupted sperm whale acoustic activity and resulted in the animals converging on the vessel. Sperm whales have also been observed to stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Because they spend large amounts of time at depth and use low frequency sound, sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll et al. 1999). Nonetheless, sperm whales are considered to be part of the mid-frequency marine mammal hearing group, with a hearing range between 150 hertz and 160 kilohertz (NOAA 2018).

8.4.3 Status

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 uncertain. Commercial whaling is no longer allowed; however, illegal hunting may occur at biologically unsustainable levels. Continued threats to sperm whale populations include vessel strikes, entanglement in fishing gear, competition for resources due to overfishing, population, loss of prey and habitat due to climate change, and anthropogenic noise. The species' large population size shows that it is somewhat resilient to current threats.

8.4.4 Status in the Action Area

Sperm whales appear to have a well-defined seasonal cycle in the Northwest Atlantic (CETAP 1982; Stanistreet et al. 2018). In winter, most historical records are in waters east and northeast of Cape Hatteras, with few animals north of 40 degrees North; 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. 2020). 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. 2020). By fall, sperm whales are most common south of New England on the continental shelf but also along the shelf edge in the Mid-Atlantic Bight (DoN 2005; Hayes et al. 2020).

Several sightings of sperm whales have been made in and near Blake Plateau, including the proposed survey area, during NEFSC and SEFSC summer surveys (Hayes et al. 2020; NEFSC and SEFSC 2021); however, the majority of sightings were further north (Hayes et al. 2020). Conley et al. (2017) reported no sperm whales near or in the survey. However, acoustic detections have been made year-round at hydrophones deployed along the western edge of the Blake Plateau as well as in deeper water offshore (Kowarski et al. 2023; Stanistreet et al. 2018). There are 42 records in the OBIS database for the proposed survey area, which were reported throughout the year (OBIS 2023).

8.5 Green Turtle – North Atlantic Distinct Population Segment

The green turtle is globally distributed and commonly inhabits nearshore and inshore waters, occurring throughout tropical, sub-tropical and, to a lesser extent, temperate waters. The North Atlantic DPS of green turtle is found in the North Atlantic Ocean and Gulf of Mexico (Figure 8).

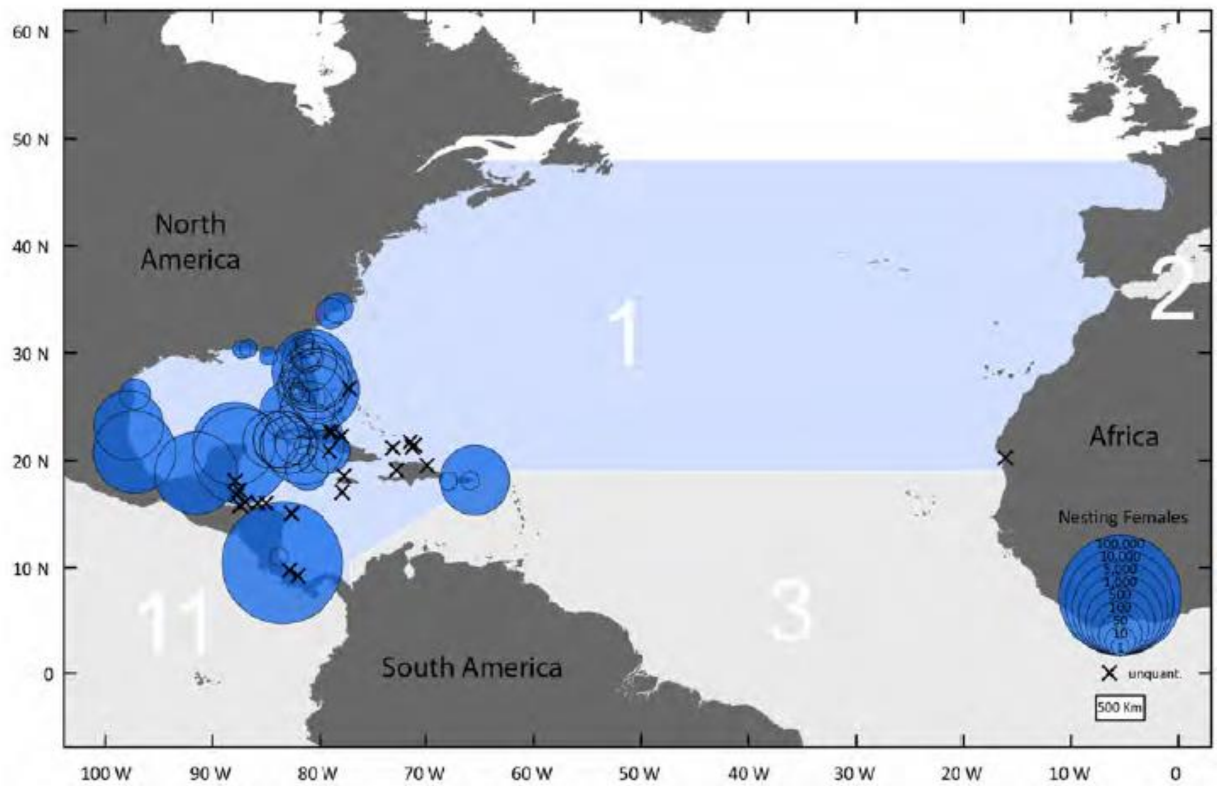

Figure 8. Map of geographic range of the threatened North Atlantic distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015)

The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into 2 listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed eleven DPSs of green turtles as threatened or endangered under the ESA (81 FR 20057). The North Atlantic DPS of green turtle is listed as threatened.

8.5.1 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). Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Compared to other DPSs, the North Atlantic DPS of green turtle exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites (Seminoff et al. 2015), and available data indicate an increasing trend in nesting. 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 percent of nesting females for the North Atlantic DPS (Seminoff et al. 2015).

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates from a DPS. For the North Atlantic DPS of green turtle, the available data indicate an increasing trend in nesting. There are no reliable estimates of population growth rate for the North Atlantic DPS as a whole, but estimates have been developed at a localized level. Modeling by Chaloupka et al. (2008) using data sets of 25 years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9 percent, and the Tortuguero, Costa Rica, population growing at 4.9 percent.

The North Atlantic DPS of green turtle has a globally unique haplotype, which was a factor in defining the discreteness of the population for the North Atlantic DPS. Evidence from mitochondrial DNA studies indicates that there are at least 4 independent nesting subpopulations in Florida, Cuba, Mexico, and Costa Rica (Seminoff et al. 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016).

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).

Since 1989, the pattern of green turtle nesting has generally shown biennial peaks in abundance with a positive trend during the 10 years of regular monitoring at index nesting beaches. From 1989 through 2016, green turtle nest counts across Florida have increased approximately 100-fold from a low of 267 in the early 1990s to a high of 27,975 in 2015. Green turtle nesting tends to follow a biennial pattern of fluctuation. 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.

Green turtles from the North Atlantic DPS range from the boundary of South and Central America (7.5 degrees North, 77 degrees West) in the south, throughout the Caribbean Sea, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48 degrees North, 77 degrees West) in the north. The range of the North Atlantic DPS of green turtle then extends due east along latitudes 48 degrees North and 19 degrees north to the western coasts of Europe and Africa (Seminoff et al. 2015). Nesting occurs primarily in Costa Rica, Mexico, Florida, and Cuba.

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

The complete nesting range of green turtles within the southeastern U.S. includes sandy beaches between Texas and North Carolina, as well as the U.S. Virgin Islands and Puerto Rico (Dow et al. 2007; NMFS and USFWS 1991). The vast majority of green turtle nesting within the southeastern U.S. occurs in Florida (Johnson and Ehrhart 1994; Meylan et al. 1995). Principal nesting areas in the U.S. are in eastern Florida, predominantly Brevard south through Broward Counties.

8.5.2 Vocalization and Hearing

Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 hertz to 2 kilohertz, with a range of maximum sensitivity between 100 to 800 hertz (Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (2016) found green turtle juveniles capable of hearing underwater sounds at frequencies of 50 hertz to 1,600 kilohertz (maximum sensitivity at 200 to 400 hertz). Hearing below 80 hertz is less sensitive but still possible (Lenhardt 1994). Based upon auditory brainstem responses of green turtles have been measured to hear in the 50 hertz to 1.6 kilohertz range (Dow et al. 2008), with greatest response at 300 hertz (Yudhana et al. 2010); a value verified by Moein Bartol and Ketten (2006). Other studies have similarly found greatest sensitivities between 200 to 400 hertz for the green turtle with a range of 100 to 500 hertz (Bartol and Ketten 2006; Ridgway et al. 1969) and around 250 hertz or below for juveniles (Bartol et al. 1999). However, Dow et al. (2008) found best sensitivity between 50 and 400 hertz.

These hearing sensitivities are similar to those reported for 2 terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 to 700 hertz, with slow declines below 100 hertz and rapid declines above 700 hertz, and almost no sensitivity above 3 kilohertz (Wever and Vernon 1956). Wood turtles are sensitive up to about 500 hertz, followed by a rapid decline above 1 kilohertz and almost no responses beyond 3 to 4 kilohertz (Patterson 1966).

In the French West Indies, a recent study recorded vocalizations of free-ranging juvenile green turtles (Charrier et al. 2022). Four main categories of vocalizations were recorded: pulses, low-amplitude calls, frequency-modulated calls, and squeaks. Pulses (mono, doublet, triplets, and multipulses consisting of an average of 5 pulses) had a main frequency around 1 kilohertz. Low-amplitude calls consisted of croaks and rumbles. The frequency range for croaks was 725 ± 330 hertz and the frequency range for rumbles was 323 ± 94 hertz. Frequency-modulated calls were either ascending, descending, or both, and ranged between 31 and 1,047 hertz. Squeaks were more than 3 kilohertz. Received levels of all vocalizations ranged between 102 to 124 dB re: 1 µPa (rms).

8.5.3 Status

Once abundant in tropical and sub-tropical waters, green turtles worldwide exist at a fraction of their historical abundance, because of over-exploitation for food and other products. Globally, egg harvest, the harvest of females on nesting beaches and directed hunting of sea turtles in foraging areas remain the 3 greatest threats to their recovery. In addition, bycatch in drift-net, long-line, set-net, pound-net, and trawl fisheries kill thousands of green turtles annually. Other threats include pollution, habitat loss through coastal development or stabilization, destruction of nesting habitat from storm events, and oil spills. On a regional scale, the different DPSs experience these threats as well, to varying degrees. Differing levels of abundance combined with different intensities of threats and effectiveness of regional regulatory mechanisms make each DPS uniquely susceptible to future perturbations. While the threats continue, the green turtle appears to be somewhat resilient to future perturbations.

Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population's decline. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green turtle generation, up to 50 years. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS of green turtle appears to be somewhat resilient to future perturbations.

8.5.4 Status in the Action Area

Important feeding areas for green turtles in U.S. waters are primarily located in Florida and southern Texas, but Long Island Sound and inshore waters of North Carolina appear to be important to juveniles during summer months (NMFS and USFWS 2007a). Juvenile green turtles are the second most commonly bycaught sea turtle species by the pound in net fisheries in the Pamlico Sound (Epperly et al. 2007; Epperly et al. 1995). Immature green turtles aggregate in certain neritic areas to forage. Modeling of young sea turtle dispersal after hatching showed relatively high abundances of young green turtles on the U.S. Atlantic coast (ages 0.5 to 1.5 years) and within the Sargasso Sea (ages 2.5 to 3.5 years; Putman et al. 2020). Satellite tagging of juvenile green turtles showed movement along the Gulf Stream in oceanic (greater than 200 meters [656 feet] water depth) waters (Mansfield et al. 2021).

Most sighting of green sea turtle are recorded on the shelf during the winter, with very few sightings during the other seasons; there are however a number of stranding records along the coast near the Blake Plateau for every season (Department of the Navy 2008). Sighting-per-unit-effort modelling calculated on the basis of line transect and platform of opportunity data predict no significant overlap of the proposed survey area and modeled occurrence of green turtles (Department of the Navy 2008). However, sightings have been made on the shelf off the southeastern U.S. during fall, winter, and spring (Department of the Navy 2008; Palka et al. 2021). There are 2 records of green turtles for the survey area in the OBIS database, 1 in May and 1 in October (OBIS 2023).

8.6 Kemp's Ridley Turtle

The Kemp's ridley turtle is considered to be the most endangered sea turtle, internationally (Groombridge 1982; Zwinenberg 1977). Its range extends from the Gulf of Mexico to the Atlantic coast, with nesting beaches limited to a few sites in Mexico and Texas (Figure 9). Kemp's ridley sea turtles have occasionally been found in the Mediterranean Sea, which may be due to migration expansion or increased hatchling production (Tomás and Raga 2008). Juvenile Kemp's ridley turtles, possibly carried by oceanic currents, have been recorded as far north as Nova Scotia. The species was listed as endangered under the ESA since 1970.

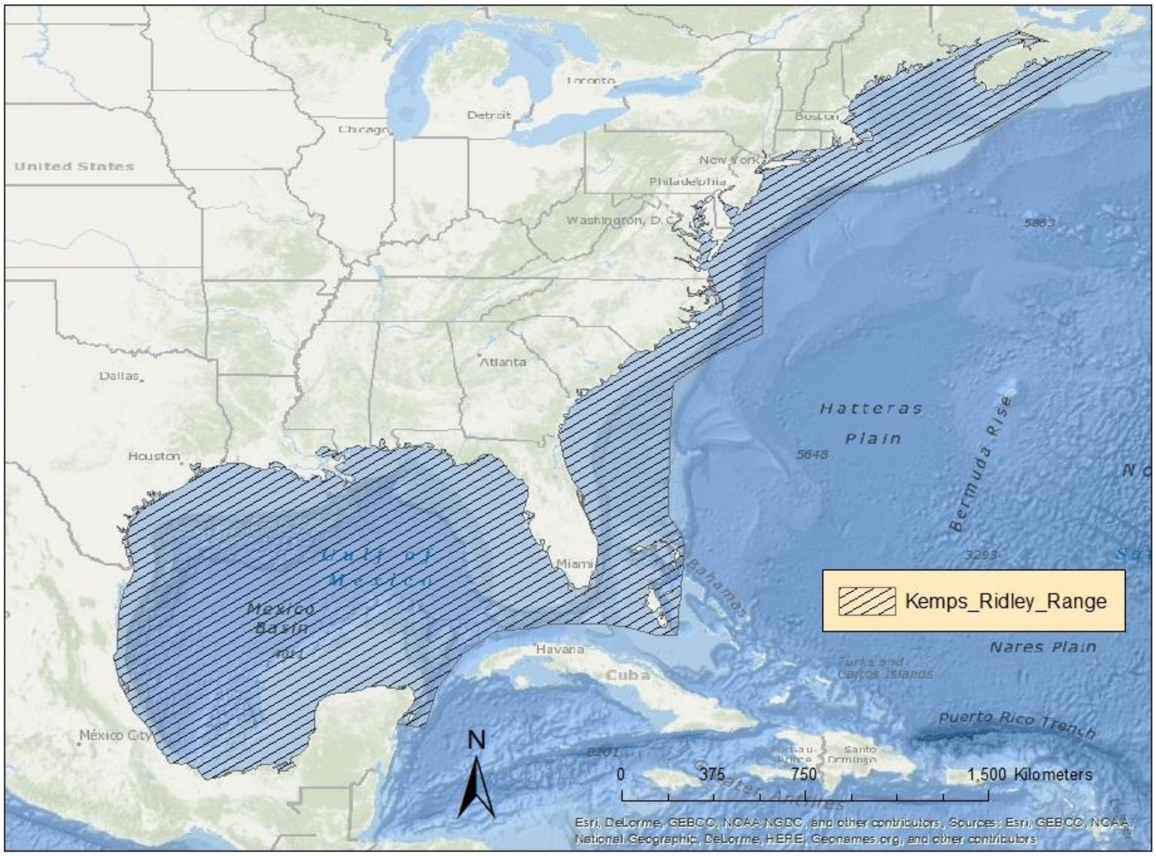

Figure 9. Map identifying the range of the endangered Kemp's ridley turtle off the U.S coast

8.6.1 Population Dynamics

Of the sea turtles species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. Nesting steadily increased through the 1990s, and then accelerated during the first decade of the 21st century. Following a significant, unexplained one-year decline in 2010, Kemp's ridley turtle nests in Mexico reached a record high of 21,797 in 2012 (NPS 2013). In 2013, there was a second significant decline, with 16,385 nests recorded. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from 3 primary nesting beaches in Mexico (NMFS and USFWS 2015). The number of nests in Padre Island, Texas has increased over the past 2 decades, with 1 nest observed in 1985, 4 in 1995, 50 in 2005, 197 in 2009, and 119 in 2014 (NMFS and USFWS 2015).

From 1980 through 2003, the number of nests at 3 primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS and USFWS 2015). In fact, nest counts dropped by more than a third in 2010 and continue to remain below predictions (Caillouet et al. 2018).

Genetic variability in Kemp's ridley turtles is considered to be high, as measured by heterozygosis at microsatellite loci (NMFS and USFWS 2011). Additional analysis of the mitochondrial DNA taken from samples of Kemp's ridley turtles at Padre Island, Texas, showed 6 distinct haplotypes, with 1 found at both Padre Island and Rancho Nuevo (Dutton et al. 2006). Additionally, the genetic diversity of immature Kemp's ridley turtles foraging in the northern Gulf of Mexico (along the Florida panhandle) closely correspond to that of nesting females in Rancho Nuevo, Mexico (Lamont et al. 2021). Despite recent declines in Kemp's ridley turtle populations, a recent study found that genetic diversity, as assessed through the mitochondrial genome, has remained stable (Frandsen et al. 2020).

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).

8.6.2 Vocalization and Hearing

As noted in Section 8.5.2, Sea turtles are low frequency hearing specialists. Juvenile Kemp's ridley turtles can hear from 100 to 500 hertz, with a maximum sensitivity between 100 to 200 hertz at thresholds of 110 dB re: 1 µPa (Bartol and Ketten 2006). These hearing sensitivities are similar to those reported for pond and wood turtles as discussed in Section 8.5.2.

8.6.3 Status

Kemp's ridley turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.), ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease.

The Kemp's ridley turtle was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances prohibited the harvest of sea turtles from May through August, and in 1990, the harvest of all sea turtles was prohibited by presidential decree. In 2002, Rancho Nuevo was declared a sanctuary. A successful head-start program has resulted in the re-establishment of nesting at Texan beaches. While fisheries bycatch remains a threat, the use of sea turtle excluder devices mitigates take. Fishery interactions and strandings, possibly due to forced submergence, appear to be the main threats to the species. The *Deepwater Horizon* oil spill event reduced nesting abundance and associated hatchling production as well as exposures to oil in the oceanic environment which has resulted in large losses of the population across various age classes, and likely had an important population-level effect on the species. We do not have an understanding of those impacts on the population trajectory for the species into the future. The species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

8.6.4 Status in the Action Area

Numerous sightings of Kemp's ridley sea turtles have been recorded along the east coast of Florida and Georgia, mostly on the shelf, with the vast majority of sightings reported during the winter with very few sightings during summer and almost no sightings reported for spring (Department of the Navy 2008). In contrast, Palka et al. (2021) reported more sightings from summer and spring than from the winter season. Numerous strandings were reported for all seasons (Department of the Navy 2008). Modelling of young sea turtle dispersal after hatching showed a portion of Kemp's ridley turtles aged 1.5 years concentrating off northeast Florida (Putman et al. 2020). Rehabilitated Kemp's Ridley turtles that were released on the coast of Long Island and tracked using satellite tags stayed on shelf and close to shore along the east coast of Florida, Georgia, and South Carolina (Robinson et al. 2020). SPUE modelling based on line transect and platform of opportunity data predicts no overlap of the offshore waters of the Blake Plateau survey area and occurrence of Kemp's turtles (Department of the Navy 2008). Most sightings have been reported on the shelf of the southeastern U.S. during winter, with fewer sightings during the remainder of the year; single sightings were made in the proposed survey area during winter and spring (Department of the Navy 2008). There are 4 records in the OBIS database for the survey area from January through June (OBIS 2023).

8.7 Leatherback Turtle

The leatherback turtle ranges from tropical to subpolar latitudes, worldwide (Figure 10). It was first listed under the Endangered Species Conservation Act (35 FR 8491) and listed as endangered under the ESA since 1973.

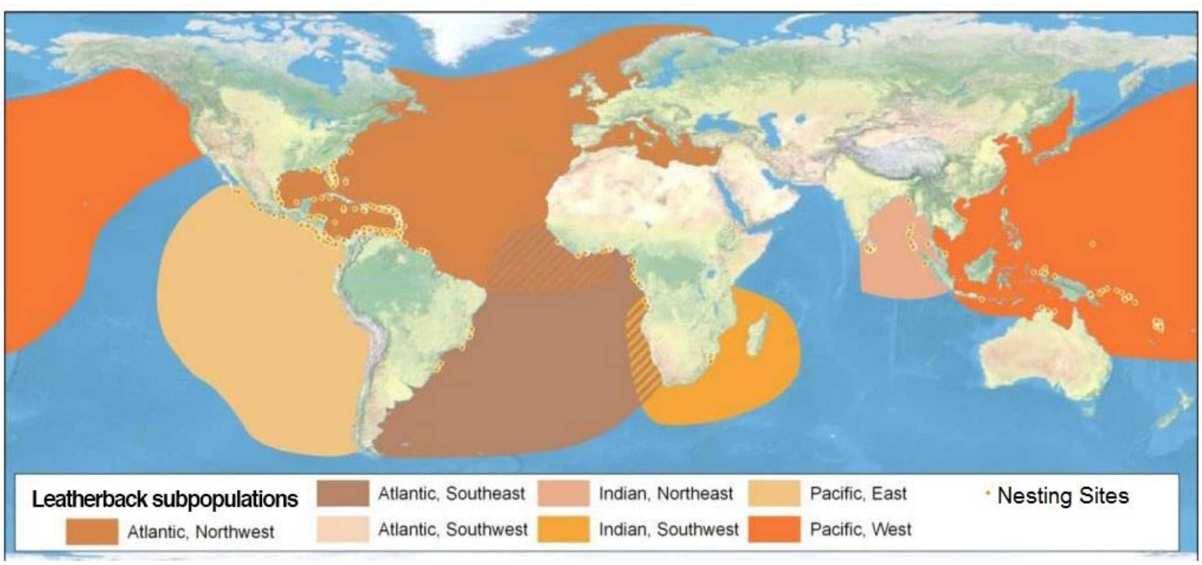

Figure 10. Map identifying the range of the endangered leatherback turtle. Adapted from (Wallace et al. 2013)

8.7.1 Population Dynamics

Leatherback turtles are globally distributed, with nesting beaches in the Atlantic, Indian, and Pacific Oceans. Movements of adults and subadults span across all major ocean basins and range from equatorial waters to temperate high-latitude regions (Shillinger and Bailey 2015). Leatherback turtles originating from the same nesting beach may forage in diverse and geographically distant regions, with variance among individuals (Eckert 2006; Eckert et al. 2006b; Hays et al 2006; Benson et al. 2011; Witt et al. 2011; Namboothri et al. 2012a). Conversely, leatherback turtles from different nesting beaches may move to the same foraging regions as adults (Fossette et al. 2014). Patterns of leatherback turtle movements between nesting beaches and foraging areas are complex, and appear to be linked to ocean currents that facilitate hatchling dispersal (Gaspar et al. 2012) or adult movements throughout the oceans (Lambardi et al. 2008). Adults are known to return to the same foraging areas after nesting (Seminoff et al. 2012), and hatchlings from different nesting beaches may reach the same foraging areas, creating a mosaic of overlapping population ranges. Wallace et al. (Wallace et al. 2010) identified 7 global regional management units (subpopulations) by reviewing the genetic data available and performing a spatial analysis of these genetic data combined with nesting, tagging, and tracking data, these include: northwest Atlantic Ocean, southwest Atlantic Ocean, southeast Atlantic Ocean, northeast Indian Ocean, west Pacific Ocean, and east Pacific Ocean.

Detailed population structure is unknown, but is likely dependent upon nesting beach location and influenced by physical barriers (i.e., land masses), current systems, and long migrations. The total index of nesting female abundance in the Northwest Atlantic Ocean is 20,659 females. Based on estimates calculated from nesting data, there are approximately 18,700 (10,000 to 31,000 nesting females) total adult leatherback turtles in the North Atlantic Ocean (TEWG 2007). The total index of nesting female abundance in the Southwest Atlantic Ocean is approximately 27 females. The total index of nesting female abundance in the Southeast Atlantic Ocean is approximately 9,198 females. The total index of nesting female abundance in the Southwest Indian Ocean is approximately 149 females. The total index of nesting female abundance in the Northeast Indian Ocean is approximately 109 females. The total index of nesting female abundance in the West Pacific Ocean is approximately 1,277 females. The total index of nesting female abundance in the East Pacific Ocean is approximately 755 females. The total index of nesting female abundance is likely an underestimate because we did not have adequate data from many nesting beaches, which have the potential for being unmonitored or unidentified.

Declines in nesting can occur rapidly in populations of leatherback turtles. In the Pacific Ocean, nesting has declined precipitously in recent decades (Benson et al. 2015). Aerial surveys of nesting beaches in Mexico detected declines from 70,000 nesting females in 1982 to fewer than 250 in 1998, with an annual mortality rate of 22.7 percent (Spotila et al. 2000). The Terengganu, Malaysia nesting population was reduced to less than 1 percent of its original size between the 1950s and 1995 (Chan and Liew 1996) and is no considered functionally extinct. Significant declines in nesting have been documented for other nesting aggregations, such as Gabon, French Guiana, and Indonesia.

Population growth rates for leatherback turtles vary by ocean basin. Leatherback turtles in the Northwest Atlantic Ocean exhibit a decreasing nest trend at nesting beaches with the greatest known nesting female abundance. This decline has become more pronounced (2008 through 2017), and the available nest data reflect a steady decline for more than a (Eckert and Mitchell 2018). Leatherback turtles in the Southwest Atlantic Ocean exhibit an increasing, although variable, nest trend (nearly 5 percent average annual increase, with the largest increase occurring in the past decade). Leatherback turtles in the Southeast Atlantic Ocean of the coast of Gabon exhibit a declining nest trend (8.6 percent annually) at the largest nesting aggregation. Leatherback turtles in the Southwestern Indian Ocean exhibit a slightly decreasing nest trend at monitored nesting beaches off the coast of South Africa. Leatherback turtles in the Northeast Indian Ocean exhibit a drastic population decline with extirpation of its largest nesting aggregation in Malaysia. The overall nest trend has drastically decreased over the past several decades. Leatherback turtles in the West Pacific Ocean exhibit low hatching success and a declining nest and population trend. Leatherback turtles in the East Pacific Ocean exhibit a decreasing trend since monitoring began, with a 97.4 percent decline (depending on the nesting beach) since the 1980s or 1990s Wallace et al. (2013). Despite intense conservation efforts, the decline in nesting has not been reverse as of 2011 (Benson et al. 2015).

Analyses of mitochondrial DNA from leatherback turtles indicates a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton et al. 1999). Further analysis of samples taken from individuals from rookeries in the Atlantic and Indian Oceans suggest that each of the rookeries represent demographically independent populations (NMFS and USFWS 2013).

Subpopulations are reproductively isolated with little to no gene flow connecting them. However, within some subpopulations there is fine-scale genetic structure. Genetic analyses using microsatellite data revealed fine-scale genetic differentiation among neighboring subpopulations in the Northwest Atlantic Ocean including: Trinidad, French Guiana/Suriname, Florida, Costa Rica, and St. Croix (Dutton and H. 2013). Tagging studies indicate individual movement and gene flow among nesting aggregations.

In the Atlantic Ocean, equatorial waters appear to be a barrier between breeding populations. In the northwestern Atlantic Ocean, post-nesting female migrations appear to be restricted to north of the equator but the migration routes vary (NMFS and USFWS 2013). Genetic studies support the satellite telemetry data indicating a strong difference in migration and foraging fidelity between the breeding populations in the northern and southern hemispheres of the Atlantic Ocean (NMFS and USFWS 2013).

Leatherback turtles are distributed in oceans throughout the world (Figure 10). Leatherback turtles occur throughout marine waters, from nearshore habitats to oceanic environments (Shoop and Kenney 1992). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011).

8.7.2 Vocalization and Hearing

As noted in Section 8.5.2, Sea turtles are low frequency hearing specialists. Piniak (2012) measured hearing of leatherback turtle hatchlings in water an in air, and observed reactions to low frequency sounds, with responses to stimuli occurring between 50 hertz and 1.6 kilohertz in air between 50 hertz and 1.2 kilohertz in water (lowest sensitivity recorded was 93 dB re: 1 µPa at 300 hertz). These hearing sensitivities are similar to those reported for pond and wood turtles as discussed in Section 8.5.2.

Leatherback eggs and hatchlings have been recorded producing sounds. (Ferrara et al. 2014) recorded sounds including pulses, sounds with harmonic and nonharmonic frequency bands, sounds with frequency and amplitude modulation, and hybrid sounds with characteristics of pulsed and harmonic sounds. Pulses, sounds without harmonically related frequency bands, and sound with harmonic frequency bands were recorded in nests with both eggs and hatchlings. These were produced at a frequency range of about 187.5 to 1,343.8 hertz, 282.2 to 1,640.6 hertz, and 119 to 24,000 hertz, respectively. All sounds were less than 0.5 seconds. (McKenna et al. 2019) also recorded sounds (no pulses) of leatherback turtle hatchlings. Sounds were produced at an average frequency range of 2.41 ± 3.02 kilohertz and average duration of 0.14 ± 0.13 seconds.

8.7.3 Status

The leatherback turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. The status of the subpopulations in the Atlantic, Indian, and Pacific Oceans are generally declining, except for the subpopulation in the Southwest Atlantic Ocean, which is slightly increasing. Leatherback turtles show a lesser degree of nest site fidelity than occurs with hardshell sea turtle species.

The primary threats to leatherback turtles include fisheries interactions (bycatch), harvest of nesting females, and egg harvesting (NMFS 2020a). Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, vegetation changes, sand extraction, beach nourishment, shoreline stabilization, and natural disasters (e.g., storm events and tsunamis) as well as cold-stunning, vessel interaction, pollution (contaminants, marine debris and plastics, petroleum products, petrochemicals), ghost fishing gear, natural predation, parasites, and disease (NMFS 2020a). Artificial lights on or adjacent to nesting beaches alter nesting adult female behavior and are often fatal to post-nesting females and emerging hatchlings as they are drawn to light sources and away from the sea. Ingestion of marine debris (plastic) is common in leatherback turtles and can block gastrointestinal tracts leading to death (NMFS 2020a). Climate change may alter sex ratios (as temperature determines hatchling sex) and nest success, range (through expansion of foraging habitat as well as alter spatial and temporal patterns), and habitat (through the loss of nesting beaches, because of sea-level rise and storms).

Oceanographic regime shifts possibly impact foraging conditions that may affect nesting female size, clutch size, and egg size of populations. The species' resilience to additional perturbation is low.

8.7.4 Status in the Action Area

Leatherback turtle sightings off the southeastern U.S. are most numerous during winter, with sightings occurring in the proposed offshore survey area during all seasons (Conley et al. 2017; Department of the Navy 2008). Palka et al. (2021) also reported year-round sightings on the shelf of the southeastern U.S. Sighting per unit effort modeling based on line transects and platform of opportunity data shows that leatherback turtles are most likely to be sighted on the shelf along the coast of Georgia and South Carolina but with some sightings expected over deep waters of Blake Plateau. Modeling of the active dispersal of juvenile leatherback turtles in the north Atlantic suggest that two- to six-year-old leatherback turtles might be relatively common in offshore waters around the Blake Plateau, including in the proposed study area (Lalire and Gaspar 2019). Tagged leatherback turtles have been tracked moving through the survey area (Palka et al. 2021). In 2019, 3 interactions between a leatherback turtle and longline fishery were reported within the survey area (Garrison and Stokes 2021). In the OBIS database, there are 123 records for the proposed survey area throughout the year, with most records reported during winter and spring (OBIS 2023).

8.8 Loggerhead Turtle – Northwest Atlantic Ocean Distinct Population Segment

Loggerhead turtles are circumglobal, and are found in continental shelf and estuarine environments throughout the temperate and tropical regions of the Atlantic, Indian, and Pacific Oceans. The Northwest Atlantic Ocean DPS of loggerhead turtles are found along eastern North America, Central America, and northern South America (Figure 11). The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated 9 DPSs of loggerhead turtles, with the Northwest Atlantic Ocean DPS listed as threatened (75 FR 12598).

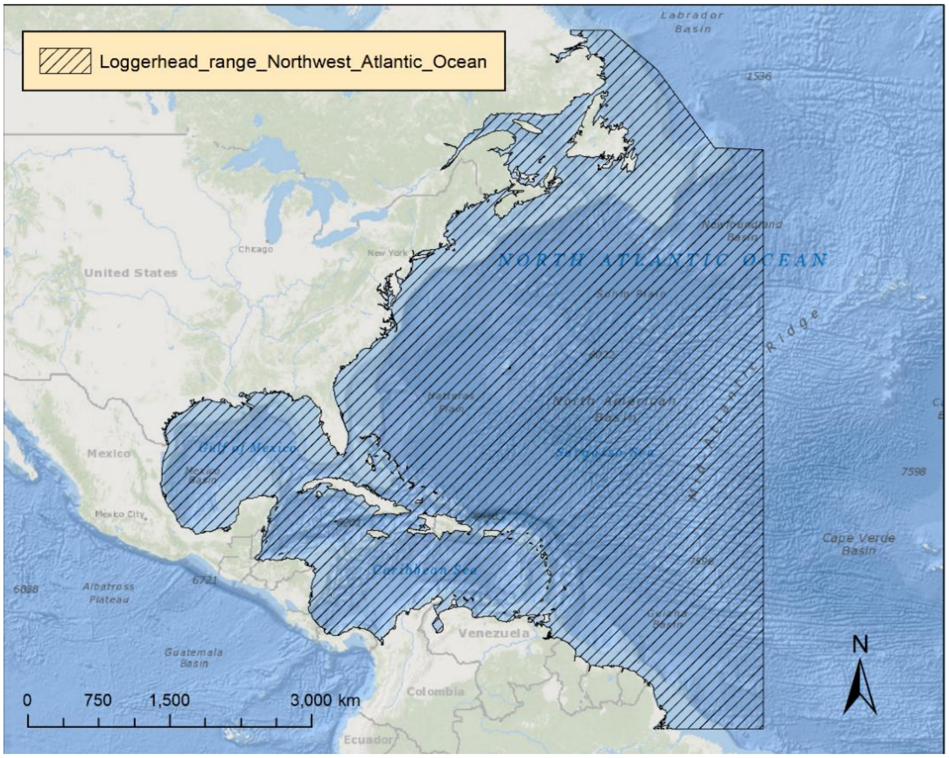

Figure 11**. Map identifying the range of the threatened Northwest Atlantic Ocean distinct population segment of loggerhead turtle**

8.8.1 Population Dynamics

It is difficult to estimate overall abundance for sea turtle populations because individuals spend most of their time in water, where they are difficult to count, especially considering their large range and use of many different and distant habitats. Females, however, converge on their natal beaches to lay eggs, and nests are easily counted. The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead sea turtles is over 110,000 (NMFS and USFWS 2023).

In-water estimates of abundance include juvenile and adult life stages of loggerhead males and females are difficult to perform on a wide scale. In the summer of 2010, NMFS' NEFSC and SEFSC estimated the abundance of juvenile and adult loggerhead sea turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada, based on AMAPPS aerial line-transect sighting survey and satellite tagged loggerheads (NMFS 2011c). They provided a preliminary regional abundance estimate of 588,000 individuals (approximate inter-quartile range of 382,000-817,000) based on positively identified loggerhead sightings (NMFS 2011). A separate, smaller aerial survey, conducted in the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, demonstrated uncorrected loggerhead sea turtle abundance ranging from a spring high of 27,508 to a fall low of 3,005 loggerheads (NMFS and USFWS 2023). We are not aware of any current range-wide in-water estimates for the DPS.

Based on genetic analysis of subpopulations, the Northwest Atlantic Ocean DPS of loggerhead turtle is further categorized into 5 recovery units corresponding to nesting beaches. These are Northern Recovery Unit, Peninsular Florida Recovery Unit, Dry Tortugas Recovery Unit, Northern Gulf of Mexico Recovery Unit, and the Greater Caribbean Recovery Unit (Conant et al. 2009a). An analysis using expanded mitochondrial DNA sequences revealed that rookeries from the Gulf and Atlantic coasts of Florida are genetically distinct, and that rookeries from Mexico's Caribbean coast express high haplotype diversity (Shamblin et al. 2014). Furthermore, the results suggest that the Northwest Atlantic Ocean DPS of loggerhead turtle should be considered as 10 management units: (1) South Carolina and Georgia, (2) central eastern Florida, (3) southeastern Florida, (4) Cay Sal, Bahamas, (5) Dry Tortugas, Florida, (6) southwestern Cuba, (7) Quintana Roo, Mexico, (8) southwestern Florida, (9) central western Florida, and (10) northwestern Florida (Shamblin et al. 2012).

The Northern Recovery Unit, from North Carolina to northeastern Florida, and is the second largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle, with an average of 5,215 nests from 1989 through 2008, and approximately 1,272 nesting females per year (NMFS and USFWS 2008). The nesting trend from daily beach surveys showed a significant decline of 1.3 percent annually from 1989 through 2008. Aerial surveys of nests showed a 1.9 percent decline annually in nesting in South Carolina from 1980 through 2008. Overall, there is strong statistical data to suggest the Northern Recovery Unit has experienced a long-term decline over that period. Data since that analysis are showing improved nesting numbers and a departure from the declining trend. Nesting in Georgia has shown an increasing trend since comprehensive nesting surveys began in 1989. Nesting in North Carolina and South Carolina has begun to show a shift away from the declining trend of the past. Increases in nesting were seen from 2009 through 2012.

The Peninsular Florida Recovery Unit is the largest nesting aggregation in the Northwest Atlantic Ocean DPS of loggerhead turtle, with an average of 64,513 nests per year from 1989 through 2007, and approximately 15,735 nesting females per year (NMFS 2008). Following a 52 percent increase between 1989 through 1998, nest counts declined sharply (53 percent) from 1998 through 2007. However, annual nest counts showed a strong increase (65 percent) from 2007 through 2017 (FFWCC 2018). Index nesting beach surveys from 1989 through 2013 has identified 3 trends. From 1989 through 1998, a 30 percent increase was followed by a sharp decline over the subsequent decade. Large increases in nesting occurred since then. From 1989 through 2013, the decade-long decline had reversed and there was no longer a demonstrable trend. From 1989 through 2016, the Florida Fish and Wildlife Research Institute concluded that there was an overall positive change in the nest counts, but the change was not statistically significant.

The Dry Tortugas, Gulf of Mexico, and Greater Caribbean Recovery Units are much smaller nesting assemblages, but they are still considered essential to the continued existence of loggerhead turtles. The Dry Tortugas Recovery Unit includes all islands west of Key West, Florida. The only available data for the nesting subpopulation on Key West comes from a census conducted from 1995 through 2004 (excluding 2002), which provided a range of 168 to 270 (mean of 246) nests per year, or about 60 nesting females (NMFS and USFWS 2007b). There was no detectable trend during this period (NMFS 2008).

The Gulf of Mexico Recovery Unit has between 100 to 999 nesting females annually, and a mean of 910 nests per year. Analysis of a dataset from 1997 through 2008 of index nesting beaches in the northern Gulf of Mexico shows a declining trend of 4.7 percent annually. Index nesting beaches in the panhandle of Florida has shown a large increase in 2008, followed by a decline in 2009 through 2010 before an increase back to levels similar to 2003 through 2007 in 2011.

The Greater Caribbean Recovery Unit encompasses nesting subpopulations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán peninsula, in Quintana Roo, Mexico, with 903 to 2,331 nests annually (Zurita et al. 2003a). Other significant nesting sites are found throughout the Caribbean Sea, and including Cuba, with approximately 250 to 300 nests annually (Ehrhart et al. 2003), and over 100 nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008). Survey effort at nesting beaches has been inconsistent, and not trend can be determined for this subpopulation (NMFS 2008). Zurita et al. (2003b) found an increase in the number of nests on 7 of the beaches on Quintana Roo, Mexico from 1987 through 2001, where survey effort was consistent during the period. Nonetheless, nesting has declined since 2001, and the previously reported increasing trend appears to not have been sustained (NMFS 2008).

8.8.2 Vocalization and Hearing

As noted in Section 8.5.2, Sea turtles are low frequency hearing specialists. Piniak Bartol et al. (1999) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 hertz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 hertz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (Bartol and Ketten 2006). Underwater tones elicited behavioral responses to frequencies between 50 and 800 hertz and auditory evoked potential responses between 100 and 1,131 hertz in 1 adult loggerhead turtle (Martin et al. 2012). The lowest threshold recorded in this study was 98 dB re: 1 µPa at 100 hertz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 hertz while juveniles responded to sounds in the range of 50 hertz to 1 kilohertz. Post-hatchlings had the greatest sensitivity to sounds at 200 hertz while juveniles had the greatest sensitivity at 800 hertz (Lavender et al. 2014). These hearing sensitivities are similar to those reported for pond and wood turtles as discussed in Section 8.5.2.

8.8.3 Status

Based on the currently available information, the overall nesting trend of the Northwest Atlantic DPS of loggerhead appears to be stable, neither increasing nor decreasing, for over 2 decades (NMFS and USFWS 2023). Destruction and modification of terrestrial and marine habitats threaten the Northwest Atlantic DPS of loggerhead. On beaches, threats that interfere with successful nesting, egg incubation, hatchling emergence, and transit to the sea include erosion, erosion control, coastal development, artificial lighting, beach use, and beach debris (NMFS and USFWS 2023). In the marine environment threats that interfere with foraging and movement include marine debris, oil spills and other pollutants, harmful algal blooms, and noise pollution (NMFS and USFWS 2023).

8.8.4 Status in the Action Area

The Department of the Navy (2008) mapped numerous sightings of loggerheads off the coasts of Florida, Georgia, and South Carolina; most records were for shelf waters during winter, but 1 sighting was made in the proposed survey area during fall. Palka et al. (2021) also showed sightings of loggerhead turtles on the shelf off the southeastern U.S. during all seasons, including 1 sighting in the proposed survey area during summer. Females stay closer to the shore after nesting but move farther offshore towards the end of summer (Hopkins-Murphy et al. 2003). SPUE modeling based on line transects and platform of opportunity data shows some overlap of occurrence of loggerhead turtles with the proposed study area, but the majority of observations were along the shelf to the west (Department of the Navy 2008). Tagged loggerhead turtles have been tracked moving through the survey area (Palka et al. 2021). In 2019, 4 interactions between a loggerhead turtle and longline fishery were reported within the proposed survey area (Garrison and Stokes 2021). There are 175 OBIS records for the survey area throughout the year (OBIS 2023).

9 Environmental Baseline

The "environmental baseline" refers to the condition of the ESA-listed species or its designated critical habitat in the action area, without the consequences of the ESA-listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process. The consequences to ESA-listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 C.F.R. §402.02). In this section, we discuss the environmental baseline within the action area as it applies to species that are likely to be adversely affected by the proposed actions.

A number of human activities have contributed to the status of populations of ESA-listed marine mammals (blue whale, fin whale, sei whale, and sperm whale) and sea turtles (North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle) in the action area. Some human activities are ongoing and appear to continue to affect marine mammal and sea turtle populations in the action area for this consultation. Some of these activities, most notably commercial whaling, occurred extensively in the past and continue at low levels that no longer appear to significantly affect marine mammal populations, although the effects of past reductions in numbers persist today. The following discussion summarizes the impacts, which include climate change, unusual mortality events, vessel interactions (vessel strike and whale watching), fisheries (fisheries interactions), pollution (marine debris, pollutants and contaminants, and hydrocarbons), aquatic nuisance species, anthropogenic sound (vessel sound and commercial shipping, aircraft, seismic surveys, marine construction, active sonar, and military activities), and scientific research activities.

Focusing on the impacts of the activities in the action area specifically allows us to assess the prior experience and state (or condition) of the threatened and endangered individuals that occur in the action area that will be exposed to effects from the proposed actions under consultation. This is important because in some states or life history stages, or areas of their ranges, ESA-listed individuals will commonly exhibit, or be more susceptible to, adverse responses to stressors than they would be in other states, stages, or areas within their distributions. These localized stress responses or stressed baseline conditions may increase the severity of the adverse effects expected from the proposed actions.

9.1 Climate Change

There is a large and growing body of literature on past, present, and future impacts of global climate change, exacerbated and accelerated by human activities. Effects of climate change include sea level rise, increased frequency and magnitude of severe weather events, changes in air and water temperatures, and changes in precipitation patterns, all of which are likely to affect ESA-listed species. NOAA's climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://climate.gov). This section provides some examples of impacts to ESA-listed species and their habitats that have occurred or may occur as the result of climate change in the action area.

The rising concentrations of greenhouse gases in the atmosphere, now higher than any period in the last 800,000 years, have also affected the chemistry of the ocean, causing it to become more acidic. Ocean acidification negatively affects calcium carbonate-dependent organisms such as pteropods (free-swimming pelagic sea snails and sea slugs) which are an important part of the food web in Northwest Atlantic Ocean waters. Some studies in the nutrient-rich regions have found that food supply may play a role in determining the resistance of some organisms to ocean acidification (Markon et al. 2018; Ramajo et al. 2016). Reduction in prey items can create a collapse of the zooplankton populations and thereby result in potential cascading reduction of prey at various levels of the food web, thereby reducing the availability of the larger prey items of marine mammals.

Changes in the marine ecosystem caused by global climate change (e.g., ocean acidification, salinity, oceanic currents, DO levels, nutrient distribution) could influence the distribution and abundance of lower trophic levels (e.g., phytoplankton, zooplankton, submerged aquatic vegetation, crustaceans, mollusks, forage fish), ultimately affecting primary foraging areas of proposed and ESA-listed species including ESA-listed cetaceans and sea turtles in the action area. Also, marine species' ranges in the action area are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions. Large-scale changes in the earth's climate are in turn causing changes locally to the Carolina Trough and Blake Plateau's climate and environment. Climate change impacts can vary widely depending on depth since deeper areas may experience different temperature fluctuations than shallow areas. Over the last 100 years, sea surface temperatures have increased across much of the northwest Atlantic, consistent with the global trend of increasing sea surface temperature due to anthropogenic climate change (Beazley et al. 2021). The effects of ocean warming have already been observed in the marine ecosystem across the Northwest Atlantic, through northward shifts in the range of commercially harvested fish and their catch distribution (Pinsky and Fogarty 2012) and varying shifts of ESA-listed cetaceans. Chavez-Rosales et al. (2022) examined habitat suitability for 16 cetacean species in the western Northwest Atlantic Ocean, including fin, sei, and sperm whale using generalized additive models developed from data collected by the NEFSC from 2010 to 2017. The models were based on observed species distribution as a function of 21 environmental covariates and compared species-specific core habitats between 2010 and 2017. Chavez-Rosales et al. (2022) noted that the largest shifts in the core habitat were for several species including fin whale, sei whale, and sperm whale. It was noted that the effects of these shifts are still unknown, but for already stressed species, the contraction or displacement of their historical habitat could worsen their population status. In addition to cetaceans, McMahon and Hays (2006) predicted increased ocean temperatures will expand the distribution of leatherback turtles into more northern latitudes. The authors noted this is already occurring in the Atlantic Ocean.

In addition to increased ocean warming and changes in species' distribution, climate change is linked to increased extreme weather and climate events including, but not limited to, hurricanes, cyclones, tropical storms, heat waves, and droughts (IPCC 2022). Research from IPCC (2022) shows that it is likely extratropical storm tracks have shifted poleward in both the Northern and Southern Hemispheres, and heavy rainfalls and mean maximum wind speeds associated with hurricane events will increase with continued greenhouse gas warming. These extreme weather events have the potential to have adverse effects on ESA-listed sea turtles in the action area. For example, after hurricane Dorian, a category 5 hurricane that swept over the Bahamas in 2019, the country saw a loss of up to 1,500 sea turtle nests (Garza 2019). Increased instances of extreme weather events such as these have the potential to reduce sea turtle populations by reducing hatchling success rates.

This review provides some examples of impacts to ESA-listed species and their habitats that may occur as the result of climate change within the action area. While it is difficult to accurately predict the consequences of climate change to a particular species or habitat, a range of consequences are expected that are likely to change the status of the species and the condition of their habitats, and may be exacerbated by additional threats in the action area.

9.2 Vessel Traffic

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. Vessel interactions can come in the form of vessel traffic and vessel strike.

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. (2017) indicated that the presence of vessels within 400 meters (1,312.34 feet) of blue whales resulted in surface and dive that were, on average, 49 and 36 percent shorter, respectively. Further, it was noted that the number of breaths taken by blue whales was reduced by 51 percent compared to control observations without vessel presence within 2,000 meters (6,561.68 feet) of whales (Lesage et al. 2017). 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 kilometers 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 between ESA-listed cetaceans and sea turtles as it relates to vessel strike in the action area.

9.2.1 Vessel Strike

Vessel strikes are considered a serious and widespread threat to ESA-listed cetaceans in the action area (especially large whales) 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) indicated that the highest occurrence of reported cetacean vessel strikes were in the Atlantic Ocean with over 62.4 percent of occurrences compared to other ocean basins.

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 to be expected. All sizes and types of vessels can hit whales, but most lethal and severe injuries are caused by vessels 80 meters (262.5 feet) 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 kilometers 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). The vast majority of commercial vessel strike mortalities of cetaceans are likely undetected and unreported, as most are likely never reported. 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 percent 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). In the Northwest Atlantic, in areas adjacent to the action area, along the North Carolina and Virginia border (south of Northampton, Virginia), unpublished data from NMFS' Marine Mammal Health and Stranding Response Program show there are 4 records of vessel strike for fin whale and 3 records of vessel strike for sei whale (NMFS Marine Mammal Health and Stranding Response Program unpublished data).

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 1 of the most commonly struck species, but sperm whales are also struck at increased 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 vessel (e.g., military and research), but traffic that is most likely to result in vessel strikes comes from commercial shipping. The latest five-year annual average mortalities and serious injuries related to vessel strikes for ESA-listed marine mammal stocks within U.S. waters likely to be found in the action area and experience adverse effects as a result of the proposed action are given in Table 9 below. 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 9. Average Annual Mortalities and Serious Injuries Related to Vessel Strikes for Endangered Species Act-Listed Marine Mammals for Stocks in the Northwest Atlantic Ocean from 2016 to 2020 (Hayes et al. 2022)

Species	Observed	Estimated
Blue Whale	1	NA
Fin Whale	0.4	NA
Sei Whale	0.2	NA
Sperm Whale	4	0

NA=not available.

Vessel strikes are a poorly studied threat to sea turtles, but have the potential to be highly significant given that 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, and this may increase their risk of vessel strike. For example, in areas of southeast Florida, adjacent to the action area, 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 percent of loggerheads had at least 1 injury. Vessel strikes accounted for 75 percent of the 60 injuries.

9.3 Fisheries

Fisheries constitute an important and widespread use of the ocean resources throughout the action area. Fisheries off the coast of South Carolina, Georgia, and Florida contributed millions of dollars in total revenue to state and local economies. For example, for the year 2021, commercial fisheries contributed an estimated 22.5 million, 27.4 million, and 198.26 million U.S. dollars to the state and local economies of Georgia, South Carolina, and Western Florida, respectively. For 2021 commercial fisheries off the coast of

Georgia, South Carolina, and Western Florida collected a total of 3,991, 3,864, and 32,706 metric tons of seafood, respectively. These fisheries are all located along the transit routes of the action area.

Fisheries can adversely affect fish populations, other species (including ESA-listed cetaceans and sea turtles in the action area), and habitats. Direct effects of fisheries interactions on cetaceans 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 can represent a significant threat to non-target populations. 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 gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine mammals.

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 climatic 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.

9.3.1 Fisheries Interactions

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. The majority of 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 percent of entanglement is caused by derelict fishing gear (Baulch and Perry 2014). From 2007 to 2020, the Southeast Atlantic coast of the United States had the lowest number of large whale entanglements compared to other regions of the United States. Nevertheless, from 2007 to 2020, the U.S. Southeast Atlantic had an average of 2.8 large whale entanglements per year (Figure 1 of NMFS 2022c). Unpublished entanglement data over the last 10 years from NMFS' Marine Mammal Health and Stranding Response Program indicate that 2 sei whales were found entangled off the coast of North Carolina and Florida and 1 sperm whale was entangled off the coast of Georgia (NMFS Marine Mammal Health and Stranding Response Program unpublished data). It is unconfirmed if all entanglement events were from fishing line as some were unidentified lines which may be attributed to marine debris.

The latest five-year average mortalities and serious injuries related to fisheries interactions for the ESA-listed cetaceans likely to be found in the action area are given in Table 10 below (Hayes et al. 2022). Data represent only known 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 10. Average Annual Mortalities and Serious Injuries Related to Fisheries Interactions for Endangered Species Act-Listed Cetaceans within the Northwest Atlantic from 2016 to 2020 (Hayes et al. 2022)

Species	Mortality
Blue Whale	0
Fin Whale	1.45
Sei Whale	0.4
Sperm Whale	NA

NA=not available

Cetaceans 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. It is theorized that marine mammals 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 remain unknown in the action area.

Sea turtle bycatch in fisheries occurs in both large-scale commercial fishing operations as well as small-scale, artisanal fisheries. Fishing gears that are known to interact with sea turtles include trawls, longlines, purse seines, gillnets, pound nets, dredges and to a lesser extent, pots and traps (Finkbeiner et al. 2011; Lewison et al. 2013).In the action area, the Southeast shrimp trawl fishery in the Southeast Atlantic and Gulf of Mexico has historically accounted for the overwhelming majority (up to 98 percent) of sea turtle bycatch in U.S. fisheries (Finkbeiner et al. 2011). From 2013 to 2023, there have been 642 green, 264 loggerhead, 50 Kemp’s ridley, 2 leatherback, and 2 hawksbill sea turtles reported as incidentally captured off the coast of Georgia and Florida. However, these data do not solely include incidental capture from bycatch as the data represent incidental capture from recreational and commercial fishing, dredging, relocation trawling, non-turtle research activities, and power plant operations (NMFS Sea Turtle Stranding and Salvage Network 2023).

Regulations that went into effect in the early 1990's require shrimp trawlers in the Atlantic and Gulf of Mexico to modify their gear with TEDs designed to allow turtles to escape trawl nets and avoid drowning. Analyses by Epperly and Teas (2002) indicated that, while early versions of TEDs were effective for some species, the minimum requirements for the escape opening dimension were too small for larger sea turtles, particularly loggerheads and leatherbacks. NMFS implemented revisions to the TED regulations in 2003 to address this issue (68 FR 8456, February 21, 2003). Revised TED regulations in 2014 were estimated to reduce shrimp trawl related mortality by 94 percent for loggerheads and 97 percent for leatherbacks (NMFS 2014c). In 2019, a final rule was published (84 FR 70048) requiring TEDs on skimmer trawls greater than 12.19 meters (40 feet). The conservation benefit from the 2019 rule was estimated to prevent bycatch of up to 801 to 1,168 sea turtles in Southeastern U.S. shrimp fisheries. Furthermore, in 2021, NMFS introduced an advanced notice of a proposed rule to require TEDs on skimmer trawls less than 12.19 meters (40 feet) operating in Southeast U.S. shrimp fisheries (86 FR 20475).

9.4 Pollution

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

9.4.1 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 has been discovered to be accumulating in gyres throughout the oceans, specifically in high rates within the action area. For example, plankton tow data from Law et al. (2010) shows high levels of micro plastics within the Blake Plateau and Carolina Trough with concentrations of 1 to 10 pieces per cubic meter in certain areas in the North Atlantic subtropical gyre. Cetaceans are impacted by marine debris, including plastics, glass, metal, polystyrene foam, rubber, and derelict fishing gear (Baulch and Perry 2014; Li et al. 2016).

Over half of cetacean species (including blue, fin, sei, and sperm whales) are known to ingest marine debris (mostly plastic), with up to 31 percent of individuals in some populations containing marine debris in their guts and being the cause of death for up to 22 percent of individuals found stranded on shorelines (Baulch and Perry 2014), including in areas adjacent to or near the action area. For example, in waters off the coast of the Florida Keys, an adult sperm whale was found stranded in May 2022. During autopsy, researchers found a mass of intertwined line, net pieces, and plastic bag type material in the whale's stomach. This debris likely interfered with the whale's ability to digest food and absorb nutrition, leading to its emaciated condition and subsequent stranding (NMFS 2022d). In addition to cetaceans, sea turtles ingest plastic because it closely resembles jellyfish, a common natural prey item (Schuyler 2014). Ingestion of plastic debris can block the digestive tract, which can cause turtle mortality as well as sub-lethal effects including dietary dilution, reduced fitness, and absorption of toxic compounds (Laist et al. 1999; Lutcavage et al. 1997). Santos et al. (2015) found that a surprisingly small amount of plastic debris was sufficient to block the digestive tract and cause death. They reported that 10.7 percent of green turtles in survey area waters were killed by plastic ingestion, while 39.4 percent had ingested enough plastic to kill them. These results suggest that debris ingestion is a potentially important source of turtle mortality in the action area, 1 that may be masked by other causes of death. Gulko and Eckert (2003) estimated that between one-third and one-half of all sea turtles ingest plastic at some point in their lives. Prevalence of sea turtle ingestion of plastic in the action area is high. Eastman et al. (2020) examined gastrointestinal tracts of 42 post-hatchling loggerhead (*Caretta caretta*) sea turtles stranded in Northeast Florida. Necropsies revealed abundant numbers of plastic fragments ranging from 0.36 to 12.39 millimeters (0.014 to 0.48 inches) in size (length), recovered from the gastrointestinal tracts of 39 of the 42 animals (92.86 percent), with GI burdens ranging from 0 to 287 fragments with a mass of up to 0.33 grams (.012 ounces) per turtle. Post-hatchlings weighed from 16.0 to 47.59 grams (.56 to 1.7 ounces) yielding a plastic to body weight percentage of up to 1.23 percent. Several types of plastic fragments were isolated, but hard fragments and sheet plastic were the most common type. Schuyler et al. (2015) estimates that 52 percent of sea turtles globally have ingested plastic debris. Schuyler et al. (2016) synthesized the factors influencing debris ingestion by turtles into a global risk model, taking into account the area where turtles are likely to live, their life history stage, the distribution of debris, the time scale, and the distance from stranding location. They found that oceanic life stage turtles are at the highest risk of debris ingestion. Based on this model green, loggerhead, and leatherback turtles were found to be at a high and increasing risk from plastic ingestion (Schuyler 2014).

In addition to the ingestion of debris, cetaceans and sea turtles often become entangled in marine debris, including fishing gear (Baird et al. 2015; Laist et al. 1999; Lutcavage et al. 1997; NRC 1990). As noted in Section 9.3.1, instances of ESA-listed cetacean and sea turtle strandings from entanglement have occurred near the action area. Despite debris removal 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. Entanglement in marine debris can lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, choking, fitness consequences, and mortality for ESA-listed cetaceans and sea turtles in the action area. Entanglement can also result in drowning for air breathing marine species including cetaceans and sea turtles.

9.4.2 Pollutants and Contaminants

Exposures to pollution and contaminants have the potential to cause adverse health effects in ESA-listed cetaceans and sea turtles. Marine ecosystems receive pollutants from a variety of local, regional, and international sources, and their levels and sources are therefore difficult to identify and monitor (Grant and Ross 2002). Marine pollutants come from multiple municipal, industrial, and household sources as well as from atmospheric transport (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata 1993). In the action area, contaminants may be introduced by coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities (Garrett 2004; Grant and Ross 2002; Hartwell 2004). For example, the Carolina Trough and Blake Plateau are adjacent to major ports along the coast of the Southeast U.S. 2019 U.S. port statistics from the American Association of Port Authorities show that the port of Jacksonville, Florida; Charleston, South Carolina; and Savannah, Georgia had an estimated annual cargo volume of 17.7 million, 24.59 million, and 41.9 million tons of cargo, ranking as the 35^{th}, 27^{th}, and 15^{th} U.S. ports with the highest cargo ship trade activity, respectively (American Association of Port Authorities 2023). As a result, the action area contains major shipping routes, with many cargo ships passing through, increasing the risk for pollutants to be introduced into the marine environment.

Coastal pollution is also another major source of contamination in the action area. Sources of coastal pollution include wastewater treatment plants, septic systems, industrial facilities, agriculture, animal feeding operations, and improper refuse disposal. Agricultural discharges, as well as discharges from large urban centers, contribute contaminants as well as coliform bacteria to coastal watersheds. Contaminants can be carried long distances from terrestrial or nearshore sources and ultimately accumulate in offshore pelagic environments (USCOP 2004). For example, in Georgia, large industries have been attracted to the coastal region. These industries, especially the pulp and paper and chemical industries, have contributed to major pollution problems. Large volumes of pollutants have been discharged into the marine environment, especially near Savannah, Brunswick, and St. Marys (Johnson et al. 1974).

In addition to coastal sources of pollution, emergency events have occurred within the action area that lead to the release of contaminants into the marine environment. For example, NOAA's ResponseLink (https://responselink.orr.noaa.gov) reports that in June 2015, a Space X Dragon rocket that was launched from Cape Canaveral, Florida, exploded several minutes after launch. The debris and payload of the rocket crashed offshore in the action area approximately 240 kilometers (150 miles) off Jacksonville, FL resulting in the release of 908.4 liters (240 gallons) of highly toxic monomethylhydrazine and dinitrogen tetroxide (NOAA ORR). Other emergency events resulting in the release of oil are discussed in Section 9.4.3.

Chemical contaminants, particularly those that are persistent in the environment, are a particular concern for marine animals that often occupy high trophic positions (i.e., ESA-listed cetaceans and sea turtles). Persistent organic pollutants, which include legacy pesticides (e.g., DDT, chlordane), legacy industrial-use chemicals (e.g., PCBs), and other contaminants of concern (e.g., polybrominated diphenyl ethers, perfluorinated compounds) accumulate in fatty tissues of marine organisms and are magnified through the food chain, leading upper trophic predators to be highly exposed (National Academies of Sciences and Medicine 2016). High concentrations of PCBs and DDT have been reported in tissues of cetaceans and sea turtles in coastal regions adjacent to the action area off the coast of Georgia (Seguel et al. 2020; USFWS 1993). These legacy persistent organic pollutants have been linked to a number of adverse health effects including endocrine disruption, reproductive impairment or developmental effects, and immune dysfunction or disease susceptibility (National Academies of Sciences and Medicine 2016). In addition to PCBs and DDT, Polybrominated diphenyl ethers commonly used as flame retardants, are another class of persistent organic pollutants that have spread globally in the environment and have also been reported in cetaceans and sea turtles in the action area(National Academies of Sciences and Medicine 2016).

Numerous factors can affect concentrations of persistent pollutants in cetaceans and sea turtles, such as age, sex, birth order, diet, and locality/habitat use (Mongillo et al. 2012; Muñoz and Vermeiren 2020). In cetaceans, pollutant 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 cetacean 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). Also, for sea turtles, maternal transfer of persistent organic pollutants threatens developing embryos with a pollution legacy and poses conservation concerns due to its potential adverse effects on subsequent generations (Muñoz and Vermeiren 2020). Because pollutants are both ubiquitous and persistent in the environment, ESA-listed cetaceans and sea turtles in the action area will continue to be exposed.

9.4.3 Hydrocarbons

Hydrocarbons, complex mixtures of fossil fuel-associated pollutants, pose a threat to ESA-listed cetaceans, sea turtles, and the prey populations they rely on. For example, polycyclic aromatic hydrocarbons represent a group of organic compounds that can result in adverse effects on marine species. Anthropogenic sources of polycyclic aromatic hydrocarbons include crude oil, fumes, vehicle exhaust, coal, organic solvents, and wildfires. Exposure may be continual, associated with run-off from impervious cover in developed coastal regions, or natural seeps that produce low-level but steady exposure. Acute events such as oil spills may produce pulses of more significant exposure. Depending on the route of exposure (inhalation/aspiration, ingestion, direct dermal contact), polycyclic aromatic hydrocarbons can produce a broad range of health effects to ESA-listed cetaceans and sea turtles including lung disease, disruption of the hypothalamic-pituitary-adrenal axis, and altered immune response (National Academies of Sciences and Medicine 2016).

Cetaceans 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 cetaceans to petroleum products causes changes in behavior and may directly injure animals (Geraci 1990). In addition, sea turtles may experience serious 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).

Oil spills are accidental and unpredictable events, but are a direct consequence of oil and gas development and production from oil and gas activities as well as from the use of vessels. Oil releases can occur at any number of points during the exploration, development, production, and transport of oil. Most instances of oil spill are generally small (less than 1,000 barrels), but larger spills may occur. Over the last 2 decades, there has not been a large-scale oil spill in the action area, but several small-scale vessel spills have occurred as documented by NOAA’s ResponseLink (https://responselink.orr.noaa.gov). For example, in March 2005, a US Navy vessel, approximately 120.7 kilometers (75 miles) offshore Jacksonville, Florida, lost 22,712 liters (6,000 gallons) of diesel fuel. In addition, in December 2007, a 70-foot fiberglass vessel sank just south of the north jetty at Winyay Bay, South Carolina with 3,785.4 liters (1,000 gallons) of diesel fuel on board resulting in a mile long oil sheen. More recently, in April 2022, a 45-foot fishing vessel with 300 gallons of diesel fuel onboard, sank 20 miles southeast of Charleston, South Carolina.

9.5 Aquatic Nuisance Species

The introduction of non-native species is considered 1 of the primary threats to ESA-listed species (Anttila et al. 1998; Pimentel et al. 2004; Wilcove and Chen 1998). Clavero and Garcia-Bertro (2005) found that invasive species were a contributing cause to over half of the extinct species in the IUCN database and invasive species were the only cited cause in 20 percent of those cases. Invasive species consistently rank as 1 of the top threats to the world's oceans (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005; Wambiji et al. 2007).

When non-native plants and animals are introduced into habitats where they do not naturally occur, they can have significant impacts on ecosystems and native fauna and flora (including ESA-listed species). Non-native species can be introduced through infested stock for aquaculture and fishery enhancement, ballast water discharge, and from the pet and recreational fishing industries. In general, species located higher within a food web (including most ESA-listed species under NMFS' jurisdiction) are more likely to become extinct as a result of an invasion (Byrnes et al. 2007; Harvey and May 1997). Shifts at the base of food webs fundamentally alter predator-prey dynamics for species in higher trophic levels (Moncheva and Kamburska 2002) such as ESA-listed cetaceans and sea turtles in the action area.

For example, invertebrates can have major impacts on the ecosystems they invade. Benthic invertebrates, such as mussels, polychaetes, and hydroids can become dominant filter feeders, greatly reducing the amount of organic energy that is available to native taxa in the water column (NMFS 2012b). This transfer of energy from the water column into the benthos fundamentally alters the ecology of the host habitat, resulting in less prey available for other filter feeders. Adverse effects of this include reduced body condition, growth, survival, and/or reproduction of native pelagic organisms at the same or similar trophic level as the invader if the native competitor cannot adapt to another food source. These changes would be manifested up the food chain to higher trophic level organisms in the habitat, including ESA-listed cetaceans and sea turtles (NMFS 2012b).

Lionfish (*Pterois volitans* and *Pterois miles*) have become a major invasive species in the western north Atlantic with dense aggregations recorded in mesophotic reefs (Goodbody-Gringley et al. 2019). As lionfish populations grow, they put additional stress on coral reefs through the predation of herbivores that prey on algae from coral reefs (Kindinger and Albins 2017). Without herbivores, algal growth may overpopulate which can be detrimental to the health of coral reefs and higher-level trophic species that depend on them (e.g., sea turtles).

9.6 Disease/Parasites

Green sea turtles in the action area off Florida have been documented with fibropapillomatosis. Fibropapillomatosis is a neoplastic disease that can negatively affect green turtle populations. Fibropapillomatosis is characterized by both internal and external tumorous growths, which can range in size from very small to extremely large. Large tumors can interfere with feeding and essential behaviors, and tumors on the eyes can cause permanent blindness (Foley et al. 2005). Fibropapillomatosis has long been present in sea turtle populations with the earliest recorded mention from the late 1800s in the Florida Keys (Hargrove et al. 2016). In 2013, fibropapillomatosis was documented in 2,380 of 9,574 green turtles (25 percent) found south of 29 degrees North, and in 62 of 1,517 green turtles (4 percent) found in Florida north of 29 degrees North (Hargrove et al. 2016; Jones et al. 2015). Renan de Deus Santos et al. (2017) assessed stress responses (corticosterone, glucose, lactate, and hematocrit) to capture and handling in green sea turtles with different fibropapillomatosis severity levels. Their findings suggest that moderate fibropapillomatosis severity may affect a turtle's ability to adequately feed themselves (as evidenced by poor body condition), and advanced-stage fibropapillomatosis severity may result in an impaired corticosterone response. Despite some conflicting conclusions, the overwhelming consensus among turtle researchers is that, at present, fibropapillomatosis does not significantly affect the overall survival of sea turtle populations (Hargrove et al. 2016). However, fibropapillomatosis cannot be discounted as a potential threat to green sea turtle populations as the distribution, prevalence rate, severity, and environmental co-factors associated with the disease have the capacity to change over time (Jones et al. 2015).

9.7 Liquefied Natural Gas Facilities

Existing LNG import and export terminals are adjacent to the action area's potential transit routes off Elba Island Savannah, Georgia (Federal Energy Regulatory Commission website accessed January 26, 2017: https://cms.ferc.gov/). Natural gas is chilled to approximately -260 °F (-162.2 ºC) into liquid form for transportation overseas. LNG is loaded onto tankers and upon arrival in the United States is converted back into a gas for distribution via pipeline. LNG is re-gasified by circulating water (or some other fluid) through a radiator-like system that warms LNG to vaporization temperatures. LNG facilities use either a closed-loop or open-loop system to convert the liquid into gas. Open-loop systems require a continuous stream of water in order to warm LNG (100-200 million gallons per day), usually withdrawn directly from the river system or ocean in which the terminal is sited. Eggs, larvae, and other organisms in the water column close to shore (e.g., sea turtles) can be impinged or entrained as water is withdrawn from the source to the terminal. Once the LNG is vaporized, the seawater used in cooling is either discharged back into the environment or utilized again through the cooling loop. The discharge can be at temperatures significantly different from ambient. Potential stressors to ESA-listed species associated with the operation of LNG facilities include increased dredging activities to allow for the passage and berthing of LNG vessels, pile driving for pier and berth construction, increased risk of ship strikes due to vessel traffic, potential early life stage losses from ballast water and facility intakes, loss of habitat due to water withdrawal, and increased ambient water temperature from discharged water.

9.8 Anthropogenic Sound

ESA-listed cetaceans and sea turtles that occur in the action area are regularly exposed to several sources of anthropogenic sounds. 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. ESA-listed cetaceans in the action area 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). The ESA-listed species have the potential to 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 possibly harm marine animals or significantly interfere with their normal activities (NRC 2005). Within the action area, ESA-listed cetaceans and sea turtles may be impacted by anthropogenic sound in various ways. Responses to sound exposure on ESA-listed cetaceans and sea turtles are discussed in Section 10.4.

9.8.1 Vessel Sound and Commercial Shipping

Individual vessels produce unique acoustic signatures, although these signatures may change with vessel speed, vessel load, and activities that may be taking place on the vessel. 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 to 50 hertz and range from 195 dB re: 1 μPa^2 second at 1 meter for fast-moving (greater than 37 kilometers per hour [20 knots]) supertankers to 140 dB re: 1 μPa^2 second at 1 meter for smaller vessels (NRC 2003c). Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels about 2 kilohertz, which may interfere with important biological functions of cetaceans (Holt 2008). At frequencies below 300 hertz, ambient sound levels are elevated by 15 to 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 (Hildebrand 2009b; McKenna et al. 2012; NRC 2003c; NRC 2003b). Commercial shipping continues to be a major source of low-frequency sound in the ocean, particularly in the Northern Hemisphere where the majority of vessel traffic occurs (Hildebrand 2004). Measurements made over the period of 1950 through 1970 indicated low frequency (50 hertz) vessel traffic sound in the northwest Atlantic Ocean was increasing by 0.55 dB per year (Ross 1976; Ross 1993; Ross 2005). More recent PAM data from Wall et al. (2021) showed that northwest Atlantic, including the Blake Plateau region, had the highest amplitude levels for vessel noise in bands less than 250 hertz with peaks at 63 hertz. Wall et al. (2021) stated that the month with the highest amplitude levels were during July. As noted in Section 9.4.2, the action area is adjacent to 3 major U.S. ports. The ports of Jacksonville, Florida; Charleston, South Carolina; and Savannah, Georgia each ranked as the 35th, 27th, and 15th U.S. ports with the highest cargo ship trade activity for 2019, respectively (American Association of Port Authorities 2023). As shown in Figure 12, 2021 AIS data from MarineTraffic (2023) shows the action area comprises of high density vessel traffic areas both along the coast and in areas further from the shore in the Blake Plateau and Carolina Trough.

Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels above 2 kilohertz. The low frequency sounds from large vessels overlap with many mysticetes predicted hearing ranges (7 Hertz to 35 kilohertz; NOAA 2018) and may mask their vocalizations and cause stress (Rolland et al. 2012). The broadband sounds from large vessels may interfere with important biological functions of odontocetes, including foraging (Blair et al. 2016; Holt

2008). At frequencies below 300 hertz, ambient sound levels are elevated by 15 to 20 dB when exposed to sounds from vessels at a distance (McKenna et al. 2013). Analysis of sound from vessels revealed that their propulsion systems are a dominant source of radiated underwater sound at frequencies less than 200 hertz (Ross 1976). Additional sources of vessel sound include rotational and reciprocating machinery that produces tones and pulses at a constant rate. Other commercial and recreational vessels also operate within the action area and may produce similar sounds, although to a lesser extent given their much smaller size.

Sonar systems are used on commercial, recreational, and military vessels and may affect cetaceans (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, 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 frequency active sonar, often produces intense sounds at high source levels, and these may affect 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 9.8.5 and 9.8.6.

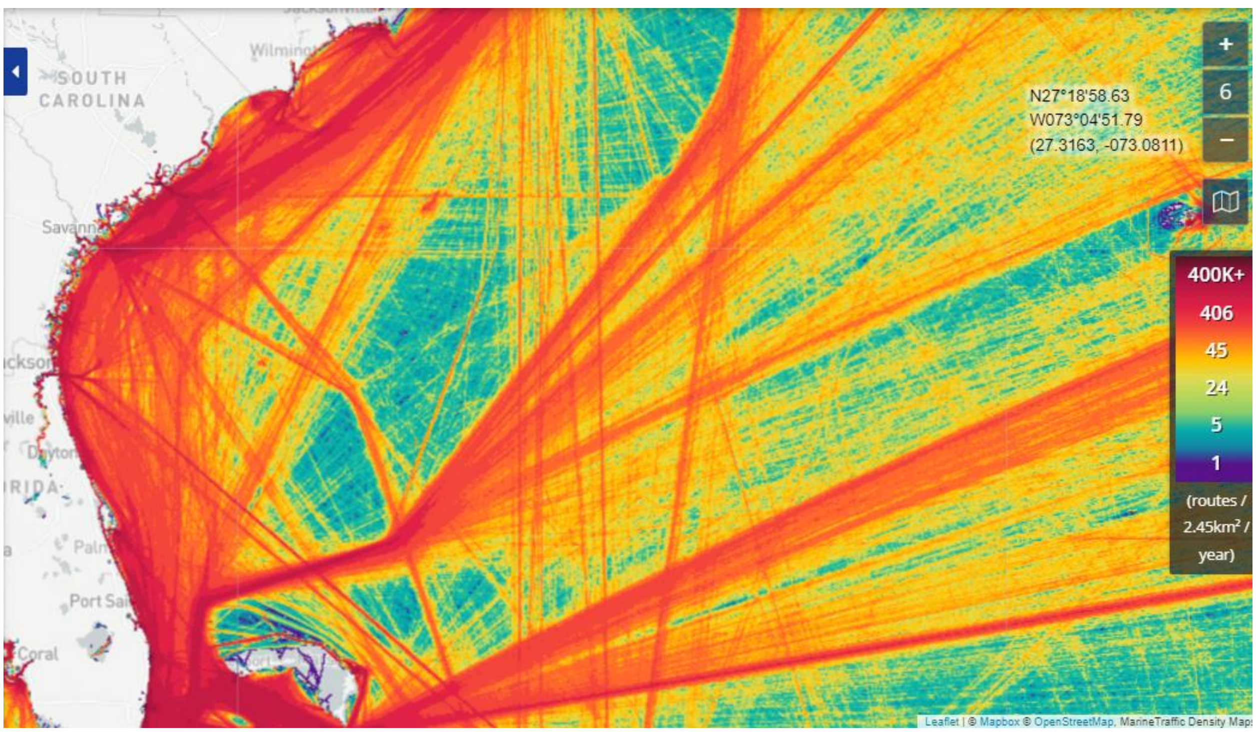

Figure 12. Map of 2021 vessel traffic density off the U.S. Southeast Atlantic off Florida, Georgia, and South Carolina. Image retrieved from MarineTraffic (2023)

9.8.2 Aircraft

Aircraft within the action area may consist of small commercial or recreational airplanes or helicopters, to large commercial airliners. Major airports that are adjacent to the action area include Charleston

International Airport, Jacksonville International Airport, and Orlando International Airport. Orlando International airport is ranked as the seventh most trafficked airport in the U.S. (Airports Council International 2022). Aircrafts produce a variety of sounds that can potentially affect marine mammals. While it is difficult to assess these impacts, several studies have documented what appear to be 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 to 3 kilometers (0.5 to 1.6 nautical miles) away, although the airplane noises ceased as soon as the airplanes left the area, which was relatively quickly 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 pinnipeds at certain frequencies. Nevertheless, noise from aircraft is expected to be minimal due to the location of the action area, which is far from a populated area and has sparse aircraft traffic.

9.8.3 Seismic Surveys

There are seismic survey activities involving towed airgun arrays that may occur within the action area. They are the primary exploration technique to locate hydrocarbon deposits, fault structure, and other geological hazards. Airguns contribute a massive 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 kilohertz (Goold and Coates 2006). Seismic airgun noise can propagate substantial distances at low frequencies (e.g., Nieukirk et al. 2004). These activities may produce noise that could affect ESA-listed marine mammals within the action area.

These airgun arrays generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of 10 to 20 seconds for extended periods (NRC 2003b). Most of the energy from the airguns is directed vertically downward, but significant sound emission also extends horizontally. Peak sound pressure levels from airguns usually reach 235 to 240 dB re: 1 µPa (rms) at dominant frequencies of 5 to 300 Hertz (NRC 2003a). Most of the sound energy is at frequencies below 500 Hertz, which is within the hearing range of baleen whales and sperm whales (Nowacek et al. 2007). 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 USGS 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 do not 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.

The NSF funded and L-DEO conducted seismic surveys in the Northwest Atlantic Ocean on the R/V *Atlantis* in 2018 and R/V *Marcus G. Langseth* in 2014 through 2015 and recently off the coast of North Carolina on the R/V *Marcus G. Langset*h in 2023. 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. The biological opinions and subsequent monitoring reports for these activities concluded that affects from the airgun array would only result in ESA harassment of ESA-listed cetaceans and sea turtles. In 2018, we issued an opinion on the Bureau of Ocean Energy Management's issuance of 5 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 consideration for waters off North Carolina, South Carolina, Georgia, and Florida were withdrawn. Each seismic survey includes a MMPA IHA and each are subject to a separate ESA section 7 consultation. The finalized consultations all resulted in a "no jeopardy" opinion.

9.8.4 Marine Construction

Marine construction activities in the action area that produce sound include drilling, dredging, pile-driving, cable-laying, and explosions. These activities are known to 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. In-water marine construction and operation can also increase pollution in the water and result in the loss of habitat. All or some of these activities may cause effects to individuals within the action area.

9.8.5 Active Sonar

Active sonar emits high-intensity acoustic energy and receives reflected and/or scattered energy. A wide range of sonar systems are in use 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 for 1 kilohertz and less, mid-frequency for 1 to 10 kilohertz, high-frequency for 10 to 100 kilohertz; and very high-frequency for greater than 100 kilohertz (Hildebrand 2004). Low-frequency systems are designed for long-range detection (Popper et al. 2014a). The effective sound source level of a low-frequency airgun array, when viewed in the horizontal direction can be 235 dB re: 1 μPa at 1 meter or higher (Hildebrand 2004). 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 includes those incorporated into weapons (e.g., torpedoes and mines) or weapon countermeasures (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. They typically generate sound at frequencies of 3 to 200 kilohertz, with sound source levels ranging from 150 to 235 dB re: 1 μPa at 1 meter (Hildebrand 2004). Depth sounders and sub-bottom profilers are operated primarily in nearshore and shallow environments; however, fish finders are operated in both deep and shallow areas.

9.8.6 Military Activities

Many researchers have described behavioral responses of marine mammals to the sounds produced by helicopters and fixed-wing aircraft, boats and ships, as well as dredging, construction, geological explorations, etc. (Richardson et al. 1995c). Dredging and construction can also modify habitat, and vessel traffic associated with all marine activities poses a risk for vessel strike, Most observations have been limited to short-term behavioral responses, which included cessation of feeding, resting, or social interactions. Smultea et al. (2008b) documented a recognized "stress behavioral reaction" by a group of sperm whales in response to small aircraft fly-bys. The group ceased forward movement, moved closer together in a parallel flank-to-flank formation, and formed a fan-shaped semi-circle with the lone calf remaining near the middle of the group. In-air noise levels from aircraft can be problematic for marine life, and that sound can extend into water.

Within the action area, multiple stressors associated with military activities pose a threat to ESA-listed marine mammals and sea turtles. 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 NSF and L-DEO's high-energy seismic survey. 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 U.S. Navy performs testing activities to ensure that its military forces have the latest technologies and techniques available to them.

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 lower 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 expected to be temporary and would not affect the reproduction, survival, or recovery of these species. Sound (in-air and in-water) produced during U.S. Navy activities is also expected to result in instances of PTS, TTS, and behavioral harassment to marine mammals and sea turtles. 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. Through these consultations with NMFS, the U.S. Navy has implemented monitoring and conservation measures to reduce the potential effects of in-air and underwater sound from activities on ESA-listed species in the Atlantic Ocean. Conservation measures include employing visual observers and implementing mitigation zones during activities using active sonar and explosives.

9.9 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 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), PAM, biological sampling (i.e., biopsy sampling, breath sampling, fecal sampling, and sloughed skin sampling), and tagging. Research activities generally involve 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, and 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. Most recent research activities involve authorized sub-lethal "takes" with some resulting mortality.

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 each found that the authorized research activities would have no more than short-term effects and were not determined to result in jeopardy to the species or adverse modification of designated critical habitat.

Additional "take" is likely to be authorized in the future as additional permits are issued. It is noteworthy that although the numbers tabulated in the Effects of the Action (Section 10) of this opinion represent the maximum number of "takes" authorized in a given year, monitoring and reporting indicate that the actual number of "takes" rarely approach the number authorized. Therefore, it is unlikely that the level of exposure indicated below in the effects assessment has or would occur in the near term. However, our analysis assumes that these "takes" would occur because they have been authorized. It is also noteworthy that these "takes" are distributed across the Atlantic Ocean. Although marine mammals are generally wide-ranging, we do not expect many of the authorized "takes" to involve individuals that would also be "taken" under the proposed high-energy seismic survey and research activities.

9.10 Impact of the Baseline on Endangered Species Act-Listed Species

Collectively, the baseline described above has had, and likely continues to have, lasting impacts on the ESA-listed species considered in this consultation. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strikes, incidental bycatch, and entanglement), whereas others result in more indirect (e.g., fishing that affects prey availability) or non-lethal (e.g., whale watching) impacts.

Assessing the aggregate impacts of these stressors on the species considered in this consultation is difficult. This difficulty is compounded by the fact that many of the species in this consultation are wide-ranging and subject to stressors in locations throughout and outside the action area.

We consider the best indicator of the aggregate impact of the Environmental Baseline on ESA-listed resources in the action area to be the status and trends of those species. As noted in Section 8, some of the species considered in this consultation are experiencing increases in population abundance, some are declining, and, for others, their status remains unknown. Taken together, this indicates that the activities identified in the Environmental Baseline are affecting species in different ways. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the activities described in the Environmental Baseline. Therefore, while the Environmental Baseline may slow their recovery, recovery is not being prevented. For the species that may be declining in abundance, it is possible that the suite of conditions described in the Environmental Baseline is preventing their recovery. However, is also possible that their populations are at such low levels (e.g., due to historical commercial whaling) that even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, species may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their limited population size to become a threat in and of itself. A thorough review of the status and trends of each species is discussed in the Status of Species Likely to be Adversely Affected (Section 8) of this consultation and what this means for the populations is discussed in the Integration and Synthesis (Section 12).

10 Effects of the Actions

Section 7 regulations define "effects of the action" as all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR §402.02).

This effects analysis section is organized following the stressor, and exposure and response assessment framework described in Section 2. In this section, we further describe the probability of individuals of ESA-listed cetaceans (blue whale, fin whale, sei whale, and sperm whale) and sea turtles (North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle) in the action area being exposed to airgun noise based on the best scientific and commercial evidence available, and the probable responses of those individuals (given their probable exposures) based on the available evidence. For any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment will consider the risk posed to the viability of the population(s) those individuals comprise and to the ESA-listed species those populations represent. For this consultation, we are particularly concerned about behavioral and stress-related physiological disruptions and potential unintentional mortality that may result in animals that fail to feed, reproduce, or survive because these responses are likely to have population-level consequences. The purpose of this assessment and, ultimately, of this consultation, is to determine if it is reasonable to expect the proposed action to have effects on ESA-listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

10.1 Stressors Remaining to be Considered

During consultation, we determined that sound fields produced by the airgun array will likely adversely affect ESA-listed species by introducing acoustic energy introduced into the marine environment. This stressor and the likely effects on ESA-listed species are discussed in the Exposure and Response Analyses (Sections 10.3 and 10.4).

10.2 Mitigation to Minimize or Avoid Exposure

As described in the Description of the Proposed Actions (Section 3), the NSF and L-DEO's proposed action and NMFS Permits Division's proposed IHA and possible renewal requires monitoring and conservation measures that include the use of shutdown and buffer zones, shutdown procedures, pre-start clearance and ramp-up procedures, vessel-based visual monitoring with NMFS-approved PSOs, PAM, vessel strike avoidance measures, seasonal restrictions, and additional conservation measures considered to minimize or avoid exposure of ESA-listed species. The NMFS Permits Division's conservation measures to minimize or avoid exposure are described in the draft IHA in Appendix A (Section 18).

10.3 Exposure Analysis

Exposure analyses identify the ESA-listed species that are likely to co-occur with the action's effects on the environment in space and time, and identify the nature of that co-occurrence. This section identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the action's effects and the population(s) or sub-population(s) those individuals represent. Although there are multiple acoustic and non-acoustic stressors associated with the proposed actions, the stressor of primary concern is the acoustic impacts of the airgun array.

In this section, we quantify the likely exposure of ESA-listed species to sound from the airgun array. For this consultation, the NSF, L-DEO, and NMFS Permits Division estimated exposure to the sounds from the airgun array that would result in ESA harm and harassment of ESA-listed cetaceans and sea turtles.

Section 3 of the ESA defines take as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct" (16 U.S.C. §1532(19)). Harm is defined by regulation (50 C.F.R. §222.102) as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering." NMFS does not have a regulatory definition of "harass." However, on May 1, 2023, NMFS adopted as final, the previous interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding, or sheltering."

Therefore, under the ESA, harassment is expected to occur during the seismic survey activities' and may involve a wide range of harassment for ESA-listed species including but not limited to avoidance, changes in vocalizations or dive patterns; or disruption of feeding, migrating, or reproductive behaviors. Some of these types of harassment may stem from TTS. However, exposure estimates do not differentiate behavioral response vs. TTS, nor do they provide information regarding the potential fitness or other biological consequences of the responses on the affected individuals. In the following sections, we consider the best available scientific evidence to determine the likely nature of these responses and their potential fitness consequences in accordance with the definitions of "take" related to harm or harass under the ESA for ESA-listed species.

Our exposure analysis relies on 2 basic components: (1) information on species distribution (i.e., density or occurrence within the action 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 some response). Using this information, and information on the high-energy seismic survey (e.g., active acoustic sound source specifications, area or volume of water that would be ensonified at certain sound levels, trackline locations, days of operation, etc.), we then estimate the number of instances in which an ESA-listed species may be exposed to sound fields from the airgun array that are likely to result in adverse effects such as harm or harassment. In many cases, estimating the potential exposure of animals to anthropogenic stressors is difficult due to limited information on animal density estimates in the action area and overall abundance, the temporal and spatial location of animals; and proximity to and duration of exposure to the sound source. For these reasons and by regulation, we evaluate the best available data and information in order to reduce the level of uncertainty in making our final exposure estimates.

10.3.1 Exposure Estimates of ESA-Listed Cetaceans

As discussed in the Status of Species Likely to be Adversely Affected (Section 8), there are 4 ESA-listed cetacean species that are likely to be adversely affected by the proposed actions: blue whales, fin whales, sei whales, and sperm whales.

The NSF and L-DEO applied acoustic thresholds to determine at what point during exposure to the airgun array cetaceans are harmed and harassed. An estimate of the number of cetaceans that would be exposed to sounds from the airgun array is included in NSF's draft environmental assessment/analysis (LGL 2023). The NSF, L-DEO, and NMFS Permits Division did not provide any exposure or take estimates from sound sources other than the airgun array, although other equipment producing sound would be used during airgun array operations (e.g., the sub-bottom profiler, multi-beam echosounder, split-beam echosounder, and acoustic Doppler current profiler). We determined that ESA-listed species and critical habitat are not likely to be adversely affected from these sound sources above in Section 7.2 through 7.7.

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 ESA-listed cetaceans considered in this consultation. Possible responses considered in this analysis consist of:

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

In their *Federal Register* notice of the proposed IHA and request for comments and possible renewal, the NMFS Permits Division stated that they did not expect sound emanating from non-airgun sources to exceed levels produced by the airgun array. Therefore, the NMFS Permits Division did not expect additional exposure from sound sources other than the airgun array. We agree with this assessment and similarly focus our analysis on exposure from the airgun array. The sub-bottom profiler, multi-beam echosounder, acoustic Doppler current profiler, and pinger are also expected to affect a smaller ensonified area within the larger sound field produced by the airgun array and are not expected to be of sufficient duration that will lead to take of ESA-listed species (Section 7.1).

In this section, we describe the NSF, L-DEO, and NMFS Permits Division's analytical methods to estimate the number of ESA-listed cetacean species that might be exposed to the sound field.

10.3.1.1 ESA-Listed Cetacean Occurrence – Density Estimates

Of the 31 species of cetaceans that have the reasonable potential to co-occur with the seismic survey activities, the blue whale, fin whale, sei whale, and sperm whale are ESA-listed. Blue whales, fin whales, and sei whales are classified in the low-frequency hearing group. Sperm whales are classified in the mid-frequency hearing group (NOAA 2018).

We reviewed available cetacean densities and group dynamics with the NSF, L-DEO, and the NMFS Permits Division and agreed upon which densities constituted the best available scientific information for each ESA-listed cetacean species. The NMFS Permits Division adopted these estimates for use in their proposed IHA and we have adopted them for our ESA Exposure Analysis.

Estimates of cetacean densities in the action area were utilized in the development of NSF and L-DEO's draft environmental assessment/analysis (LGL 2023) and IHA application (LGL 2022). NMFS Permits

Division concurred with these data. The NSF and L-DEO used habitat-based stratified cetacean densities for the North Atlantic Ocean for the U.S. Navy Atlantic Fleet Testing and Training Area from Roberts et al. (2022). The habitat-based density models were produced by the Duke University Marine Geospatial Ecology Laboratory and represent the best available information regarding cetacean densities in the seismic survey area. The density data from (Roberts et al. 2022) incorporates aerial and vessel line-transect survey data from NMFS Science Centers and other organizations and updates prior habitat-based cetacean density models (i.e., Roberts et al. 2016). Roberts et al. (2016) comprised of 8 physiographic and 16 dynamic oceanographic and biological covariates, and controls for the influence of sea state, group size, availability bias, and perception bias on the probability of making a sighting. (Roberts et al. 2022) updated Roberts et al. (2016) by expanding the model to utilize over 2.8 million linear kilometers (1.74 million miles) of survey effort collected between 1992-2020, yielding density maps for over 30 species and multi-species guilds. More information on this density model is available online at: https://seamap.env.duke.edu/models/Duke/EC/. The habitat-based density models consisted of 5 kilometer (2.7 nautical mile) by 5 kilometer (2.7 nautical mile) GIS raster grid cells. Average densities in the grid cells for the U.S. Navy Atlantic Fleet Testing and Training Area overlapping the seismic survey area (plus a 40 kilometer [21.6 nautical mile] buffer) were averaged for each species for each of 2 water depth categories (intermediate and deep water depths) to determine monthly mean density values for each species. The highest mean monthly density was chosen for each species from the months of May through October.

Data sources and density calculations are described in detail in NSF's draft environmental assessment/analysis (LGL 2023) and L-DEO's IHA application (LGL 2022). There is uncertainty about the representativeness of the density data and the assumptions used to estimate exposures. For some cetacean species, the densities derived from past surveys may not be precisely representative of the densities that would be encountered during the seismic survey activities. Density estimates for each ESA-listed cetacean likely to be adversely affected by the proposed actions are found in Table 11. The approach used here is based on the best available data.

The number of cetaceans that can be exposed to the sounds from the airgun array on 1 or more occasions is estimated for the seismic survey area using expected seasonal density of animals in the area (Table 11). Summing exposures along all of the tracklines yields the total exposures for each species for the proposed actions of the 36-airgun array configuration for the seismic survey activities and NMFS Permits Division's proposed issuance of an IHA and possible renewal.

Table 11. Densities of Endangered Species Act-Listed Cetaceans in the Action Area During the National Science Foundation and Lamont-Doherty Earth Observatory's High-Energy Seismic Survey of the Blake Plateau and Carolina Trough

Species	Season (Month of Highest Density during May through October for Intermediate/Deep Water Depths)	Density – Intermediate Water Depths (Individuals per km^2)	Density – Deep Water Depths (Individuals per km^2)
Blue Whale	Same Each Month	0.0000115	0.0000124
Fin Whale	May/May	0.0000266	0.0000271
Sei Whale	October/October	0.0001681	0.0001753
Sperm Whale	June/May	0.0013001	0.0090562

km^2=square kilometers.

10.3.1.2 Total Ensonified Area for ESA-listed Cetaceans

As noted in Section 3, the high-energy survey would consist of 5,730 kilometer (3,094 nautical miles) tracklines of two-dimensional MCS seismic reflection data and 952 kilometer (513 nautical miles) tracklines of OBS refraction data across the Carolina Trough and Blake Plateau. Overall, just over half (55 percent) of all survey effort would occur in intermediate water (100–1000 meters [328 to 3,280 feet] deep), and 45 percent would occur in deep water (>1000 meters [3,280 feet] deep). Details on LDEO's approach to modeling the ensonified area emanating from these tracklines are presented in Sections 3.3.1 and are further discussed in NSF's draft environmental assessment/analysis (LGL 2023) and L-DEO's IHA application (LGL 2022). NSF used LDEO's model to determine radial distances from the airgun array to the 160 dB re: 1 µPa [rms] behavioral disturbance threshold for cetaceans within intermediate and deep water depths as shown in Table 4.

The daily ensonified area (for the 160 dB re: 1 µPa [rms] behavioral disturbance threshold) for the MCS reflection survey tracklines is estimated to be approximately 2,296.3 square kilometers (886.6 square nautical miles) for intermediate water depths and 1,097.5 square kilometers (423.7 square nautical miles) for deep water depths. The daily ensonified area (for the 160 dB re: 1 µPa [rms] behavioral disturbance threshold) for OBS refraction survey tracklines is estimated to be approximately 1,931.7 square kilometers (745.8 square nautical miles) for intermediate water depths, and 1,879.2 square kilometers (725.5 square nautical miles) for deep water depths. These areas were calculated by using the radial distances from the airgun array to the predicted isopleths corresponding to the 160 dB re: 1 µPa (rms) threshold (Table 4), along a planned trackline that would be surveyed in 1 day (approximately 182 kilometers [113.09 miles] during the MCS survey and 222 kilometers [137.9 miles] during the OBS survey). The daily ensonified area is multiplied by the total number of survey days (32 days for the MCS survey and 8 days for the OBS survey). The product is multiplied by 1.25 to account for an additional 25 percent contingency (e.g., potential delays) to allow for additional airgun array operations such as testing of the sound source or re-surveying tracklines with poor data quality. This also considers uncertainties in the density estimates used to estimate take.

This provides an estimate of the total area (square kilometers) expected to be ensonified to the behavioral disturbance thresholds for cetaceans (which includes TTS and ESA harassment). The total area ensonified at 160 dB re: 1 µPa (rms) for the MCS survey is 91,852.1 square kilometers (35,464.2 square nautical miles) and 43,900.8 square kilometers (13,692.8 square nautical miles) for intermediate and deep waters, respectively when accounting for overlap and using endcaps (Table 12). Also, when accounting for the same criteria, the total area ensonified at 160 dB re: 1 µPa (rms) for the OBS survey is 19,316.9 square kilometers (5,286.8 square nautical miles) and 18,792.2 square kilometers (7,255.7 square nautical miles) for intermediate and deep waters, respectively (Table 12).

Table 12. 160 dB re: 1 µPa (rms) Harassment Isopleths, Trackline Distance, Ensonified Area, Number of Survey Days, Percent Increase, and Total Ensonified Areas During the National Science Foundation and Lamont-Doherty Earth Observatory's High-Energy Seismic Survey of the Blake Plateau and Carolina Trough

Criteria (Water Depth)	Daily Trackline Distance (km)	Daily Ensonified Area (km^2)*	Survey Days	Ensonified Area (km^2)	Total Ensonified Area with 25 Percent Increase (km^2)*
Sound Source – 36-Airgun Array (MCS)					
160 dB re: 1 µPa (rms) (greater than 1,000 m)	76.26	1,097.5	32	35,120	43,900.8
160 dB re: 1 µPa (rms) (100 to 1,000 m)	105.74	2,296.3	32	73,481.6	91,852.1
Sound Source – 36-Airgun Array (OBS)					
160 dB re: 1 µPa (rms) (greater than 1,000 m)	134.31	1,879.2	8	15,033.6	18,792.2
160 dB re: 1 µPa (rms) (100 to 1,000 m)	87.69	1,931.7	8	15,453.6	19,316.9

km=kilometers, km^2=square kilometers.

* Including endcaps and accounting for overlap

In addition to the ensonified area noted above, based on the small anticipated isopleths for ESA harm (in this case considered to be received sound levels exceeding the marine mammal threshold for PTS as shown in Table 6 and Table 7) and in consideration of the conservation measures (i.e., shutdown and buffer zones, shutdown procedures, pre-start clearance and ramp-up procedures, vessel-based visual monitoring by NMFS-approved PSOs, vessel strike avoidance measures, seasonal restrictions, and additional conservation measures), we do not expect take in the form of ESA harm for ESA-listed cetaceans.

10.3.1.3 Cetacean Exposures as a Percentage of Population

Blue whales, fin whales, sei whales, and sperm whales of all age classes are likely to be exposed during the seismic survey activities. Given that the high-energy seismic survey would be conducted in summer (June through October), we expect that most animals would be in or migrating to/from their feeding grounds north of the action area. Blue whales, fin whales, sei whales, and sperm whales are expected to be feeding, traveling, or migrating in the action area and some females may have young-of-the-year accompanying them. Mature male sperm whales are generally expected to be further north in the higher latitudes of the Atlantic Ocean. Therefore, we expect a juvenile male and female bias to sperm whale exposure. For sperm whales, exposure of adult males is expected to be lower than other age and sex class combinations as male sperm whales are generally solitary and may migrate toward the northern portion of their range (poleward of about 40 to 50 degrees latitude). For blue whales, fin whales, sei whales, and sperm whales, these individuals can be exposed to the seismic survey activities while they are transiting through the action area. We would normally assume that sex distribution is even for blue whales, fin whales, sei whales, and sexes are exposed at a relatively equal level.

It should be noted that the exposure numbers by ESA harassment are expected to be conservative for several reasons. First, estimated exposure was increased by 25 percent, in the form of the ensonified area over the operational seismic survey days, therefore increasing the total ensonified area. This accounts for the possibility of additional seismic survey activities associated with airgun array testing and repeat coverage of any areas where initial data quality is sub-standard, and in recognition of the uncertainties in the density estimates used to estimate exposures as described above. Additionally, cetaceans are expected to move away from a loud sound source that represents an aversive stimulus, such as an airgun array, potentially reducing the number of exposures by ESA harm and harassment. However, the extent to which cetaceans (blue whales, fin whales, sei whales, and sperm whales) would move away from the sound source is difficult to quantify and is not accounted for in the exposure estimates. Last, due to the range of each of these species compared to the relatively small size of the action area and the relatively short duration of the seismic survey activities, the potential for exposure is reduced.

The population abundance estimates of cetacean species (i.e., blue whale, fin whale, sei whale, and sperm whale) 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. NMFS' stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises the stock. For most species of cetaceans, stock abundance estimates are based on sightings within the U.S. EEZ, however for some species, this geographic area may extend beyond U.S. waters. Survey abundance estimates may be used for other species. All managed stocks in this region are assessed in NMFS' U.S. Atlantic stock assessment report (Hayes et al. 2022). The percentage of exposure for each population of ESA-listed cetacean in the action area is summarized in the section below. Exposure estimates were derived from multiplying the highest intermediate and deep-water densities from May through October (Table 11) by the total ensonified area with a 25 percent increase (Table 12).

It should also be noted that abundances used in this opinion differ from those used in the proposed IHA. This is because population abundances were not available in NOAA stock assessment reports for some small delphinid species (no ESA-listed species), and population abundances are needed for MMPA small numbers determination. Thus, the percentage of exposure for each population may differ from those in the proposed IHA.

Blue Whale – The estimated exposure of the Western North Atlantic stock (approximately 402 individuals) of blue whales is 2 individuals to behavioral harassment and/or TTS, which is approximately 0.5 percent of the stock or regional population.

Fin Whale – The estimated exposure of the Western North Atlantic stock (approximately 6,802 individuals) of fin whales is 5 individuals to behavioral harassment and/or TTS, which is approximately 0.07 percent of the stock or regional population.

Sei Whale – The estimated exposure of the Nova Scotia (formerly Western North Atlantic) stock (approximately 6,292 individuals) of sei whales is 30 individuals to behavioral harassment and/or TTS, which is approximately 0.48 percent of the stock or regional population.

Sperm Whale – The estimated exposure of the regional population (approximately 4,349 individuals) of sperm whales is 709 individuals to behavioral harassment and/or TTS, which is approximately 16.3 percent of the stock or regional population.

10.3.2 Exposure Estimates of ESA-Listed Sea Turtles

As discussed in the Status of Species Likely to be Adversely Affected (Section 8), there are 4 ESA-listed sea turtle species or populations that are likely to be adversely affected by the proposed actions: the North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and the Northwest Atlantic Ocean DPS of loggerhead turtle.

10.3.2.1 ESA-Listed Sea Turtle Occurrence – Density Estimates

We reviewed available sea turtle densities with the NSF and L-DEO and agreed upon which densities constituted the best available scientific information for the 4 ESA-listed sea turtle species likely to be adversely affected by the seismic survey activities. We have adopted them for our ESA exposure analysis.

In developing their draft environmental assessment/analysis, NSF and LDEO utilized estimates for sea turtle densities in the action area. Densities for leatherback, green, and loggerhead sea turtles were derived from those reported off the Florida current presented in Bovery and Wyneken (2015). Densities for pelagic-stage Kemp's ridley sea turtles were derived from outputs of the models described by Putman et al. (2020). The model was used to estimate the mean maximum daily abundance of Kemp's ridley sea turtles within the survey area from May through October for the years 2010–2017; the densities in intermediate and deep water were then calculated by dividing the abundance by the extent of the survey area in each water-depth category.

Data sources and density calculations are described in detail in the NSF and L-DEO's draft environmental assessment/analysis (LGL 2023). There is uncertainty about the representativeness of the density data and the assumptions used to estimate exposures. For some sea turtle species, the densities derived from past surveys may not be precisely representative of the densities that will be encountered during the seismic survey activities. Density estimates for each sea turtle species are in Table 13. The approach used here is based on the best available data.

Table 13. Densities of Endangered Species Act-Listed Sea Turtles in the Action Area During National Science Foundation and Lamont-Doherty Earth Observatory's High-Energy Seismic Survey of the Blake Plateau and Carolina Trough

Species	Season (Month of Highest Density during May through October for Intermediate/Deep Water Depths)	Density – Intermediate Water Depths (Individuals per km^2)	Density – Deep Water Depths (Individuals per km^2)
Green Turtle – North Atlantic DPS	NA	0.0026	0.0026
Kemp's Ridley Turtle	NA	0.0000595	0
Leatherback Turtle	NA	0.000180000	0.000180000
Loggerhead Turtle – Northwest Atlantic Ocean DPS	NA	0.0052	0.0052

km^2=square kilometers.

10.3.2.2 Total Ensonified Area for ESA-Listed Sea Turtles

Sections 3 and 10.3.1.2 detail the total trackline distances for both the MCS and OBS surveys in intermediate and deep water. Details on LDEO's approach to modeling the ensonified area emanating from these tracklines are presented in Sections 3.3.1 and are further discussed in NSF's draft environmental assessment/analysis (LGL 2023) and L-DEO's IHA application (LGL 2022). NSF used LDEO's model to determine radial distances from the airgun array to the 175 dB re: 1 µPa [rms] behavioral disturbance threshold within intermediate and deep water depths as shown in

Table 5.

The daily ensonified area (for the 175 dB re: 1 µPa [rms] behavioral disturbance threshold) for the MCS reflection survey tracklines is estimated to be approximately 604 square kilometers (233.2 square nautical miles) for intermediate water depths and 289.5 square kilometers (111.78 square nautical miles) for deep water depths. The daily ensonified area (for the 175 dB re: 1 µPa [rms] behavioral disturbance threshold) for OBS refraction survey tracklines is estimated to be approximately 503 square kilometers (194.21 square nautical miles) for intermediate water depths, and 505.9 square kilometers (195.3 square nautical miles) for deep water depths. The same steps for estimating the total ensonified zone for the 160 dB re: 1 µPa (rms) behavioral disturbance threshold for cetaceans, including the 1.25 percent increase, were applied to get the total ensonified zone for the 175 dB re: 1 µPa [rms] behavioral disturbance threshold for sea turtles. The total area (square kilometers) expected to be ensonified to the 175 dB re: 1 µPa [rms] behavioral disturbance threshold for sea turtles (which includes TTS and behavioral harassment) is presented in Table 14.

Table 14. 175 dB re: 1 µPa (rms) Isopleths, Trackline Distance, Ensonified Area, Number of Survey Days, Percent Increase, and Total Ensonified Areas During the National Science Foundation and Lamont-Doherty Earth Observatory's High-Energy Seismic Survey of the Carolina Trough and Blake Plateau

Criteria (Water Depth)	Daily Trackline Distance (km)	Daily Ensonified Area (km^2)*	Survey Days	Ensonified Area (km^2)	Total Ensonified Area with 25 Percent Increase (km^2)*
Sound Source – 36-Airgun Array (MCS)					
175 dB re: 1 µPa (rms) (greater than 1,000 m)	76.26	289.5	32	9,262.61	11,578.3
175 dB re: 1 µPa (rms) (100 to 1,000 m)	105.74	604	32	19,328	24,158.1
Sound Source – 36-Airgun Array (OBS)					
175 dB re: 1 µPa (rms) (greater than 1,000 m)	134.31	505.9	8	4,047.2	5,058.7
175 dB re: 1 µPa (rms) (100 to 1,000 m)	87.69	503	8	4,024	5,030.2

km=kilometers, km^2=square kilometers.
* Including endcaps and accounting for overlap

In addition to the ensonified area noted above, based on the small anticipated isopleths for ESA harm (in this case considered to be received sound levels exceeding the sea turtle threshold for PTS as shown in Table 6 and Table 7) and in consideration of the conservation measures (i.e., shutdown and buffer zones, shutdown procedures, pre-start clearance and ramp-up procedures, vessel-based visual monitoring by NMFS-approved PSOs, vessel strike avoidance measures, seasonal restrictions, and additional conservation measures), we do not expect take in the form of ESA harm for sea turtles.

10.3.2.3 Sea Turtle Exposures as a Percentage of the Population

Adult, juvenile, and post-hatchling North Atlantic DPS of green, Kemp's ridley, leatherback, and Northwest Atlantic Ocean DPS of loggerhead sea turtles are likely to be exposed during the seismic survey activities. Given that the high-energy seismic survey would be conducted in the summer or early fall, we expect that most animals would be nesting or foraging. All sea turtle species are expected to be feeding, traveling, or migrating in the action area and some females may move closer to shore to nest. Because the seismic survey area is further offshore, we assume that sex distribution is even for the North Atlantic DPS of green, Kemp's ridley, leatherback, and Northwest Atlantic Ocean DPS of loggerhead sea turtles, and sexes are exposed at a relatively equal level.

The exposure numbers by ESA harassment are expected to be conservative for the same reasons presented for ESA-listed cetaceans discussed in Section 10.3.1.3. The number of exposures presented below represent the estimated number of instantaneous moments in which an individual from each species will be exposed to sound fields from seismic survey activities at or above the behavioral disturbance threshold. While the exposures do not necessarily represent individual sea turtles, the overall exposure is relatively low compared to the abundance of each sea turtle population that may occur within the action area. Given this, we expect that most sea turtles will not be exposed more than once, meaning the exposure numbers likely represent individual animals. As for the duration of each instance of exposure estimated, we were unable to produce estimates specific to the proposed action due to the temporal and spatial uncertainty of the research vessel and sea turtles within the action area. However, all the exposures are expected to be less than a single day due to the movement of the research vessel and animals.

Green Turtle – North Atlantic DPS – The estimated exposure of the North Atlantic DPS (population abundance unknown) of green turtle is 116 individuals to behavioral harassment and/or TTS.

Kemp's Ridley Turtle – The estimated exposure of Kemp's ridley turtles (regional population abundance unknown) is 2 individuals to behavioral harassment and/or TTS.

Leatherback Turtle – The estimated exposure of leatherback turtles (regional population abundance unknown) is 8 individuals to behavioral harassment and/or TTS.

Loggerhead Turtle – Northwest Atlantic Ocean DPS – The estimated exposure of the Northwest Atlantic Ocean DPS (population abundance unknown) of loggerhead turtle is 234 individuals to behavioral harassment and/or TTS.

10.4 Response Analysis for Endangered Species Act-Listed Marine Mammals and Sea Turtles to the Acoustic Noise from the Airgun Array

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, including ESA-listed cetaceans and sea turtles considered in this consultation. Possible responses considered in this analysis consist of:

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

The response analysis also considers information on the potential for stranding and the potential effects on prey of ESA-listed cetaceans and sea turtles in the action area.

As discussed in the Assessment Framework (Section 2) of this consultation, response analyses determine how ESA-listed resources are likely to respond after exposure to stressors from an action that cause changes to the environment or act directly on ESA-listed species. For the purposes of consultation, our assessments try to detect potential lethal, sub-lethal (or physiological), or behavioral responses that might result in reduced fitness of ESA-listed individuals. Ideally, response analyses consider and weigh evidence of adverse consequences, as well as evidence suggesting the absence of such consequences.

During the proposed actions, ESA-listed cetaceans and sea turtles may be exposed to sound from the airgun array. The NSF, L-DEO, and NMFS Permits Division (for cetaceans) provided estimates of the expected number of ESA-listed cetaceans and sea turtles that could be exposed to received levels greater than or equal to 160 dB re: 1 μPa (rms) for cetaceans and 175 dB re: 1 μPa (rms) for sea turtles from the airgun array (Section 10.3). Based on information presented in the response analysis, ESA-listed cetaceans and sea turtles exposed to these sound levels could be harmed, exhibit changes in behavior, suffer stress, or even strand.

We evaluated both the NSF and L-DEO's (and the NMFS Permit Division for cetacean species) exposure estimates of the number of ESA-listed cetaceans and sea turtles that will be "taken."

Generally, we estimate "take" by considering:

1. Acoustic thresholds above which NMFS believes the best available science indicates cetaceans will be behaviorally harassed, experience TTS, or incur some degree of PTS;
2. The area or volume of water that will be ensonified above these levels in a day;

3. The density or occurrence of marine mammals within these ensonified areas; and
4. The number of days of seismic survey activities.

In consideration of the received sound levels, we believe the potential for ESA harm of low-frequency cetaceans (blue whales, fin whales, and sei whales), mid-frequency cetaceans (sperm whales), and sea turtles (North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle) is unlikely. Harm is unlikely even before the moderating effects of aversion and/or other compensatory behaviors (e.g., Nachtigall et al. 2018) are considered. The constant movement of both the R/V *Marcus G. Langseth* and the ESA-listed cetaceans and sea turtles in the action area, and the short duration of exposure to loud sounds because the research vessel is not expected to remain in any area where individual animals may concentrate for an extended period of also make harm unlikely. In addition, as described in Section 10.3.1.3 and 10.3.2.3, we expect that ESA-listed cetaceans and sea turtles are likely to move away from a sound source that represents an aversive stimulus, especially at levels that could result in PTS, because animals will be aware of the R/V *Marcus G. Langseth*'s approach given its slow speed when conducting seismic survey activities.

Based on the anticipated small isopleths for ESA harm, and in consideration of the conservation and monitoring measures, we conclude take by ESA harm will not occur.

We rely on acoustic thresholds to determine sound levels at which ESA harassment may occur then utilize these thresholds to calculate ensonified areas. We then multiply these areas by data on species' densities to estimate the number of ESA-listed cetaceans and sea turtles that could be exposed to sounds generated by the airgun array as enumerated in Sections 10.3.1.3 and 10.3.2.3.

For ESA harassment, NMFS has historically relied on a minimum acoustic threshold of 160 dB re: 1 μPa (rms) for impulsive sound sources. These values are based on observations of behavioral disturbance in mysticetes, but are used for all cetacean species. For this action, we relied on this historic NMFS acoustic threshold to estimate the number of takes by behavioral harassment of ESA-listed cetaceans.

Using the above acoustic thresholds, we evaluated the exposure and take estimates of ESA-listed cetaceans associated with the sounds from the airgun array.

10.4.1 Potential Response of Cetaceans to Acoustic Sources

Exposure of cetaceans 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. TTS, which is a form of ESA behavioral harassment, results in a temporary change to hearing sensitivity (Finneran 2013), and the impairment can last minutes to days, but full recovery of hearing sensitivity is expected. However, 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

2009). At higher received levels, particularly in frequency ranges where animals are more sensitive, PTS (which is a form of ESA harm) 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, in which case each pulse need not be as loud as a single pulse to have the same accumulated effect. Instances of TTS and PTS 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 cetacean species hearing range, let alone its sensitivity and levels necessary to induce TTS or PTS. Baleen whales (e.g., blue whales, fin whales, and sei whales) have an estimated generalized functional hearing frequency range of 7 Hertz to 35 kilohertz and sperm whales have an estimated generalized functional hearing frequency range of 150 Hertz to 160 kilohertz (Southall 2007).

Thresholds for TTS and PTS 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. The best available information supports the position that received levels at a given frequency will need to be approximately 168 dB re: 1 μPa^2-second (SEL weighted) or 213 dB re: 1 µPa (Peak SPL) for TTS onset from impulsive sound for low-frequency cetaceans, and 170 dB re: 1 μPa^2-second (SEL weighted) or 224 dB re: 1 µPa (Peak SPL) for TTS onset from impulsive sound for high-frequency cetaceans (Southall et al. 2007c). PTS is expected at received levels of 183 dB re: 1 μPa^2-second (SEL weighted) or 219 dB re: 1 µPa (Peak SPL) from impulsive sound for low-frequency cetaceans, and 185 dB re: 1 μPa^2-second (SEL weighted) or 230 dB re: 1 µPa (Peak SPL) from impulsive sounds for high-frequency cetaceans (Southall et al. 2007c).

In terms of exposure to the R/V *Marcus G. Langseth*'s airgun array, an individual needs to be within a few meters of the largest airgun to experience a single pulse greater than 230 dB re: 1 µPa (Peak SPL; Caldwell and Dragoset 2000). If an individual experienced exposure to several airgun pulses of approximately 219 dB re: 1 µPa (Peak SPL) for low-frequency cetaceans and 230 dB re: 1 µPa (Peak SPL) for mid-frequency cetaceans, PTS could occur. Cetaceans have to be within certain modeled radial distances specified in Table 4, Table 6, and Table 7 from the R/V *Marcus G. Langseth*'s 36-airgun array to be within the ESA harm threshold isopleth, or risk a TTS or other measurable behavioral responses.

As stated earlier, only ESA harassment of ESA-listed cetaceans is expected during the high-energy seismic survey. Ranges to some behavioral impacts include distances exceeding 100 kilometers (54 nautical miles), although significant behavioral effects are much more likely at higher received levels within a few kilometers of the sound source. Behavioral reactions will be short-term, likely lasting the duration of the exposure, and long-term consequences for individuals or populations are unlikely.

We expect that most individuals will move away from the airgun array as it approaches; however, a few individuals may be exposed to sound levels that could result in behavioral harassment in the form of TTS.

As the seismic survey proceeds along each transect trackline and the vessel approaches ESA-listed individuals, the sound intensity increases, and individuals will experience conditions (e.g., stress, loss of prey, discomfort, etc.) that will likely prompt them to move away from the research vessel and sound source and thus avoid exposures that will induce TTS. Ramp-ups reduce the probability of TTS-inducing exposure at the start of seismic survey activities for the same reasons because, as acoustic intensity increases, animals will likely move away, making it unlikely they will be exposed 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 meter (1,640.4 feet) shutdown zone during the 36-airgun array operations, which is beyond the distances believed to have the potential for PTS in any of the ESA-listed cetaceans, as described above. As stated in the Exposure Analysis, each individual could be exposed to 160 dB re: 1 μPa (rms) levels. We do not expect this to produce a cumulative TTS auditory injury. 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 generally move at least a short distance away as received sound levels increase, reducing the likelihood of exposure at levels that could affect an individual's fitness. In summary, if there are animals exposed to TTS, we expect that any TTS will be temporary and that animals are expected to quickly make a full recovery.

10.4.1.1 Cetaceans and Auditory Interference (Masking)

Interference, or 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 (blue whale, fin whale, and sei whale) and to some extent sperm whales. The high-energy seismic survey could mask baleen whale and sperm whale calls at some of the lower frequencies for these species. This could affect communication between individuals, affect their ability to receive information from their environment, or affect sperm whale echolocation (Evans 1998; NMFS 2006h). Most of the energy of sperm whale clicks is concentrated at 2 to 4 kilohertz and 10 to 16 kilohertz and, though the findings by Madsen et al. (2006) suggest frequencies of pulses from airgun arrays can overlap this range, the dominant frequency component of the R/V *Marcus G. Langseth*'s airgun array is below 200 Hertz (two to 188 Hertz). Any masking that might occur will likely be temporary because acoustic sources from the seismic surveys are not continuous and the research vessel will continue to transit through the area. In addition, the seismic survey activities on the R/V *Marcus G. Langseth* will occur over the course of approximately 61 days. 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). Overlap of the dominant low frequencies of airgun pulses with low-frequency baleen whale calls may pose a somewhat greater risk of masking. 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 *Marcus G. Langseth*'s airgun array will emit an approximately 0.01 second pulse when fired approximately every 10 seconds for the high-energy seismic survey, while sperm whale calls last 0.5 to 1 second. Therefore, pulses will not "cover up" the vocalizations of sperm whales to a significant extent (Madsen et al. 2002b). We address the response of ESA-listed cetaceans stopping vocalizations because of sound from the airgun array in Section 10.4.1.2.

Although sound pulses from airguns begin as short, discrete sounds, they interact with the marine environment and lengthen through processes such as reverberation. This means that, in some cases such as in shallow water environments, airgun sound can become part of the acoustic background. Few studies of how impulsive sound in the marine environment deforms from short bursts to lengthened waveforms exist, but impulsive sound can add significantly to the acoustic background (Guerra et al. 2011), potentially interfering with the ability of animals to hear otherwise detectible sounds in their environment.

The sound localization abilities of cetaceans suggest that, if signal and sound come from different directions, masking will not be as severe as the usual types of masking studies might suggest (Richardson 1995). The dominant background noise may be directional, if it comes from a particular anthropogenic 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. In the cases of higher frequency hearing by the bottlenose dolphin (*Tursiops truncatus*), beluga whale (*Delphinapterus leucas*), and killer whale (*Orcinus orca*), empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking sound (Bain and Dahlheim 1994; Bain et al. 1993; Bain 1993; Bain 1994; Dubrovskiy 2004). 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 2009; Parks et al. 2007; Terhune 1999).

These data demonstrating adaptations for reduced masking pertain mainly to the very high frequency echolocation signals of toothed whales. There is less information about the existence of corresponding mechanisms at moderate or low frequencies or in other types of cetaceans. For example, Zaitseva et al. (1980) found that, for bottlenose dolphin, the angular separation between a sound source and a masking noise source had little effect on the degree of masking when the sound frequency as 18 kilohertz, in contrast to the pronounced effect at higher frequencies. Studies have noted directional hearing at frequencies as low as 0.5 to 2 kilohertz in several cetaceans, including killer whales (Richardson et al. 1995b). This ability may be useful in reducing masking at these frequencies.

Some studies indicate that low- and mid-frequency cetaceans may also alter components of their vocalizations in response to anthropogenic noise. For example, humpback whales (*Megaptera novaeangliae*) in Glacier Bay National Park, Alaska were recorded increasing the amplitude of their vocalizations by 0.8 dB for every 1 dB increase in ambient noise (mostly due to vessel noise) while also vocalizing less frequently (Fournet et al. 2018; Frankel and Gabriele 2017). Similarly, some North Atlantic right whales increased the amplitude of their vocalizations during periods of increased noise (Parks et al. 2011) and gray whales (*Eschrichtius robustus*) exhibited changes in their calling rates, call received levels, number of pulses per call, and call repetition rates, increasing their calling rate and amplitude, when different noise sources were added to the environment during a sound playback experiment off Baja California Sur, Mexico (Dahlheim and Castellote 2016). However, there may be energetic costs to producing louder and more frequent calls. 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 recorded at sites near seismic survey airgun activity decreased their call localization rate (the number of localized calls per hours 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 act to 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 (including blue whales, fin whales, and sei whales) given the lower frequencies at which they hear best and produce calls. For toothed whales (sperm whales), which 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 during the period of time the airgun arrays are producing sound for the proposed actions.

10.4.1.2 Cetaceans and Behavioral Responses

We expect the greatest response of cetaceans to airgun array sounds, in terms of number of responses and overall impact, to be in the form of changes in behavior. The ESA-listed individuals may briefly respond to underwater sound by slightly changing their behavior or relocating a short distance, in which case some of the responses can equate to harassment of individuals, but are unlikely to result in meaningful behavioral responses at the population level. 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. This has been suggested for humpback whales along the Brazilian coast because of increased seismic survey activity (Parente et al. 2007). Cetacean responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012; Harris et al. 2018). These differences are reflected in a variety of aquatic, aerial, and terrestrial animal responses to anthropogenic noise that may ultimately have fitness consequences (Costa et al. 2016; Fleishman et al. 2016; Francis and Barber 2013; New et al. 2014; NRC 2005). Although some studies are available that address responses of ESA-listed cetaceans considered in this consultation directly, additional studies to other related whales (such as bowhead whales, gray whales, and North Atlantic right whales) are relevant in determining the responses expected by species under consideration. Therefore, we consider studies from non-ESA-listed or species outside the action area.

Animals generally respond to anthropogenic perturbations as they would to predators, increasing vigilance, and altering habitat selection (Reep et al. 2011). There is increasing evidence that this predator-like response is true for animals' response to anthropogenic sound (Harris et al. 2018). Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013). Because of the similarities in hearing anatomy of terrestrial mammals and cetaceans, we expect it possible for ESA-listed cetaceans to behave in a similar manner to terrestrial mammals when they detect a sound stimulus. For additional information on the behavioral responses cetaceans exhibit in response to anthropogenic noise, including non-ESA-listed cetaceans species, see the *Federal Register* notice of the proposed IHA and request for comments and possible renewal (88 FR 17646 to 17677) as well as scientific reviews (e.g., Gomez et al. 2016; Southall et al. 2007b).

Several studies have aided in assessing the various levels 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). However, humpback whale males increasingly stopped vocal displays on Angolan breeding grounds as received seismic airgun levels increased (Cerchio 2014). Some blue whales, fin whales, and sperm whales stopped calling for short and long periods apparently in response to airguns (Bowles et al. 1994; Clark and Gagnon 2006; McDonald et al. 1995). Fin whales (presumably adult males) engaged in singing in the Mediterranean Sea moved out of the area of a seismic survey while airguns were operational as well as for at least a week thereafter (Castellote et al. 2012). The survey area affected was estimated to be about 100,000 square kilometers (29,155.3 square nautical miles; (Castellote et al. 2012). 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 or find evidence of anomalous behavior that could be directly ascribed to the use of airguns at sound levels of approximately less than 145 dB re: 1 μPa (rms; Wilcock et al. 2014). Blue whales may also attempt to compensate for elevated ambient sound by calling more frequently during seismic surveys (Iorio and Clark 2009). Bowhead whale calling rates were found to decrease during migration in the Beaufort Sea when seismic surveys were being conducted (Nations et al. 2009). Calling rates decreased when exposed to seismic airguns at estimated received levels of 116 to 129 dB re: 1 μPa (rms), but did not change at received levels of 99 to 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-second over the course of 10 minutes (Blackwell et al. 2015). Once sound levels exceeded approximately 127 dB re: 1 μPa^2-second over 10 minutes, call rates began to decline and at approximately 160 dB re: 1 μPa^2-second over 10 minutes, bowhead whales appeared to cease calling altogether (Blackwell et al. 2015).

While we are aware of no data documenting changes in North Atlantic right whale vocalization associated with seismic surveys, as mentioned previously, they shift calling frequencies and increase call amplitude over both the long- and short-term due to chronic exposure to vessel sound (Parks 2009; Parks and Clark 2007; Parks et al. 2007; Parks et al. 2011; Parks et al. 2012; Tennessen and Parks 2016). Sperm whales, at least under some conditions, may be particularly sensitive to airgun sounds, as they have been documented to cease calling in association with airguns being fired hundreds of kilometers away (Bowles et al. 1994). Other studies have found no response by sperm whales to received airgun sound levels up to 146 dB re: 1 μPa (peak-to-peak; Madsen et al. 2002a; McCall Howard 1999). For the species considered in this consultation, some exposed individuals may cease calling or otherwise alter their vocal behavior in response to the R/V *Marcus G. Langseth*'s airgun array during the seismic survey activities. The effect is expected to be temporary and brief given the research vessel 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 *Marcus G. Langseth*'s airgun array once the acoustic stressor has diminished.

There are numerous studies of the responses of some baleen whales to airgun arrays. Responses to lower-amplitude sounds are known; most studies seem to support a threshold of approximately 160 dB re: 1 μPa (rms), the level used in this consultation to determine the extent of acoustic effects for cetaceans, as the received sound level to cause behavioral responses other than vocalization changes (Richardson et al. 1995b). Activity of individuals at the time of exposure seems to influence response (Robertson et al. 2013) because feeding individuals respond less than mother and calf pairs and migrating individuals (Harris et al. 2007; Malme and Miles 1985; Malme et al. 1984a; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995a; Richardson et al. 1995b; Richardson et al. 1999). Migrating bowhead whales show strong avoidance reactions to received sound levels from 120 to 130 dB re: 1 μPa (rms) at distances of 20 to 30 kilometers (10.8 to 16.2 nautical miles), but only changed dive and respiratory patterns while feeding. These animals showed avoidance at higher received sound levels (152 to 178 dB re: one μPa [rms]; Harris et al. 2007; Ljungblad et al. 1988; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995a; Richardson et al. 1995b; Richardson et al. 1999; Richardson et al. 1986a; Richardson et al. 1986b). Nations et al. (2009) also found that bowhead whales were displaced during migration in the Beaufort Sea during active seismic surveys. In fact, as mentioned previously, the available data indicate that most, if not all, baleen whale species exhibit avoidance of active seismic airguns (Barkaszi et al. 2012; Castellote et al. 2012; Gordon et al. 2003; NAS 2017; Potter et al. 2007; Southall et al. 2007a; 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 re-occupy within a day (Richardson et al. 1986b). We do not know whether the individuals exposed in these ensonified areas are the same as those returning or whether they tolerate repeat exposures, but they may still experience a stress response. However, we expect the presence of the PSOs and the shutdown that will occur if a cetacean is present in the shutdown zone will lower the likelihood that cetaceans may be exposed to sounds from the airgun array.

Gray whales respond similarly to seismic surveys as described for bowhead whales. Gray whales discontinued feeding and/or moved away at received sound levels of 163 dB re: 1 μPa (rms) (Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007a; Malme and Miles 1985; Malme et al. 1984a; Malme et al. 1987; Malme et al. 1986; Meier et al. 2007; Würsig et al. 1999; Yazvenko et al. 2007). Migrating gray whales began to show changes in swimming patterns at approximately 160 dB re: 1 μPa (rms) and slight behavioral changes at 140 to 160 re: 1 μPa (rms; Malme and Miles 1985; Malme et al. 1984a). As with bowhead whales, habitat continues to be used despite frequent seismic survey activity and long-term effects have not been identified, if they are present at all (Malme et al. 1984b). Johnson et al. (2007b) reported that gray whales exposed to airgun sounds during seismic surveys off Sakhalin Island, Russia, did not experience any biologically significant or population-level effects, based on research in the area from 2002 through 2005. Furthermore, when conservation measures, such as those proposed by the NMFS Permits Division, are taken to avoid conducting seismic surveys during times of the year when most gray whales are expected to be present and to closely monitor operations, gray whales may not exhibit any noticeable behavioral responses to seismic survey activities (Gailey et al. 2016). Given the similar conservation measures that will be implemented for the proposed actions, we expect some of the ESA-listed cetacean species considered in this consultation will respond in a similar manner as gray whales.

Humpback whales exhibit a pattern of lower threshold responses when not occupied with feeding. Migrating humpbacks altered their travel path (at least locally) along Western Australia at received sound levels as low as 140 dB re: 1 μPa (rms) when females with calves were present, or 7 to 12 kilometers (3.8 to 6.5 nautical miles) from the acoustic source (McCauley et al. 2000b; McCauley et al. 1998). A startle response occurred as low as 112 dB re: 1 μPa (rms). Closest approaches were generally limited to 3 to 4 kilometers (1.6 to 2.2 nautical miles), although some individuals (mainly males) approached to within 100 meters (328.1 feet) on occasion where sound levels were 179 dB re: 1 μPa (rms). Changes in course and speed generally occurred at estimated received levels of 157 to 164 dB re: 1 μPa (rms). Similarly, on the east coast of Australia, migrating humpback whales appear to avoid seismic airguns at distances of 3 kilometers (1.6 nautical miles) at levels of 140 dB re: 1 μPa^2-second. A recent study examining the response of migrating humpback whales to a full 51,291.5 cubic centimeter (3,130 cubic inch) airgun array found that humpback whales exhibited no abnormal behaviors in response to the active airgun array. While there were detectible 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). Some humpback whales were also found to reduce their speed and change course along their migratory route. Overall, these results suggest that the behavioral responses exhibited by humpback whales are unlikely to have significant biological consequences for fitness (Dunlop et al. 2017). Dunlop et al. (2020) also observed a decrease in the probability of a humpback whale group joining with another individual singer at 125 to 150 dB re: 1 µPa^2-second, although this was not statistically significant. Feeding humpback whales appear to be somewhat more tolerant. Humpback whales off the coast of Alaska, in response to various underwater sound sources, exhibited a startle response at 150 to 169 dB re: 1 µPa (rms); however, no clear evidence of avoidance was apparent at received sound levels up to 172 dB re: 1 µPa (rms; Malme et al. 1984a; Malme et al. 1985). Potter et al. (2007) found that humpback whales on feeding grounds in the Atlantic Ocean did exhibit localized avoidance of airgun arrays. Among humpback whales on Angolan breeding grounds, no clear difference was observed in encounter rate or point of closest approach during seismic versus non-seismic periods (Weir 2008).

Observational data are sparse for specific baleen whale life histories (breeding and feeding grounds) in response to airguns. Available data support a general avoidance response. Some fin whale 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 have found at least small differences in sighting rates (lower during seismic survey activities), as well as whales being more distant during seismic survey activities (Moulton and Miller 2005b). When spotted at the average sighting distance, individuals have likely been exposed to approximately 169 dB re: 1 µPa (rms; Moulton and Miller 2005a).

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. 2006; Miller et al. 2009; Moulton and Miller 2005b; Stone 2003; Stone et al. 2017; Stone and Tasker 2006; Weir 2008). Detailed study of sperm whales in the Gulf of Mexico suggests some alteration in foraging from less than 130 to 162 dB re: 1 µPa peak-to-peak, although other behavioral reactions were not noted by several authors (Gordon et al. 2006; Gordon et al. 2004; Jochens et al. 2006; Madsen et al. 2006; Winsor and Mate 2006). This has been contradicted by other studies, which found avoidance reactions by sperm whales in the Gulf of Mexico in response to seismic ensonification (Jochens and Biggs 2004; Jochens 2003; Mate et al. 1994).

Johnson and Miller (2002) noted possible avoidance at received sound levels of 137 dB re: 1 µPa. Other anthropogenic sounds, such as pingers and sonars, disrupt behavior and vocal patterns (Goold 1999; Watkins et al. 1985; Watkins and Schevill 1975). Miller et al. (2009) found sperm whales to be generally unresponsive to airgun exposure in the Gulf of Mexico, although foraging behavior may have been affected based on changes in echolocation rate and slight changes in dive behavior. Displacement from the area was not observed.

Winsor and Mate (2013) did not find a non-random distribution of satellite-tagged sperm whales at and beyond 5 kilometers (2.7 nautical miles) from airgun arrays, suggesting individuals were not displaced and did not move away from the airgun array at and beyond these distances in the Gulf of Mexico. However, no tagged whales within 5 kilometers (2.7 nautical miles) were available to assess potential displacement within 5 kilometers (2.7 nautical miles; 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 kilometers (27 nautical miles). The lack of response by this species may, in part, be due to its higher range of hearing sensitivity and the low-frequency (generally less than 200 Hertz) pulses produced by seismic airguns (Richardson et al. 1995b). Sperm whales are exposed to considerable energy above 500 Hertz during the course of seismic surveys (Goold and Fish 1998), so, even though this species generally hears at higher frequencies, this does not mean that it cannot hear airgun sounds. Breitzke et al. (2008) found that source levels were approximately 30 dB re: 1 µPa lower at 1 kilohertz and 60 dB re: 1 µPa lower at 80 kilohertz 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 sometimes are extremely tolerant of noise pulses (NMFS 2010d).

In summary, ESA-listed cetaceans are expected to exhibit a wide range of behavioral responses when exposed to sound fields from the airgun array. Baleen whales (blue whales, fin whales, and sei whales) are expected to mostly exhibit avoidance behavior, and may alter their vocalizations. Toothed whales (sperm whales) are expected to exhibit less overt behavioral changes, but may alter foraging behavior, including echolocation vocalizations. While exposure to the airgun array may be temporary, normal behavioral patterns of ESA-listed cetaceans (blue whales, fin whales, sei whales, and sperm whales) can be disrupted.

Cetaceans and Physical or Physiological Effects

Individual whales exposed to airguns (as well as other sound sources) could experience effects that are not readily observable, such as stress (Romano et al. 2002), that may have adverse effects. Other possible responses to impulsive sound sources like airgun arrays include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox et al. 2006; Southall et al. 2007b; Tal et al. 2015; Zimmer and Tyack 2007), but, similar to stress, these effects are not readily observable. Importantly, these more severe physical and physiological responses have been associated with explosives and/or mid-frequency tactical sonar, but not seismic airguns. Therefore, we do not expect ESA-listed cetaceans to experience any of these more severe physical and physiological responses because of the seismic survey activities.

Stress is an adaptive response and does not normally place an animal at risk. 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; the liberation of glucose into the bloodstream; 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. (2004) found beluga whales and bottlenose dolphins exposed to a seismic watergun (up to 228 dB re: 1 μPa at 1 meter 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 as a primary way to gather information about their environment, we assume that limiting these abilities, as is the case when masking occurs, will be stressful. We also assume that some individuals exposed at sound levels above the ESA harassment 160 dB re: 1 μPa (rms) threshold will experience a stress response, which may also be associated with an overt behavioral response. However, because, in all cases, exposure to sounds from the airgun array are expected to be temporary, we expect stress responses to be short-term. Given the available data, animals will be expected to return to baseline state (e.g., baseline cortisol level) within hours to days, with the duration of the stress response depending 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.

Data specific to cetaceans are not readily available to access other non-auditory physical and physiological responses to sound. However, based on studies of other vertebrates, exposure to loud sound may also adversely affect reproductive and metabolic physiology (reviewed in Kight and Swaddle 2011). Premature birth and indicators of developmental instability (possibly due to disruptions in calcium regulation) have been found in embryonic and neonatal rats exposed to loud sound. Studies of rats have shown that their small intestine leaks additional cellular fluid during loud sound exposure, potentially exposing individuals to a higher risk of infection (reflected by increases in regional immune response in experimental animals). In addition, exposure to 12 hours of loud sound may alter cardiac tissue in rats. In a variety of response categories, including behavioral and physiological responses, female animals appear to be more sensitive or respond more strongly than males. It is noteworthy that, although various exposures to loud sound appear to have adverse results, exposure to music largely appears to result in beneficial effects in diverse taxa. Clearly, the impacts of even loud sounds are complex and not universally negative (Kight and Swaddle 2011). Given the available data, and the short duration of exposure to sounds generated by airgun arrays, we do not anticipate any effects to the reproductive and metabolic physiology of ESA-listed marine mammals exposed to these sounds.

It is possible that an animal's prior exposure to sounds from seismic surveys influences its future response. We have little information as to what response individuals will have to future exposures to sources from seismic surveys compared to prior experience. If prior exposure produces a learned response, then subsequent response to exposure of an individual will likely be similar to or less than prior responses to novel stimuli and behavioral responses will occur as a consequence (such as moving away and reduced time budget for activities otherwise undertaken; 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 sensitization 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 (see Exposure Analysis, section 10.3). Additionally, the proposed actions will take place over approximately 61 days (spread between 2 operational legs); minimizing the likelihood that sensitization will occur. As stated before, we believe that exposed individuals will move away from the sound source, especially in the open ocean of the action area, where we expect species to be transiting through.

Marine Mammals and 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 2007a). In September 2002, 2 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 (139,126.2 cubic centimeters [8,490 cubic inches]) 22 kilometers (11.9 nautical miles) 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 1 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. 2004). 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 cetaceans to strand because of the high-energy seismic survey. The high-energy seismic survey would take place in the Northwest Atlantic Ocean off the Blake Plateau and Carolina Trough, and the closest approach to the coastline will be 90 kilometers (48.6 nautical miles). If exposed to seismic survey activities, we expect ESA-listed cetaceans 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 Northwest Atlantic Ocean with no documented strandings.

10.4.2 Acoustic Thresholds for Sea Turtles

Like cetaceans, if exposed to loud sounds sea turtles may experience ESA harm and/or harrassment. 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. 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 1 day.

As with marine mammals, we assume that sea turtles will not move towards a sound source that causes them stress or discomfort. Some experimental data suggest sea turtles may avoid seismic sound sources (McCauley et al. 2000b; 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). For this reason, conservation measures will be implemented to limit sea turtle exposures to 150 meters (492.1 feet) or more from the sound source. In most cases, we expect sea turtles will move away from sounds produced by the airgun array. Although data on the precise sound levels that can result in TTS or PTS are lacking for sea turtles and the effectiveness of conservation measures is not fully understood, we do not expect the vast majority of sea turtles present in the action area to be exposed to sound levels that will result in TTS. However, it could occur for a few individuals but the probability of occurrence will be extremely low. For those individuals that will experience TTS, the available data suggest hearing will return to normal within days of the exposure (Moein et al. 1994).

10.4.3 Potential Responses of Sea Turtles to Acoustic Sources

10.4.3.1 Sea Turtles and Behavioral Responses

As with ESA-listed marine mammals, it is likely that sea turtles will experience behavioral responses in the form of avoidance. We do not have much specific information on how sea turtles will respond, but we present the available information. Behavioral responses to human activity have been investigated for green and loggerhead (McCauley et al. 2000a; 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. (2000a) 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 were observed exhibiting avoidance behavior, 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). 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 meters (32.8 feet) with minor behavioral responses (Holst et al. 2006; Holst and Smultea 2008a; Holst et al. 2005c; NMFS 2006a; NMFS 2006h; Smultea et al. 2005).

Observational evidence suggests that sea turtles are not as sensitive to sound as are 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 in order to avoid the active airgun array. As such, we expect temporary displacement of exposed individuals from some portions of the action area during the seismic survey.

10.4.3.2 Sea Turtles and Physical or 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 a prey response (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 with 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.

10.4.4 Potential Responses of Marine Mammal and Sea Turtle Prey to Acoustic Sources

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 includes fishes, zooplankton, cephalopods, and other invertebrates such as crustaceans, molluscs, and jellyfish. Studies described herein provide extensive support for this, which is the basis for later discussion on implications for ESA-listed marine mammals and sea turtles. 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. Until more information specific to prey of the ESA-listed species considered in this opinion is available, we expect that prey (e.g., teleosts, zooplankton, cephalopods) of ESA-listed marine mammals and sea turtles considered in this consultation will react in manners similar to those fish and invertebrates described herein.

As for marine mammals and sea turtles, it is possible that seismic surveys can 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. Current data indicate that possible physical and physiological responses include hearing threshold shifts, barotraumatic ruptures, stress responses, organ damage, and/or mortality. For invertebrates, research is more limited, but the available data suggest that exposure to seismic survey activities can result in anatomical damage and mortality, in some cases. In crustaceans and bivalves, there are mixed results with some studies suggesting that seismic surveys do not result in meaningful physiological and/or physical effects, while others indicate such effects may be possible under certain circumstances. Furthermore, even within studies there may be differing results depending on what aspect of physiology one examines (e.g., Fitzgibbon et al. 2017). In some cases, the discrepancies likely relate to differences in the contexts of the studies. For example, in a relatively uncontrolled field study, Parry et al. (2002) did not find significant differences in mortality between oysters that were exposed to a full seismic airgun array and those that were not. A recent study by Day et al. (2017) in a more controlled setting did find significant differences in mortality between scallops exposed to a single airgun and a control group that received no exposure. However, the increased mortality documented by Day et al. (2017) was not significantly different from the expected natural mortality. All available data on echinoderms suggests they exhibit no physical or physiological response to exposure to seismic survey activities. Based on the available data, we assume that some fishes and invertebrates that serve as 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.

The prey of ESA-listed marine mammals and sea turtles may also exhibit behavioral responses if exposed to active seismic airgun arrays. Based on the available data, as reviewed by Carroll et al. (2017), considerable variation exists in how fishes behaviorally respond to seismic 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. Similarly, data on the behavioral response of invertebrates suggests 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. As with marine mammals, behavioral responses by fishes and invertebrates may also be associated with a stress response.

There has been research suggesting that that seismic airgun arrays may lead to a significant reduction in zooplankton, including copepods. McCauley et al. (2017) found that the use of a single airgun (approximately 2,458.1 cubic centimeters [150 cubic inches]) led to a decrease in zooplankton abundance of over 50 percent and a two- to three-fold increase in dead adult and larval zooplankton when compared to control scenarios. Effects were observed out to 1.2 kilometers (0.6 nautical miles), the maximum distance to which sonar equipment used in the study was able to detect changes in abundance. McCauley et al. (2017) noted that, for seismic survey activities to have a significant impact on zooplankton at an ecological scale, the spatial or temporal scale of the seismic activity must be large in comparison to the ecosystem in question. In particular, three-dimensional seismic surveys, which involve the use of multiple overlapping tracklines to survey a particular area, are of concern (McCauley et al. 2017). This is, in part, because, in order for such activities to have a measurable effect, they need to outweigh the naturally fast turnover rate of zooplankton (McCauley et al. 2017).

Fields et al. (2019a) demonstrated different results through a series of control experiments using seismic shots from 2 airguns (4,260.6 cubic centimeters [260 cubic inches]) in 2009 and 2010 on *Calanus finmarchicus*. Their data show that seismic blasts have limited effects on the mortality or escape response of *C. finmarchicus* within 10 meters (32.8 feet) of the seismic airguns, but there was no measurable impact at greater distances. The study also found significantly higher immediate mortality at distances greater than 5 meters (16.4 feet) from the airgun and a higher cumulative mortality (7 days after exposure) at a distance somewhere between 10 to 20 meters (32.8 to 65.6 feet) from the airgun, and observed no sublethal effects, but did see changes in gene expression (Fields et al. 2019a). Furthermore, Fields et al. (2019a) demonstrated that shots from seismic airguns had no effect on the escape response of *C. finmarchicus*. They concluded that the effects of shots from seismic airguns are much less than reported by McCauley et al. (2017).

Given the results from each of these studies, it is difficult to assess the effects seismic airgun arrays may have on the instantaneous or long-term survivability of zooplankton/krill that are exposed. The energy of the seismic survey activities (54,077.3 cubic centimeters [3,300 cubic inches] versus 2,458.1 or 4,260.6 cubic centimeters [150 or 260 cubic inches]) proposed in this consultation suggests that any copepod or crustacean directly exposed to the seismic airgun array (underneath or within 5 meters [16.4 feet] would likely suffer less mortality than described by McCauley et al. (2017).

Additionally, the majority of copepod prey available to baleen whales or fishes that are prey to these marine mammals are expected to be near the water's surface (Witherington et al. 2012). Results from McCauley et al. (2017) provide little information on the effects to copepods at the water surface because their analyses excluded zooplankton at the surface bubble layer. We expect that sounds from the airgun array will affect copepod prey within the action area less than that reported in McCauley et al. (2017) because the airguns will primarily transmit sound downward and will be towed at depths of 6 meters (19.7 feet) so sounds will be relatively low at the water surface where most copepods and crustaceans occur. The proposed actions will take place over a broad spatial area and will last for 61 days. Thus, we do not believe the spatial or temporal scale of the high-energy seismic survey is large in relation to the marine environment off the U.S. East Coast. While the high-energy seismic survey may temporarily alter copepod or crustacean abundance in the action area, we expect such effects to be insignificant because most copepods will be near the water surface where the sound from airgun arrays is expected to be relatively low and the high turnover rate of zooplankton and ocean circulation will minimize any effects.

Fish or invertebrate mortality 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. 2000b; 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 exhibited startle, displacement, and/or grouping responses upon exposure to airguns. This effect generally persisted for several minutes, although subsequent exposures of the same individuals did not necessarily elicit a response (Fewtrell 2013a). In addition, Davidsen et al. (2019) performed controlled exposure experiments on Atlantic cod (*Gadus morhua*) and saithe (*Pollachius virens*) to test their response to airgun noise. Davidsen et al. (2019) noted that 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 change 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 or some other signal that induces them to leave the area, they are capable of moving away from the sound source (e.g., airgun array) if it causes them discomfort and will return to the area and be available as prey for marine mammals and sea turtles.

There are reports showing sub-lethal effects to some fish species from airgun arrays. Several species at various life stages have been exposed to high-intensity sound sources (220 to 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-second, but pike did show 10 to 15 dB of hearing loss with recovery within 1 day (Popper et al. 2005). Caged pink snapper (*Pelates* spp.) have experienced PTS when exposed over 600 times to received sound levels of 165 to 209 dB re: 1 μPa peak-to-peak. Exposure to airguns at close range was found to produce balance issues in exposed fry (Dalen and Knutsen 1986). Exposure of monkfish (*Lophius* spp.) and capelin (*Mallotus villosus*) 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 to 60 minutes after firing of the airgun ceased. A downward shift was also noted by Skalski et al. (1992) at received seismic sounds of 186 to 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 3 days (Skalski 1992). These fish also showed a startle response when the seismic survey vessel was as much as 2.5 kilometers (1.3 nautical miles) away; this response increased in severity as the vessel approached and sound levels increased, but returned to normal after about 2 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 1 hour and returned to normal depth (sound environments of 185 to 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; 2000b) 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 to 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 to 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 to 50 meters (65.6 to 164 feet) 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 to 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 to 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). Bass did not appear to vacate during a shallow-water seismic survey with received sound levels of 163 to 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 to 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 are important prey for sperm whales and some sea turtle species. Squid responses to operating airguns have also been studied, although to a lesser extent than fishes. In response to airgun exposure, squid exhibited both startle and avoidance responses at received 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. 2000b; McCauley et al. 2000c). The authors also noted some movement upward. During ramp-up, squid did not discharge ink but alarm responses occurred when received sound levels reached 156 to 161 dB re: 1 µPa (rms). Tenera Environmental (2011) reported that Norris and Mohl (1983, summarized in Mariyasu et al. 2004) observed lethal effects in squid (*Loligo vulgaris*) at levels of 246 to 252 dB after 3 to 11 minutes. Andre et al. (2011) exposed 4 cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*) to 2 hours of continuous sound from 50 to 400 Hertz 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. Another laboratory observed abnormalities in larval scallops after exposure to low frequency noise in tanks (de Soto et al. 2013). Lobsters did not exhibit delayed mortality, or apparent damage to mechanobalancing systems up to 8 months post-exposure to airguns fired at 202 or 227 dB peak-to-peak pressure (Christian 2013; Payne et al. 2013). However, feeding did increase for up to a month after exposure to the airguns (Christian 2013; Payne et al. 2013).

The overall response of fishes and squids is to exhibit startle responses and undergo vertical and horizontal movements away from the sound field. Although some ESA-listed baleen whales (e.g., fin whales and sei whales) consume fish regularly, we expect that any disruption to their prey will be temporary. We are not aware of any studies regarding sound effects on and the detection ability of other invertebrates such as krill (*Euphausiacea* spp.), the primary prey of most ESA-listed baleen whales. However, we do not expect krill to experience effects from airgun noise. Therefore, we do not expect any adverse effects from lack of prey availability in localized areas to baleen whales (i.e., blue whales, fin whales, and sei whales). 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 squids 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. 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, both marine mammals and their prey will re-distribute back into the action area once seismic survey activities have passed or concluded.

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. However, we do not expect this to have a meaningful impact on ESA-listed marine mammals and sea turtles. 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.

10.5 Summary of Effects

In this section, we assess the consequences of the responses of the individuals that have been exposed, the populations those individuals represent, and the species those populations comprise.

We expect up to 2 blue whales, 4 fin whales, 30 sei whales, and 709 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. We expect up to 116 North Atlantic DPS of green turtles, 2 Kemp's ridley turtles, 8 leatherback turtles, and 234 Northwest Atlantic Ocean DPS of loggerhead turtles, to be exposed to the airgun array within 175 dB re: 1 µPa (rms) ensonified areas during the seismic survey activities and exhibit responses in the form of ESA behavioral harassment.

Because of the requirements in the NMFS Permits Division's proposed IHA, and the nature of the seismic survey activities (high-energy airgun array), as described above, we do not expect any injury 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 in the form of TTS, to the exposed marine mammals (blue whale, fin whale, sei whale, and sperm whale). 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 of loggerhead turtle). Harassment is not expected to have more than short-term effects on individual ESA-listed marine mammal and sea turtle species (blue whale, fin whale, sei whale, and sperm whale; North Atlantic DPS of green turtle, Kemp's ridley turtle, leatherback turtle, and Northwest Atlantic Ocean DPS of loggerhead turtle).Because of the large 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.

The estimates of the number of individuals exhibiting measureable behavioral responses are considered conservative (i.e., they are likely higher than what the actual exposures would be and a lower number are likely to be harassed given the conservation measures that will be implemented). We do not expect the effects of ESA harassment of these individuals, which will be temporary, will have population-level effects.

11 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 C.F.R. §402.02). Future Federal actions that are unrelated to the proposed actions are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

We expect that those aspects described in the Environmental Baseline (Section 9) will continue to impact ESA-listed resources into the foreseeable future. We expect climate change, vessel interactions (vessel strikes and whale watching), fisheries (fisheries interactions), pollution (marine debris, pollutants and contaminants, and hydrocarbons), aquatic nuisance species, disease/parasites, liquefied natural gas facilities, anthropogenic sound (vessel sound and commercial shipping, aircraft, seismic surveys, offshore energy development, marine construction, active sonar, and military activities), and scientific research activities to continue into the future for ESA-listed cetaceans and sea turtles. Many of these activities will require ESA consultation because they have a Federal nexus and are not part of our consideration of cumulative effects for this reason.

Because of recent trends and based on available information, we expect the amount and frequency of vessel activity to persist in the action area, and that ESA-listed cetaceans and sea turtles will continue to be affected. Different aspects of vessel activity can affect ESA-listed species, such as vessel noise, disturbance, and the risk of vessel strike causing injury or mortality to cetacean, especially large whales. However, movement towards bycatch reduction and greater foreign protections are generally occurring throughout the Northwest Atlantic Ocean off the Georgia, South Carolina, and Florida that may aid in abating the downward trajectory of some populations due to activities such as fishing in the action area.

During this consultation, we searched for information on future state, tribal, local or private (non-Federal) actions that were reasonably certain to occur in the action area. We conducted electronic searches of *Google* and other electronic search engines for other potential future state or private activities that are likely to occur in the action area. We are not aware of any state, tribal, or private activities that are likely to occur in the action area during the foreseeable future that were not considered in the Environmental Baseline of this consultation. Potential non-Federal or private actions reasonably certain to occur within the action area include scientific research activities and liquefied natural gas facilities.

The best scientific and commercial data available provide little specific information on any long-term effects of these potential sources of disturbance on ESA-listed cetaceans and sea turtles. Thus, this consultation assumed effects in the future would be similar to those in the past and are reflected in the anticipated trends described in the Status of the Species Likely to be Adversely Affected and Environmental Baseline, respectively.

12 Integration and Synthesis

The Integration and Synthesis is the final step in our assessment of the risk posed to species and their designated critical habitat because of implementing the proposed actions. In this section, we add the Effects of the Action (Section 10) to the Environmental Baseline (Section 9) and the Cumulative Effects (Section 11) to formulate the agency's biological opinion as to whether the proposed actions are likely to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing its numbers, reproduction, or distribution. This assessment is made in full consideration of the Status of the Species Likely to be Adversely Affected (Section 8).

The following discussions separately summarize the probable risks the proposed actions pose to threatened and endangered species that are likely to be adversely affected as a consequence of exposure to the stressors associated with the seismic survey activities, specifically the sound from the use of the airgun array. These summaries integrate the exposure profiles presented previously with the results of our response analyses.

12.1 Jeopardy Analysis

The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02). Therefore, the jeopardy analysis considers both the survival and recovery of the species.

Based on our effects analysis, adverse effects to ESA-listed species are likely to result from the proposed actions. The following discussions summarize the probable risks that seismic survey activities and the associated MMPA authorization of harassment of marine mammals as a result of these activities pose to ESA-listed species over the 61 days of the high-energy seismic survey. These summaries integrate our exposure and response analyses from the Effects of the Actions (Section 10).

12.1.1 Blue Whale

Adult, juvenile, and calf blue whales are present in the action area and may be exposed and respond to noise from the seismic survey activities.

The blue whale is endangered because of past commercial whaling. In the North Atlantic Ocean, at least 11,000 blue whales were harvested from the late 19th to mid-20th centuries. In the North Pacific Ocean, at least 9,500 blue whales were killed between 1910 and 1965. In the Southern Hemisphere, it is estimated that about 360,000 blue whales were killed in the last century, reducing the population of Antarctic blue whales from 239,000 individuals (95 percent CI = 202,000 to 311,000 individuals) in 1904 to just 360 individuals (95 percent CI = 150 to 840 individuals) in the early 1970's. Currently, the Antarctic blue whale population estimate is 2,280 individuals (CV=0.36; NMFS 2020b). 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 climate change and ecosystem change.

The global, pre-exploitation population size estimate for blue whales is approximately 181,200 (IWC 2007b). Current estimates indicate approximately 5,000 to 12,000 blue whales globally (IWC 2007b). Blue whales are separated into ocean basin populations for the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere. In U.S. waters, NMFS recognizes 3 stocks: the eastern North Pacific Ocean, central North Pacific Ocean, and western North Atlantic Ocean. The blue whale is listed as endangered under the ESA throughout its range, but the mostly likely stock to be in the action area is the western North Atlantic stock. Blue whale abundance for the eastern North Pacific stock is estimated at 1,898 individuals (lower [N_{min}] and upper 20th percentile: 1,767 to 2,038 individuals; Calambokidis and Barlow 2020). Abundance estimates for the central North Pacific stock (around the Hawaiian Islands) is 137 individuals (95 percent CI=23 to 796 individuals; Bradford et al. 2021). 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 (Nmin= 402 individuals; Hayes et al. 2020). In the Southern Hemisphere, the abundance estimate for Antarctic blue whales is 2,280 individuals based on surveys from 1991/1992 through 2003/2004 (95 percent CI = 1, 160–4,500 individuals; Branch 2007). While no range-wide estimate for pygmy blue whales exists (Thomas et al. 2016), the latest estimate for pygmy blue whales off the west coast of Australia is 662 to 1,559 individuals based on PAM (McCauley and Jenner 2010) or 712 to 1,754 individuals based on photographic mark-recapture (Jenner 2008). The abundance estimate for pygmy blue whales off New Zealand based on a closed capture-recapture model is 718 individuals (95 percent CI = 279–1,926 individuals; Barlow et al. 2018). There are no current abundance estimates for the Chilean (unnamed subspecies) blue whale across its entire range; however, based on line transect surveys conducted off central Chile December 1997 through January 1998, estimated abundance is 303 individuals (95 percent CI=176 to 625 individuals; Williams et al. 2011). Estimated abundance based on capture-recapture for central and southern Chile from 2004 through 2011 is between 570 to 760 individuals (95 percent CI for right and left flank photographs: 475 to 705 individuals and 638 to 933 individuals, respectively; Galletti Vernazzani et al. 2017).

Current estimates indicate the Eastern North Pacific stock shows no signs of population growth since the early 1990s, perhaps because the population is nearly at carrying capacity (Carretta et al. 2018). An overall population growth rate for the species or growth rates for the 2 other individual U.S. stocks (central North Pacific Ocean and western North Atlantic Ocean) are not available at this time. In the Southern Hemisphere, it is estimated that whaling reduced the population from 239,000 individuals (95 percent CI = 202,000 to 311,000 individuals) in 1904 to just 360 individuals (95 percent CI = 150 to 840 individuals) in the early 1970's. Currently, the Antarctic population appears to be increasing at a rate of 8.2 percent per year (95 percent CI 1.6 to 14.8 percent; Branch 2007). Population trends are largely unknown for the pygmy blue whale, though it is estimated that the current population represents less than 23 percent of the historical pre-whaling population (NMFS 2020b).

No reduction in the distribution of blue whales in the Blake Plateau and Carolina Trough or changes to the geographic range of the species is expected because of the NSF and L-DEO's seismic survey activities and the NMFS Permits Division's issuance of an IHA.

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 2 individuals, which could be adults, juveniles, and/or calves, is expected because of the seismic survey activities. We anticipate ESA behavioral harassment, which will include 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. We do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of blue whales due to the seismic survey activities and the NMFS Permits Division's issuance of an IHA, a reduction in the species' likelihood of survival is not expected.

The 2020 Recovery Plan for the blue whale (NMFS 2020b) 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 because of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division's issuance of an IHA 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.

12.1.2 Fin Whale

Adult, juvenile, and calf fin whales are present in the action area and may be exposed and respond to noise from the seismic survey activities.

The fin whale is endangered because of past commercial whaling. Prior to commercial whaling, hundreds of thousands of fin whales existed. The pre-exploitation estimate for the fin whale population in the North Pacific Ocean was 42,000 to 45,000 (Ohsumi and Wada 1974). In the North Atlantic Ocean, at least 55,000 fin whales were killed between 1910 and 1989. Approximately 704,000 fin whales were killed in the Southern Hemisphere from 1904 through 1975. Fin whales may be killed under "aboriginal subsistence whaling" in Greenland, under Japan's commercial whaling program, and Iceland's formal objection to the IWC's ban on commercial whaling. Additional threats include vessel strikes, reduced prey availability due to overfishing or climate change, and anthropogenic sound. The species' overall large population size may provide some resilience to current threats, but trends are largely unknown.

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 4 stocks: Western North Atlantic, Northeast Pacific, California/Oregon/Washington, and Hawaii. The fin whale is listed as endangered under the ESA throughout its range, but the stock mostly likely to be present in the action area is the Western North Atlantic stock. The current population abundance estimate for the Western North Atlantic stock is 6,802 individuals (CV = 0.24), and N_{min} = 5,573 individuals (Hayes et al. 2022). While there are no reliable estimates of abundance (current or historical) for the entire Northeast Pacific stock, studies have estimated abundance for specific surveyed areas: eastern Bering Sea (in 2002: 419 individuals [CV = 0.33]; in 2008: 1,368 individuals [CV = 0.34]; in 2010: 1,061 individuals [CV = 0.38]); western Alaska and the eastern and central Aleutian Islands (between 2001 and 2003: 1,652 individuals (95 percent CI = 1,142 to 2,389 individuals); offshore waters of the Gulf of Alaska (in 2013: 3,168 individuals [CV = 0.26] and in 2015: 916 individuals [CV = 0.39]). The minimum population estimate for the Northeast Pacific stock is 2,554 individuals (Muto et al. 2021). For the California/Oregon/Washington and Hawaii stocks, the current population estimate is 11,065 individuals (CV = 0.405) in 2018 (N_{min} = 7,970 individuals) and 203 individuals (CV = 0.99) in 2017 (N_{min} = 101 individuals), respectively (Carretta et al. 2022). Abundance data for the Southern Hemisphere stock are limited; however, there were assumed to be somewhat more than 15,000 in 1983 (Thomas et al. 2016). The most current population estimate for fin whales in the Antarctic south of 60 degrees South is 5,445 individuals (95 percent CI = 2,000 to 14,500 individuals) between 1991 and 2004 (Leaper and Miller 2011). The International Whaling Commission (IWC) also recognizes the China Sea stock of fin whales, found in the Northwest Pacific Ocean, which currently lacks an abundance estimate (Reilly et al. 2013). For apparent resident populations (Mediterranean Sea and East China Sea), population estimates for the western Mediterranean, Corsican-Ligurian-Provençal Basin, and Pelagos Sanctuary are 3,583 individuals (95 percent CI = 2,130 to 6,027 individuals) in 1991, 901 individuals (95 percent CI = 591 to 1,374 individuals) in 1992, and 539 individuals (95 percent CI = 345 to 732 individuals), respectively (NMFS 2019).

Population trends for the Western North Atlantic, Hawaii, Southern Hemisphere, Mediterranean, and East China Sea stocks are not currently available. For the Northeast Pacific stock, there was an increasing trend by 4.8 percent (95 percent CI = 4.1 to 5.4 percent) between 1987 and 2003 (Carretta et al. 2022). For the

California/Oregon/Washington stock, there is strong evidence that population abundance is increasing; from 1991 through 2014, abundance increased 7.5 percent annually (Nadeem et al. 2016), though it is unknown how much of that rate could be attributed to immigration rather than birth and death processes (Carretta 2019). An overall population trend in U.S. Pacific Ocean waters has not been established, but there is evidence that there has been increasing rates in the recent past in different parts of the region. Overall population growth rates and total abundance estimates for the Hawaii stock, China Sea stock, western North Atlantic stock, and Southern Hemisphere fin whales are not available at this time.

No reduction in the distribution of fin whales from the Northwest Atlantic Ocean in the Blake Plateau and Carolina Trough 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 Division's issuance of an IHA.

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 individuals, which could be adults, juveniles, and/or calves, is expected because of the seismic survey activities. We anticipate ESA behavioral harassment, which will include 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. We do not anticipate any delay in reproduction as a result. 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 Division's issuance of an IHA, a reduction in the species' likelihood of survival is not expected.

The 2010 Final Recovery Plan (NMFS 2010e) 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 because of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division's issuance of an IHA 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.

12.1.3 Sei Whale

Adult, juvenile, and calf sei whales are present in the action area and may be exposed and respond to noise from the seismic survey activities.

The sei whale is endangered because of past commercial whaling. No estimates of pre-exploitation population size are available and the total number of sei whales in the North Atlantic Ocean is not known (Waring and et al. 2009). Now, only a few individuals are taken each year by Japan. Iceland has expressed an interest in targeting sei whales. Current threats include vessel strikes, fisheries interactions (including entanglement), climate change (habitat loss and reduced prey availability), and anthropogenic noise. Given the species' overall abundance, they may be somewhat resilient to current threats. However, trends are largely unknown, especially for individual stocks, many of which have relatively low abundance estimates.

Sei whales are listed as endangered throughout their range; however, there are no current estimates of global abundance for sei whales. Pre-whaling estimates of 250,000 sei whales decreased to 32,000 sei whales during the 1970s and 1980s (Wiles 2017). 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 Eastern North Pacific Ocean. The most likely stock to occur in the action area is the Nova Scotia stock. 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). The population estimate for the Hawaii stock of sei whales is 391 individuals (CV = 0.9) based on a survey of the Hawaiian Islands Exclusive Economic Zone from August through December 2010 (Bradford et al. 2017). This is the best estimate even though a majority of sei whales would be expected to be in higher-latitude feeding grounds during that time of the year (Carretta et al. 2022). The minimum number for the Hawaii stock of sei whales is 204 individuals. In the eastern North Pacific Ocean, the sei whale population is estimated at 311 individuals (CV = 0.76) based on surveys in 2008 and 864 individuals (CV = 0.4) based on surveys in 2014; the best estimate is the mean of these 2 estimates, or 519 individuals (CV=0.4; Nmin=374 individuals; Barlow 2016). 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. The apparent increase in Eastern North Pacific stock of sei whales from 2008 through 2014 may be partially due to recovery from commercial whaling, but may also be due to distributional shifts (Barlow 2016).

No reduction in the distribution of sei whales from the Northwest 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 Division's issuance of an IHA.

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 30 individuals, which could be adults, juveniles, and/or calves, is expected because of the seismic survey activities. We anticipate ESA behavioral harassment, which will include 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. We do not anticipate any delay in 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 Division's issuance of an IHA, 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 because the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division's issuance of an IHA 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.

12.1.4 Sperm Whale

Adult, juvenile, and calf sperm whales are present in the action area and may be exposed and respond to noise from the seismic survey activities.

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 uncertain. Commercial whaling is no longer allowed; however, illegal hunting may occur at biologically unsustainable levels. 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 climate change, and anthropogenic noise. This species' large population size shows that it is somewhat resilient to current threats.

The sperm whale is the most abundant of the large whale species, with total abundance estimates between 200,000 and 1,500,000. The most recent estimate indicated a global population of between 300,000 and 450,000 individuals (Whitehead 2009). The higher estimates may be approaching population sizes prior to commercial whaling, the reason for ESA-listing. It is estimated that well over 1,000,000 sperm whales were killed between the 1950's and 1999 (NMFS 2015c). There are 6 recognized sperm whale stocks in U.S. waters: Puerto Rico and U.S. Virgin Islands, Northern Gulf of Mexico, North Atlantic, North Pacific, California/Oregon/Washington, and Hawaii.

Sperm whales are listed as endangered throughout their range, though the stock most likely to be present in the action area is the North Atlantic stock. There are no reliable estimates for sperm whale abundance across the entire North Atlantic Ocean. The population estimate for Puerto Rico and U.S. Virgin Islands stock is unknown. The best population estimate for the Northern Gulf of Mexico stock is 1,180 individuals (CV = 0.22) from 2017 and 2018 summer/fall surveys (N_{min} = 983 individuals; (Garrison et al. 2020). For the North Atlantic stock, the best recent abundance estimate is 4,349 individuals (CV = 0.28), which is the sum of abundance estimates from Central Florida to the lower Bay of Fundy in 2016 (N_{min} = 3,451 individuals; Garrison 2020; Palka 2020). No trend analysis has been conducted for the North Atlantic stock. In the North Pacific Ocean, the abundance of sperm whales was estimated to be 1,260,000 individuals prior to commercial whaling. In 1997, population estimates in the northeastern temperate North Pacific Ocean were 26,300 individuals (CV = 0.81) and 32,100 individuals (CV = 0.36) based on visual and acoustic surveys, respectively (NMFS 2015c). In the eastern tropical Pacific Ocean, the abundance of sperm whales was estimated to be 22,700 individuals (95 percent CI = 14,800 to 34,600 individuals) in 1993 (NMFS 2015c). There are insufficient data to reliably estimate the population abundance of the North Pacific stock; however, N_{min} is estimated at 244 sperm whales in the Gulf of Alaska (Rone et al. 2017). The best population estimate for the California/Oregon/Washington stock is 1,997 individuals (CV = 0.57) in 2014 (N_{min} = 1,270 individuals; Moore and Barlow 2014). The population estimate for the Hawaii stock is 5,707 individuals (CV = 0.23) in 2017 (N_{min} = 4,486 individuals(Becker et al. 2021). There are currently no reliable population estimates for sperm whales in the South Pacific Ocean. There is insufficient data to evaluate trends in abundance and growth rates of sperm whale populations at this time. An attempt to determine trends for the Northern Gulf of Mexico stock showed no significant differences in abundance estimates between 2003 and 2018; however, there is little statistical power to detect a trend because of the relatively imprecise estimates and limited survey area (Garrison et al. 2020). Additionally, it has been reported that the California/Oregon/Washington stock abundance appeared stable, but the estimated growth rate include high uncertainty levels.

No reduction in the distribution of sperm whales from the Northwest Atlantic Ocean in the Blake Plateau and Carolina Trough 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 Division’s issuance of an IHA.

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 709 individuals, which could be adults, juveniles, and/or calves, is expected because of the seismic survey activities. We anticipate ESA behavioral harassment, which will include 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 delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of sperm whales due to the seismic survey activities and the NMFS Permits Division’s issuance of an IHA, a reduction in the species’ likelihood of survival is not expected.

The 2010 Final Recovery Plan for the sperm whale (NMFS 2010f) 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 because of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division’s issuance of an IHA 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.

12.1.5 Green Turtle – North Atlantic Distinct Population Segment

Adult, juvenile, and post-hatchling North Atlantic DPS of green turtles are present in the action area and may be exposed and respond to noise from the seismic survey activities.

Once abundant in tropical and subtropical waters, green turtles worldwide exist at a fraction of their historical abundance because of over-exploitation for food and other products. Globally, egg harvest, the harvest of females on nesting beaches and directed hunting of sea turtles in foraging areas remain the 3 greatest threats to their recovery. In addition, bycatch in drift-net, long-line, set-net, pound-net, and trawl fisheries kill thousands of green turtles annually. Other threats include pollution, habitat loss through coastal development or stabilization, destruction of nesting habitat from storm events, artificial lighting, poaching, global climate change, natural predation, disease, cold-stunning events, and oil spills.

Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population's decline. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS of green turtle appears to be somewhat resilient to future perturbations.

For the North Atlantic DPS of green turtle the available data indicate an increasing trend in nesting. There is no reliable estimates of population growth rate of the North Atlantic DPS as a whole, but estimates have been developed at a localized level. 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. The North Atlantic DPS of green turtle exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites (Seminoff et al. 2015)

No reduction in the distribution of North Atlantic DPS of green turtles from the Northwest Atlantic Ocean in the Blake Plateau and Carolina Trough 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 Division's issuance of an IHA.

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 116 individuals, which could be adults, juveniles, and/or post-hatchlings, is expected because of the seismic survey activities. We anticipate ESA behavioral harassment, which will include 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. We do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of North Atlantic DPS of green turtles due to the seismic survey activities and the NMFS Permits Division's issuance of an IHA, 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 North Atlantic DPS of green turtles are expected because of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division's issuance of an IHA 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 North Atlantic DPS of green turtles in the wild by reducing the reproduction, numbers, or distribution of the species.

12.1.6 Kemp's Ridley Turtle

Adult, juvenile, and post-hatchling Kemp's ridley turtles are present in the action area and may be exposed and respond to noise from the seismic survey activities.

Kemp's ridley turtles face many of the same threats as other sea turtle species, including destruction of nesting habitat from storm events, oceanic events such as cold-stunning, pollution (plastics, petroleum products, petrochemicals, etc.) ecosystem alterations (nesting beach development, beach nourishment and shoreline stabilization, vegetation changes, etc.), poaching, global climate change, fisheries interactions, natural predation, and disease.

The Kemp's ridley turtle was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances prohibited the harvest of sea turtles from May through August, and in 1990, the harvest of all sea turtles was prohibited by presidential decrees in Mexico. In 2002, Rancho Nuevo was declared a sanctuary. A successful head-start program resulted in re-establishment of nesting on Texas beaches. While fisheries bycatch remains a threat, the use of sea turtle excluder devices mitigates take. Fishery interactions and strandings, possibly due to forced submergence, appear to be the main threats to the species. The *Deepwater Horizon* oil spill event reduced nesting abundance and associated hatchling production as well as exposures to oil in the oceanic environment which has resulted in large losses of the population across various age classes, and likely had an important population-level effect on the species. We do not have an understanding of those impacts on the population trajectory for the species into the future. The species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

Of the sea turtle species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. Nesting steadily increased through the 1990s, and then accelerated during the first decade of the 21st century. Following a significant, unexplained one-year decline in 2010, Kemp's ridley turtle nests in Mexico reached a record high of 21,797 in 2012 (NPS 2013). In 2013, there was a second significant decline with 16,385 nests recorded. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from 3 primary nesting beaches in Mexico (NMFS and USFWS 2015). The number of nests in Padre Island, Texas has increased over the past 2 decades, with 1 nest observed in 1985, 4 in 1995, 50 in 2005, 197 in 2009, 209 in 2012, and 119 in 2014 (NMFS and USFWS 2015).

From 1980 through 2003, the number of nests at 3 primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS and USFWS 2015). In fact, nest counts dropped by more than a third in 2010 and continue to remain below predictions (Caillouet et al. 2018). 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). In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from 3 primary nesting beaches in Mexico (NMFS and USFWS 2015)

No reduction in the distribution of Kemp's ridley turtles from the Northwest Atlantic Ocean in the Blake Plateau and Carolina Trough 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 Division's issuance of an IHA.

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 2 individuals, which could be adults, juveniles, and/or post-hatchlings, is expected because of the seismic survey activities. Density data were not were not available to quantify the number of exposures for small sea turtles (less than 30 centimeters [11.8 inches]). Any small sea turtle found within an ensonified area of 1,417.5 square kilometers (413.3 square nautical miles) and 8,354.5 square kilometers (2,435.8 square nautical miles) are expected to be taken in the form of harassment in intermediate water depths and deep waters, respectively. We anticipate ESA behavioral harassment, which will include 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. We do not anticipate any delay in reproduction as a result. 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 Division's issuance of an IHA, 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 because of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division's issuance of an IHA 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.

12.1.7 Leatherback Turtle

Adult, juvenile, and post-hatchling leatherback turtles are present in the action area and may be exposed and respond to noise from the seismic survey activities. The severity of an animal's 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. The status of the subpopulations in the Atlantic, Indian, and Pacific Oceans are generally declining, except for the subpopulation in the Southwest Atlantic Ocean, which is slightly increasing. Leatherback turtles show a lesser degree of nest site fidelity than occurs with hardshell sea turtle species.

The primary threats to leatherback turtles include fisheries interactions (bycatch), harvest of nesting females, and egg harvesting. Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, vegetation changes, sand extraction, beach nourishment, shoreline stabilization, and natural disasters (e.g., storm events and tsunamis) as well as cold-stunning, vessel interaction, pollution (contaminants, marine debris and plastics, petroleum products, petrochemicals), ghost fishing gear, natural predation, parasites, and disease. Artificial lights on or adjacent to nesting beaches alter nesting adult female behavior and are often fatal to post-nesting females and emerging hatchlings as they are drawn to light sources and away from the sea. Ingestion of marine debris (plastic) is common in leatherback turtles and can block gastrointestinal tracts leading to death. Climate change may alter sex ratios (as temperature determines hatchling sex) and nest success, range (through expansion of foraging habitat as well as alter spatial and temporal patterns), and habitat (through the loss of nesting beaches, because of sea-level rise and storms). Oceanographic regime shifts possibly impact foraging conditions that may affect nesting female size, clutch size, and egg size of populations. The species' resilience to additional perturbation is low.

Detailed population structure is unknown, but is likely dependent upon nesting beach location and influenced by physical barriers (i.e., landmasses), current systems, and long migrations. The total index of nesting female abundance in the Northwest Atlantic Ocean is 20,659 females. Based on estimates calculated from nesting data, there are approximately 18,700 (10,000 to 31,000 nesting females) total adult leatherback turtles in the North Atlantic Ocean (TEWG 2007). The North Atlantic estimate of nesting leatherback turtles is the most likely to represent the portion of the population with animals that could be exposed to the proposed seismic survey. The total index of nesting female abundance is likely an underestimate because we did not have adequate data from many nesting beaches, which have the potential for being unmonitored or unidentified.

Population growth rates for leatherback turtles vary by ocean basin. Leatherback turtles in the Northwest Atlantic Ocean exhibit a decreasing nest trend at nesting beaches with the greatest known nesting female abundance. This decline has become more pronounced (2008 through 2017), and the available nest data reflect a steady decline for more than a decade (Eckert and Mitchell 2018). This trend is the mostly likely to represent the portion of the population with animals that could be exposed to the proposed seismic survey. Despite intense conservation efforts, the decline in nesting has not been reverse as of 2011 (Benson et al 2015).

No reduction in the distribution of leatherback turtles from the Northwest Atlantic Ocean in the Blake Plateau and Carolina Trough 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 Division’s issuance of an IHA.

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 8 individuals, which could be adults, juveniles, and/or post-hatchlings, is expected because of the seismic survey activities. Density data were not were not available to quantify the number of exposures for small sea turtles (less than 30 centimeters [11.8 inches]). Any small sea turtle found within an ensonified area of 1,417.5 square kilometers (413.3 square nautical miles) and 8,354.5 square kilometers (2,435.8 square nautical miles) are expected to be taken in the form of harassment in intermediate water depths and deep waters, respectively. We anticipate ESA behavioral harassment, which will include 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. We do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of leatherback turtles due to the seismic survey activities and the NMFS Permits Division’s issuance of an IHA, 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 because of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division’s issuance of an IHA 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.

12.1.8 Loggerhead Turtle – Northwest Atlantic Ocean Distinct Population Segment

Adult, juvenile, and post-hatchling Northwest Atlantic Ocean DPS of loggerhead turtles are present in the action area and may be exposed and respond to noise from the seismic survey activities.

Based on the currently available information, NMFS categorizes the Northwest Atlantic Ocean DPS of loggerhead turtle population trend as being stable (NMFS 2017). Due to declines in nest counts at index beaches in the U.S. and Mexico, and continued mortality of juveniles and adults from fishery bycatch, the Northwest Atlantic Ocean DPS of loggerhead turtle is at risk and likely to decline in the foreseeable future (Conant et al. 2009a). Other threats include pollution (contaminants) and impacts from climate change (nesting beaches).

A number of stock assessment and similar reviews have examined the status of loggerhead turtles in the Atlantic Ocean, but none have developed a reliable estimate of absolute population size (Conant et al. 2009b; Heppell et al. 2003; NMFS-SEFSC 2001; NMFS-SEFSC 2009; NMFS 2008; TEWG 1998; TEWG 2000; TEWG 2009). It is difficult to estimate overall abundance for sea turtle populations because individuals spend most of their time in water, where they are difficult to count, especially considering their large range and use of many different and distant habitats. Females, however, converge on their natal beaches to lay eggs, and nests are easily counted. The total number of annual U.S. nest counts for the Northwest Atlantic DPS of loggerhead sea turtles is over 110,000 (NMFS and USFWS 2023).

In-water estimates of abundance include juvenile and adult life stages of loggerhead males and females are difficult to perform on a wide scale. In the summer of 2010, NMFS' NEFSC and SEFSC estimated the abundance of juvenile and adult loggerhead sea turtles along the continental shelf between Cape Canaveral, Florida and the mouth of the Gulf of St. Lawrence, Canada, based on AMAPPS aerial line-transect sighting survey and satellite tagged loggerheads (NMFS 2011c). They provided a preliminary regional abundance estimate of 588,000 individuals (approximate inter-quartile range of 382,000-817,000) based on positively identified loggerhead sightings (NMFS 2011). A separate, smaller aerial survey, conducted in the southern portion of the Mid-Atlantic Bight and Chesapeake Bay in 2011 and 2012, demonstrated uncorrected loggerhead sea turtle abundance ranging from a spring high of 27,508 to a fall low of 3,005 loggerheads (NMFS and USFWS 2023). We are not aware of any current range-wide in-water estimates for the DPS.

No reduction in the distribution of Northwest Atlantic Ocean DPS of loggerhead turtles from the Northwest Atlantic Ocean in the Blake Plateau and Carolina Trough 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 Division's issuance of an IHA.

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 234 individuals, which could be adults, juveniles, and/or post-hatchlings, is expected because of the seismic survey activities. Density data were not were not available to quantify the number of exposures for small sea turtles (less than 30 centimeters [11.8 inches]). Any small sea turtle found within an ensonified area of 1,417.5 square kilometers (413.3 square nautical miles) and 8,354.5 square kilometers (2,435.8 square nautical miles) are expected to be taken in the form of harassment in intermediate water depths and deep waters, respectively. We anticipate ESA behavioral harassment, which will include 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. We do not anticipate any delay in reproduction as a result. Because we do not anticipate a reduction in numbers or reproduction of Northwest Atlantic Ocean DPS of loggerhead turtles due to the seismic survey activities and the NMFS Permits Division's issuance of an IHA, 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 of loggerhead turtle populations are expected because of the proposed actions, we do not anticipate the seismic survey activities and the NMFS Permits Division's issuance of an IHA 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.

13 Conclusion

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS' 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.

It is also NMFS' biological opinion that the proposed actions are not likely to adversely affect the North Atlantic right whale, hawksbill turtle, Carolina DPS of Atlantic sturgeon, Chesapeake DPS of Atlantic sturgeon, Gulf of Maine DPS of Atlantic sturgeon, New York Bight DPS of Atlantic sturgeon, South Atlantic DPS of Atlantic sturgeon, giant manta ray, oceanic whitetip shark, smalltooth sawfish, Nassau grouper, and shortnose sturgeon. In addition, the proposed actions will not adversely affect the designated critical habitat of North Atlantic right whale and the Northwest Atlantic Ocean DPS of loggerhead turtle.

14 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of threatened and endangered 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 (16 U.S.C. §1532(19)). “Harm” is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 C.F.R. §222.102). NMFS has not defined “harass” under the ESA in regulation. On May 1, 2023, NMFS adopted, as final, the previous interim guidance on the term “harass,” defining it as to “create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering,” For purposes of this consultation, we relied on NMFS’ interim definition of harassment to evaluate when the seismic survey activities are likely to harass ESA-listed marine mammals (cetaceans).

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity (50 CFR §402.02). Section 7(o)(2) provides 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 this ITS.

ESA section 9 take prohibitions do not apply to threatened species without ESA section 4(d) rules as specified in ESA section 9(a)(1)(g). The ESA does not prohibit the take of threatened species unless special regulations have been promulgated, pursuant to section 4(d), to promote the conservation of the species. ESA section 4(d) rules have been promulgated for the North Atlantic DPS of green turtles and Northwest Atlantic Ocean DPS of loggerhead turtles; therefore, section 9 take prohibitions apply to all ESA-listed cetaceans and sea turtles that are likely to be adversely affected by the proposed action.

ESA section 7(b)(4) states that take of ESA-listed marine mammals (cetaceans) must be authorized under MMPA section 101(a)(5) before the Secretary can issue an ITS for ESA-listed marine mammals. NMFS’ implementing regulations for MMPA section 101(a)(5)(D) specify that an IHA is required to conduct activities pursuant to any incidental take authorization for a specific activity that will “take” marine mammals. Once NMFS has authorized the incidental take of marine mammals under an IHA for the tentative period of April 2023 through April 2024 (valid for a period of 1 year from the date of issuance), under the MMPA, the incidental take of ESA-listed marine mammals is exempt from the ESA take prohibitions as stated in this ITS pursuant to section 7(b)(4) and 7(o)(2).

14.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent of such incidental taking on the species (50 CFR § 402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions while the extent of take specifies the impact, i.e., the amount or extent of such incidental taking on the species, which may be used if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (see 80 FR 26832). We anticipate the high-energy seismic survey in the Northwest Atlantic Ocean in the Blake Plateau and Carolina Trough is likely to result in the incidental take of ESA-listed cetaceans and sea turtles by harassment (Table 15. Behavioral harassment is expected to occur at received levels at or above 160 dB re: 1 μPa (rms) for airgun array operations for ESA-listed marine mammals and at received levels at or above 175 dB re: 1 μPa (rms) for ESA-listed sea turtles. For all species of ESA-listed marine mammals and sea turtles, this incidental take will result from exposure to acoustic energy during airgun array operations and will be in the form of ESA harassment.

Table 15. Estimated Amount of Incidental Take of Endangered Species Act-Listed Cetaceans and Sea Turtles Anticipated Because of the Proposed Actions in the Northwest Atlantic Ocean in the Blake Plateau and Carolina Trough

Species	Anticipated Incidental Take by Harassment (Potential Temporary Threshold Shift and Behavioral) by Seismic Survey Activities
Marine Mammals – Cetaceans	
Blue Whale	2
Fin Whale	4
Sei Whale	30
Sperm Whale	709
Marine Reptiles – Sea Turtles	
Green Turtle – North Atlantic DPS	116
Kemp's Ridley Turtle	2
Leatherback Turtle	8
Loggerhead Turtle – Northwest Atlantic Ocean DPS	234

DPS=distinct population segment

14.2 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 C.F.R. §402.02). The measures described below must be undertaken by the NSF, L-DEO, and the NMFS Permits Division so that they become binding conditions for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, we will issue a statement that specifies the impact of any incidental taking of threatened or endangered species. To minimize such impacts, reasonable and prudent measures, and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the ITS are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

We believe the reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

1.) The NSF and L-DEO must implement a program to minimize and report the potential effects of seismic survey activities, as well as the effectiveness of conservation measures for the incidental taking of marine mammals (blue whales, fin whales, sei whales, and sperm whales) and sea turtles (North Atlantic DPS of green turtles, Kemp's ridley turtles, leatherback turtles, and Northwest Atlantic Ocean DPS of loggerhead turtles).

2.) The NMFS Permits Division must ensure that the NSF and L-DEO implements a program to minimize and report the potential effects of seismic survey activities, as well as the effectiveness of conservation measures incorporated as part of the proposed IHA and possible renewal for the incidental taking of marine mammals (blue whales, fin whales, sei whales, and sperm whales) pursuant to section 101(a)(5)(D) of the MMPA. In addition, the NMFS Permits Division must ensure that the provisions of the IHA and possible renewal are carried out, and inform us if take is exceeded.

14.3 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA and regulations issued pursuant to section 4(d), the Federal action agency (i.e., NSF and NMFS Permits Division) must comply (or must ensure that any applicant complies) with the following terms and conditions. These include the take minimization, monitoring and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)).

The terms and conditions detailed below for each of the reasonable and prudent measures include monitoring and minimization measures where needed:

1. To implement RPM 1, the NSF must provide a copy of a draft comprehensive report on all seismic survey activities and monitoring results to us within 90 days of the completion of the high-energy seismic survey, or expiration of the IHA, whichever comes sooner. In addition, NSF must

immediately report on any injured or dead ESA-listed species to nmfs.hq.esa.consultations@noaa.gov. The subject line of the e-mail should include “report of injured or dead ESA-listed species” and consultation tracking number: OPR-2022-02949.

2. To implement RPM 2, NMFS Permits Division must confirm that all elements required in the IHA for reporting the effects on marine mammals (Appendix A, Section 18) are submitted to NMFS OPR.

15 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

We make the following discretionary conservation recommendations that we believe are consistent with this obligation and may be considered by the NSF, L-DEO, and NMFS Permits Division in relation to their 7(a)(1) responsibilities. These recommendations will provide information for future consultations involving seismic surveys and the issuance of IHAs that may affect ESA-listed species.

1. We recommend that the NSF and L-DEO promote and fund research examining the potential effects of seismic surveys on ESA-listed marine mammal, sea turtle, and fish species.

2. We recommend that the NSF and L-DEO develop a more robust propagation model that incorporates environmental variables into estimates of how far sound levels reach from airgun arrays.

3. We recommend that the NSF and L-DEO model potential impacts to ESA-listed species, validate assumptions, through refinements of current models and use of other relevant models, validate assumptions used in effects analyses, and seek information and high quality data for use in such efforts.

4. We recommend that the NSF and L-DEO conduct a sound source verification in the study area (and future locations) to validate predicted and modeled isopleth distances to ESA harm and harassment thresholds and incorporate the results of that study into buffer and shutdown zones prior to starting seismic survey activities.

5. We recommend that the NMFS Permits Division develops a flow chart with decision points for mitigation and monitoring measures to be included in future MMPA incidental take authorizations for seismic surveys.

6. We recommend the NSF and L-DEO use (and NMFS Permits Division require in MMPA IHAs) thermal imaging cameras, in addition to reticled 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.

7. We recommend the NSF and L-DEO use (and NMFS Permits Division require in MMPA IHAs) clinometers or geometers, such as those described in Hansen et al. 2020, to accurately measure lateral distances from the research vessel to ESA-listed species for potential implementation of mitigation measures (e.g., shutdown procedure) during daytime and nighttime visual observations.
8. We recommend the NSF and L-DEO use the Marine Mammal Commission's recommended method for estimating the number of cetaceans near seismic surveys based on the number of groups detected for post-seismic survey activities take analysis and use in monitoring reports.
9. We recommend the NSF, L-DEO, and NMFS Permits Division work to make the data collected as part of the required monitoring and reporting available to the public and scientific community in an easily accessible online database that can be queried to aggregate data across PSO reports. Access to such data, which may include sightings as well as 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.
10. We recommend the NSF and L-DEO utilize real-time visual sighting and acoustic detection services such as the WhaleAlert application (http://www.whalealert.org/) for marine mammals or the Ocean Alert mobile application (https://www.boem.gov/boem-harnessing-citizen-science-new-ocean-alert-mobile-app) for marine megafauna (e.g., sea turtles, sharks, and marine mammals). We recognize that the research vessel may not have reliable internet access during operations offshore, but nearshore, where many of the ESA-listed species considered in this consultation are likely found in greater numbers, we anticipate internet access may be better. Monitoring such systems will help plan seismic survey activities and transits to avoid locations with recent ESA-listed species sightings, and may also be valuable during other activities to alert others of ESA-listed species within the area, which they can then avoid.
11. We recommend the NSF and L-DEO submit their monitoring data (i.e., visual sightings) by PSOs to the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations online database so that it can be added to the aggregate marine mammal, seabird, sea turtle, and fish observation data from around the world.
12. We recommend the research vessel operator and other relevant vessel personnel (e.g., crewmembers) on the R/V *Marcus G. Langseth* take the U.S. Navy's marine species awareness training available online at: https://www.youtube.com/watch?v=KKo3r1yVBBA in order to detect ESA-listed species and relay information to PSOs.

13. We recommend NSF and L-DEO attempt to maintain a distance of 45 meters (147.6 feet) or greater whenever possible from the R/V *Marcus G. Langseth*, when ESA-listed sea turtles and fish are visually sighted, as a vessel strike avoidance measure.
14. We recommend the NSF, L-DEO, and NMFS Permits Division implement a program to mitigate, monitor, and report any potential effects and interactions between seismic survey activities as well as any effectiveness of mitigation and monitoring measures on ESA-listed species of marine mammals, sea turtles, and fish.
15. We recommend the NSF and L-DEO's seismic survey activities actively avoid *Sargassum* mats or patches in designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtle.
16. We recommend the NSF and L-DEO coordinate with government agencies (e.g. Bureau of Ocean Energy Management, NMFS, Northeast Fisheries Science Center, U.S. Navy), academic institutions (e.g., Duke University, Woods Hole Oceanographic Institution), and/or the private sector that may be conducting long-term PAM and/or tagging studies to potentially determine received sound levels and responses of protected species and their prey from the seismic survey activities in the action area.
17. We recommend the NSF and L-DEO measure ambient noise levels in the survey area to help better understand the total ensonified area from acoustic sources (e.g., vessel noise, airgun array operations) from the high-energy seismic survey to determine the extent of the action area in future ESA section 7 consultations.
18. We recommend the NSF and L-DEO consider port locations to reduce transits and the potential for effects (e.g., vessel strikes) on ESA-listed species (e.g., North Atlantic right whales) and designated critical habitat in the action area.

In order to be informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, the NSF, L-DEO, and NMFS Permits Division should notify us of any conservation recommendations they implement in their final action.

16 Reinitiation Notice

This concludes formal consultation for the NSF and L-DEO's high-energy marine seismic survey by the R/V *Marcus G. Langseth* in the Northwest Atlantic Ocean of the Blake Plateau and Carolina Trough and NMFS Permits Division's issuance and possible renewal of an IHA for the proposed high-energy marine seismic survey pursuant to section 101(a)(5)(D) of the MMPA. Consistent with 50 C.F.R. §402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency or by NMFS, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if:

1. The amount or extent of taking specified in the ITS is exceeded.

2. New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
3. The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered in this opinion.
4. A new species is listed or critical habitat designated under the ESA that may be affected by the identified action.

If the amount of tracklines, location of tracklines, acoustic characteristics of the airgun arrays, timing of the high-energy seismic survey, or any other aspect of the proposed action changes in such a way that the incidental take of ESA-listed species can be greater than estimated in the ITS of this opinion, then 1 or more of the reinitiation triggers above may be met and reinitiation of consultation may be necessary.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

18 APPENDICES

Appendix A – Proposed Incidental Harassment Authorization and Possible Renewal for the National Science Foundation and Lamont-Doherty Earth Observatory's High-Energy Seismic Survey of the Blake Plateau and Carolina Trough in the Northwest Atlantic Ocean

The text below was taken directly from the proposed IHA provided to us in the consultation initiation package from the NMFS Permits Division, in the notice of proposed IHA and request for comments and possible renewal published in the *Federal Register* on June 7, 2023 (88 FR 37390 to 37422), as well as from revisions after the public comment period. The final IHA may have minor changes that will not affect this opinion.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

INCIDENTAL HARASSMENT AUTHORIZATION

The Lamont-Doherty Earth Observatory (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 valid for one year from the date of issuance.

2. This IHA is valid only for geophysical survey activity in the Blake Plateau, off the southeastern US in the Northwest Atlantic Ocean, off the coasts of South Carolina to northern Florida, as specified in L-DEO's IHA application.

3. <u>General Conditions</u>

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 L-DEO 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 amounts listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.

d. During use of the airgun array, if any marine mammal species that are not listed in Table 1, or a species for which authorization has been granted but the takes have been met, appears within or enters the Level B harassment zone (Table 2-3), the airgun array must be shut down.

e. 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, protected species monitoring protocols, operational procedures, and IHA requirements are clearly understood.

f. L-DEO must notify the NMFS Southeast Regional Office (SERO) of the start and end date of airgun operations in the survey area via email (nmfs.ser.research.notification@noaa.gov)

4. Mitigation Requirements

a. No use of airguns is allowed from November 1 through April 30. L-DEO must submit daily observations to SERO (kara.shervanick@noaa.gov) during any non-airgun activities that are conducted between November 1 and April 30.

b. L-DEO must not conduct seismic survey activities using airguns in the nearshore portions of the survey area on or after October 1st- 31st. "Nearshore lines" are defined as those within 100 kilometers of the U.S. shore in areas north of 31 degrees North and within 80 kilometers from the U.S. coast in areas south of 31 degrees North.

c. 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).

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

e. 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 exclusion and buffer zones must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

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. 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.

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. 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.

f. Acoustic Monitoring

i. The source vessel 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.

g. Shutdown zones and buffer zones

i. Except as provided in 4(g)(ii) and 4(g)(iii), 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(i)(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, dwarf and pygmy sperm whales, a large whale with a calf, and groups of six or more large whales. No buffer zone is required.

iii. The airgun array must be shut down upon detection (visual or acoustic) of a North Atlantic right whale at any distance.

h. 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(h)(vi).

ii. 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).

iii. 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.

iv. PSOs must monitor the shutdown and buffer zones during ramp-up, and ramp-up 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.

v. 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.

vi. 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.

vii. 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.

i. Shutdown

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(i)(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 requirements described in 4(i)(iii) shall be waived for small dolphins of the following genera: *Delphinus, Lagenodelphis, Stenella, Steno,* 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 genera 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).

j. Vessel strike avoidance

i. 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 below measures except under extraordinary circumstances 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 would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply.

ii. Vessel operators and crews must maintain a vigilant watch for all protected species and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A single marine mammal at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should always be exercised. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (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 as a right whale, other whale (defined in this context as sperm whales or baleen whales other than right whales), or other marine mammals.

iii. All survey vessels, regardless of size, must observe a 10-kn speed restriction in specific areas designated by NMFS for the protection of North Atlantic right whales from vessel strikes. These include all Seasonal Management Areas (SMA) (when in effect) and any dynamic management areas (DMA) (when in effect). See *www.fisheries.noaa.gov/national/endangered-species-conservation/reducing-ship-strikes-north-atlantic-right-whales* for specific detail regarding these areas.

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

v. The vessel must maintain a minimum separation distance of 500 m from North Atlantic right whales. If a right whale is sighted within the relevant separation distance, the vessel must steer a course away at 10 knots or less until the 500-m separation distance has been established. If a whale is observed but cannot be confirmed as a species other than a right whale, the vessel operator must assume that it is a right whale and take appropriate action.

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

vii. All vessels, 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).

viii. 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 protected species 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 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 PSO tasks.

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

i. PSOs must have successfully completed an approved PSO training course. 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 PSO with experience as shown in 4(c) 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 protected species 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 3(d));

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 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 depth (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 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 protected species, 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 (meters) and/or closest distance from any element of the airgun array; and

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);

26. Conditions at time of sighting (Visibility; Beaufort Sea State);

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

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

2. Date and time 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

1. 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 protected species near the activities;

(ii) Summary of all data required to be collected (see 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, including which array was being used 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;

(vii) Raw observational data.

b. *Reporting NARW:*

(i) Although not anticipated, if a North Atlantic right whale is observed at any time by PSOs or personnel on any project vessels, during surveys or during vessel transit, L-DEO must immediately report sighting information to the NMFS North Atlantic Right Whale Sighting Advisory System: 877-WHALE-HELP (877-942-5343). North Atlantic right whale sightings in any location must also be reported to the U.S. Coast Guard via channel 16.

c. 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, the IHA-holder shall report the incident to the Office of Protected Resources (OPR) (pr.itp.monitoringreports@noaa.gov), NMFS and to the NMFS Southeast regional stranding coordinator (305-361-4586) 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, the IHA-holder shall report the incident to OPR, NMFS and to the Southeast regional stranding coordinator 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. Species identification (if known) or description of the animal(s) involved;

9. Estimated size and length of the animal that was struck;

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

11. If available, description of the presence and behavior of any other

marine mammals immediately preceding the strike;

12. 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

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

7. Actions to minimize additional harm to live-stranded (or milling) marine mammals – In the event of a live stranding (or near-shore atypical milling) event within 50 km of the survey operations, where the NMFS stranding network is engaged in herding or other interventions to return animals to the water, the Director of OPR, NMFS (or designee) will advise L-DEO of the need to implement shutdown procedures for all active airgun arrays operating within 50 km of the stranding. Shutdown procedures for live stranding or milling marine mammals include the following:

    a. If at any time, the marine mammal(s) die or are euthanized, or if herding/intervention efforts are stopped, the Director of OPR, NMFS (or designee) will advise L-DEO that the shutdown around the animals' location is no longer needed.

    b. Otherwise, shutdown procedures will remain in effect until the Director of OPR, NMFS (or designee) determines and advises L-DEO that all live animals involved have left the area (either of their own volition or following an intervention).

    c. If further observations of the marine mammals indicate the potential for re-stranding, additional coordination with L-DEO will be required to determine what measures are necessary to minimize that likelihood (e.g., extending the shutdown or moving operations farther away) and to implement those measures as appropriate.

    d. Additional information requests – If NMFS determines that the circumstances of any marine mammal stranding found in the vicinity of the activity suggest investigation of the association with survey activities is warranted, and an investigation into the stranding is being pursued, NMFS will submit a written request to L-DEO indicating that the following initial available information must be provided as soon as possible, but no later than 7 business days after the request for information.

(i) Status of all sound source use in the 48 hours preceding the estimated time of stranding and within 50 km of the discovery/notification of the stranding by NMFS; and

(ii) If available, description of the behavior of any marine mammal(s) observed preceding (i.e., within 48 hours and 50 km) and immediately after the discovery of the stranding.

(iii) In the event that the investigation is still inconclusive, the investigation of the association of the survey activities is still warranted, and the investigation is still being pursued, NMFS may provide additional information requests, in writing, regarding the nature and location of survey operations prior to the time period above.

8. 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.

9. 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 (e.g., reduction in airgun array volume) 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.

______________________________ __________________

Kimberly Damon-Randall, Date

Director, Office of Protected Resources,
National Marine Fisheries Service

Table 1. Authorized take numbers, by species

Species	Proposed Take	
	Level B	Level A
Humpback whale	2	0
Minke whale	20	1
Fin whale	5	0
Sei whale	28	2
Blue whale	2	0
Sperm whale	709	0
Cuvier's beaked whale	366	0
Mesoplodont beaked whales	155	0
Risso's dolphin	1280	0
Rough-toothed dolphin	302	0
Bottlenose dolphin	4457	0
Pantropical spotted dolphin	420	0
Atlantic spotted dolphin	1774	0
Spinner dolphin	149	0
Striped dolphin	46	0
Clymene dolphin	182	0
Fraser's dolphin	227	0
Common dolphin	182	0
Pilot whales	1428	0
Killer whale	6	0
False killer whale	6	0
Pgymy killer whale	20	0
Melon-headed whale	213	0
Kogia Spp	601	50
Harbor porpoise	3	0

Table 2. Distances to Isopleth Corresponding to Level B Harassment Thresholds.

Airgun Configuration	Water Depth (m)	Level B harassment Zone (m)

4 strings, 36 airguns, 6,600 in^3	>1,000	6,733
	100-1,000	10,100

Table 3. Distances to Isopleth Corresponding to Level A Harassment Thresholds.

Airgun Configuration	Level A harassment zone (m)		
	Low Frequency	Mid Frequency	High Frequency
4 strings, 36 airguns, 6,600 in^3	MCS Surveys		
	320.2	13.6	268.3
	OBS Surveys		
	80	13.6	268.3