# National Marine Fisheries Service
# Endangered Species Act Section 7
# Biological Opinion

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| **Title:** | Biological Opinion on Marine Geophysical Survey of the Reykjanes Ridge South of Iceland by the National Science Foundation, and the Issuance of a Marine Mammal Protection Act Incidental Harassment Authorization and Possible Renewal by the National Marine Fisheries Service Permits and Conservation Division |
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# 1 INTRODUCTION

The Endangered Species Act (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 designated critical habitat. Federal agencies must do so in consultation with National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS' jurisdiction (50 C.F.R. §402.14(a)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provide 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 incidental take statement (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 ITS must be prepared 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 National Science Foundation (NSF) and the NMFS, Office of Protected Resources (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 provide funding support for the vessel on which a marine geophysical (seismic) survey would be conducted by the Lamont-Doherty Earth Observatory (L-DEO) of the Reykjanes Ridge in the North Atlantic Ocean, south of Iceland in the summer of 2024. The second is the Permits Division's proposal to issue an incidental harassment authorization (IHA) authorizing nonlethal "takes" by Level A and Level B harassment (as defined by the Marine Mammal Protection Act [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. Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

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 electronically with NMFS OPR in Silver Spring, Maryland.

## 1.1 Background

The NSF is proposing to fund vessel support for a marine seismic survey for scientific research purposes and data collection on the Reykjanes Ridge in the North Atlantic Ocean south of Iceland in the summer of 2024. 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 seismic survey will collect data in support of a research proposal that was reviewed under the NSF merit review process and identified as a NSF program priority. The seismic survey will collect data in support of testing a thermal plume pulsing model by acquiring full crustal seismic profiles of North Atlantic V-shaped ridges. In conjunction with this action, the Permits Division proposes the issuance of an IHA pursuant to the MMPA requirements for incidental takes of marine mammals that could occur during the NSF seismic survey.

This document represents our opinion on the effects of the proposed Federal actions on threatened and endangered species, and has been prepared in accordance with section 7(a)(2) of the ESA. The NSF and the Permits Division have conducted similar actions in the past that have been the subject of ESA section 7 consultations. A previous opinion for an NSF seismic survey in the vicinity of the proposed action area included the Norwegian Sea (2003) and the issuance of an IHA for the survey, and determined that the authorized activities were not likely to jeopardize the continued existence of ESA-listed species.

The principal investigators for this survey, NSF, and L-DEO considered the seasonal presence of marine animals, weather conditions (e.g., hurricane season), equipment, and optimal timing for other proposed seismic surveys using the research vessel (R/V) *Marcus G. Langseth* (hereafter, the R/V *Langseth*), to determine when to carry out the proposed seismic surveys.

### 1.2 Consultation History

This opinion is based on information provided by the NSF in a draft environmental assessment/analysis (EA) prepared pursuant to the National Environmental Policy Act, the Permits Division's notice of a proposed IHA prepared pursuant to the MMPA, and information from previous NSF seismic surveys in the vicinity of the action area. Unless noted otherwise, our communication with the NSF and the Permits Division regarding this consultation was conducted through email and is summarized as follows:

- **December 21, 2023:** The NSF submitted a consultation request letter and a draft EA to the ESA Interagency Cooperation Division for review.
- **January 26, 2024**: After review of the information, we determined there was sufficient information, as of December 21, 2023, to initiate a formal consultation with NSF.
- **February 9, 2024**: The Permits Division hosted their early review meeting on the IHA application with the ESA Interagency Cooperation Division in attendance. The Permits Division submitted questions back to NSF on February 12, 2024.
- **February 16, 2024**: The NSF responded with answers to the questions submitted by the Permits Division.
- **February 23, 2024**: Upon internal review and discussion, the Permits Division determined that the IHA application was adequate and complete.
- **April 9, 2024**: Upon our request, the Permits Division provided the draft IHA to inform the drafting of the biological opinion.
- **May 10, 2024:** The Permits Division submitted their initiation package to the ESA Interagency Cooperation Division for review.
- **May 13, 2024**: The proposed rule for the IHA published in the Federal Register (89 FR 41850).
- **May 20, 2024**: The ESA Interagency Cooperation Division reviewed the package, determined it was complete, and initiated consultation with the Permits Division with an effective date of May 10, 2024.
- **June 13, 2024**: The Permits Division notified the ESA Interagency Cooperation Division that the public comment period had closed, and that there were no public comments. The consultation proceeded using the draft IHA as the final.

## 2 The Assessment Framework

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, insure that their actions are not likely to jeopardize the continued existence of threatened or endangered species; or adversely modify or destroy their 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 physical and biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02).

An ESA section 7 assessment involves the following steps:

Description of the proposed actions (Section 3): We describe the proposed actions. This section also includes the avoidance and minimization measures that have been incorporated into the project to reduce the potential effects to ESA-listed species.

Potential stressors (Section 4): We identify and describe the stressors that could occur because of the proposed actions and affect ESA-listed species.

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

Endangered Species Act-listed species present in the action area (Section 6): We identify the ESA-listed species that are subject to this consultation because they co-occur with the stressors produced by the proposed actions in space and time.

Species not likely to be adversely affected (Section 7). We identify the ESA-listed species that are not likely to be adversely affected by the stressors produced by the proposed actions.

Status of species likely to be adversely affected (Section 8): During the ESA section 7 consultation process, we identify the ESA-listed species 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 in the action area, without the consequences to the ESA-listed species caused by the proposed action. The environmental baseline that 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 (50 C.F.R. §402.02).

Effects of the action (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). These are broken into analyses of exposure, response, and risk. To characterize exposure, we identify the number, age (or life stage), and gender of ESA-listed individuals that are likely to be exposed to the stressors and the populations or sub-populations to which those individuals belong. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. This is our response analysis. We characterize risk to federally-listed species by assessing the consequences of these responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise. This is our summary of effects.

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 under NMFS's jurisdiction.

With full consideration of the status of the species, we consider the effects of the actions within the action area on populations or subpopulations 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.

The results of our jeopardy 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 and 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 the Permits Division;

- Government reports (including NMFS biological opinions and stock assessment reports);
- NOAA technical memos; 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 the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species.

# 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 in the United States or upon the high seas.

Two actions were evaluated in this consultation. The first action is NSF's funding of vessel support for a proposed high-energy marine geophysical survey in the North Atlantic Ocean of the Reykjanes Ridge, south of Iceland. The second action is the Permits Division's issuance of an IHA authorizing nonlethal MMPA "takes" by Level A and B harassment pursuant to section 101(a)(5)(D) of the MMPA for the proposed marine seismic surveys.

## 3.1 National Science Foundation Proposed Activities

Researchers from the University of Birmingham, University of Southampton, and University of Cambridge, with funding from the United Kingdom's (UK) Natural Environment Research Council are proposing marine geophysical research off southern Iceland, in the North Atlantic Ocean, during summer 2024. The research will include high-energy seismic surveys conducted from the research vessel (R/V) *Marcus G. Langseth* (*Langseth*), which is owned and operated by Lamont-Doherty Earth Observatory (L-DEO) of Columbia University, and funded by NSF. Due to NSF's involvement, survey operations will be conducted in accordance with all applicable international and U.S. federal regulations, including IHA and Incidental Take Statement (ITS) requirements.

The NSF proposes to fund the vessel support for a high-energy seismic survey conducted by the Principal Investigator (PI) Dr. S. Jones (University of Birmingham), and Co-PIs Professor T. Henstock (University of Southampton) and Professor N. White (University of Cambridge). The PIs propose to use the seismic surveying capabilities of R/V *Langseth*, as well as ocean bottom seismometers (OBS). The seismic survey will take place in the North Atlantic Ocean over the Reykjanes Ridge off southern Iceland, in International Waters and within Iceland's Exclusive Economic Zone (see Figure 1 in Section 5).

The purpose of the proposed marine geophysical research is to make the first definite test of the thermal plane pulsing model, which has been suggested as a primary driver of major perturbations to global climate, ecosystems, and the carbon cycle in Earth's history.

### 3.1.1 Overview of Seismic Surveys

The survey is proposed in-water depths ranging from ~500–3,000 meters within the Exclusive Economic Zone (EEZ) of Iceland, and in International Waters. The proposed survey will take place more than 100 kilometers away from any coast. The proposed survey procedures will use seismic methodology commonly conducted on the R/V *Langseth*. The proposed activities will occur 24 hours per day.

The high-energy seismic survey will use a 36-airgun array at a depth of 10-12 meters. Most of the effort (~78%) would occur in deep water (>1,000 meter); the remainder would occur in intermediate water depths (100–1,000 meters). Survey transects will include lines that acquire seismic refraction data using OBSs and lines that acquire multi-channel seismic (MCS) reflection data using a hydrophone streamer. The surveys will consist of 2 primary seismic profiles (P-A and P-F in Figure 1) that will be acquired once for MCS reflection data and then again for OBS refraction data; profile line segments without OBS deployments (see Figure 1) will only be shot once for MCS reflection data. There will be a total of ~2,754 kilometers of seismic acquisition, including 1,662 kilometers of 2-dimensional MCS seismic reflection data and 1,092 kilometers of OBS refraction data. The survey is expected to last for 38 days, including approximately 9 days of MCS operations, 5 days of operations involving OBSs, 17 days of OBS deployment and retrieval, 3 days for streamer deployment and retrieval, and 4 days for transit.

There could be additional seismic transect line coverage during either survey associated with airgun testing and any repeat coverage of areas when initial data quality is determined to be sub-standard by the science team. The following acoustic sources, in addition to the airguns, will be operated from the R/V *Langseth* continuously during the seismic surveys: multibeam echosounder (MBES), sub-bottom profiler (SBP), and Acoustic Doppler Current Profiler (ADCP).

The R/V *Langseth* is tentatively planned to depart out of and return to port in Reykjavik, Iceland, during the summer (June/July) of 2024.

### 3.1.2 Research Vessel Specifications

The seismic survey will involve 1 vessel, the U.S.-flagged R/V *Langseth* owned and operated by L-DEO. The *Langseth* has a length of 72 meters, a beam of 17 meters, and a maximum draft of 5.9 meters. It weighs 2,842 gross tons. Its propulsion system consists of 2 diesel Bergen BRG-6 engines, each producing 3,550 horsepower, and an 800 horsepower bow thruster. As a seismic research vessel, the propulsion system was designed to be quiet to avoid interference with the seismic signals.

The vessel speed during seismic operations with the 36-airgun array will be ~7.6 kilometers per hour (~4.1 knots) during MCS seismic reflection surveys and ~9.3 kilometers per hour (~5.0 knots) during OBS seismic refraction surveys. When the R/V *Langseth* is towing the airgun array and hydrophone streamer, the turning rate of the vessel is limited to 5° per minute. Thus, the maneuverability of the vessel is limited during operations with the streamer. When not towing seismic survey gear, the R/V *Langseth* typically cruises at 18.5 kilometers per hour (10 knots).

No chase/support vessel will be used during the proposed seismic survey activities. The R/V *Langseth* will also serve as the platform from which vessel-based PSOs will visually watch for animals (e.g., marine mammals).

#### 3.1.3 Airgun Array and Acoustic Receiver Description

The R/V *Langseth* will deploy an airgun array (i.e., a certain number of airguns of varying sizes in a certain arrangement) during the seismic surveys to emit acoustic energy pulses downward through the water column and into the seafloor. The airguns generally consist of a steel cylinder 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. Airgun operations are expected to be continuous during the seismic surveys except for periods of unscheduled shutdowns.

During the survey, the R/V *Langseth* will tow 36 airguns (plus 4 spares) in an array of 4 strings spaced 8 meters apart with a total discharge volume of 108,154.6 cubic centimeters (6,600 cubic inches). The 4 airgun strings will be distributed across an area of ~24 x 16 meters behind the *Langseth* and will be towed approximately 140 meters behind the vessel at a depth of 10-12 meters.

The receiving system will consist of a towed 15-kilometer long solid-state hydrophone streamer, and 50 OBSs. As the airgun arrays are towed along the survey lines, the hydrophone streamer transfers the data to the onboard processing system. OBSs will be deployed and store the returning acoustic signals; data will be analyzed later after the devices are retrieved.

The airguns will fire at a shot interval of 50 meters (24 seconds) during multi-channel seismic (MCS) reflection surveys with the hydrophone streamer and at a 154.5-meter (60 seconds) interval during OBS seismic refraction surveys. The firing pressure of the airguns is approximately 1,900 pounds per square inch.

Refraction data will be acquired using 50 OBSs from the UK Ocean-Bottom Instrumentation Facility Pool. OBSs will be placed every 4 kilometers and, following the refraction shooting of one line, OBSs on that line will be recovered, serviced, and redeployed on a subsequent refraction line, for a total of 150 deployments. The placement and recovery of OBSs takes about 24 hours. The OBSs have a height of ~1 meter, a diameter of ~1 meter, and a weight of ~22 kilograms; the steel anchor is 30.5 centimeters (cm) x 38 cm x 2.5 cm high and weighs ~24 kilograms. To retrieve the OBSs, a transponder signals at a frequency of 8-11 kilohertz (kHz) and a response is received at a frequency of 11.5-13 kHz (operator selectable) triggering a burnwire assembly that releases the instrument from the anchor on the seafloor and the device floats to the surface. The transmitting beam pattern is 55°. The sound source level is approximately 93 decibels (dB). The pulse duration is 2 milliseconds (±10%) and the pulse repetition rate is 1 per second (±50 microseconds). The anchor for the OBS is left on the seafloor.

#### 3.1.4 Additional Acoustical Data Acquisition Systems

Along with the airgun operations, three additional acoustical data acquisition systems will operate during the seismic survey from the R/V *Langseth*: MBES, SBP, and an ADCP.

The MBES and SBP will map the ocean floor during the seismic survey operations. The ADCP is mounted on the ship to measure the speed of the water currents. The ADCP operates at a frequency of 35-1,200 kHz and a maximum acoustic source level of 224 dB referenced to 1 microPascal at 1 meter (re: 1μPa-m) over a conically shaped 30° beam.

The Kongsberg EM122 is a hull-mounted MBES operating at 10.5-13 (usually 12) kHz. The transmitting beamwidth is 1 or 2° fore-aft and 150° (maximum) athwartship (i.e., perpendicular to the ship's line of travel). The maximum sound source level is 242 dB re: 1 μPa-m. Each ping consists of 8 (in-water greater than 1,000 meters) or 4 (in-water less than 1,000 meters) successive fan-shaped transmissions, each ensonifying a sector that extends 1 degree fore-aft. Continuous-wave signals increase from 2-15 milliseconds long in-water depths up to 2,600 meters. Frequency-modulated chirp signals up to 100 milliseconds long are used in-water depths greater than 2,600 meters. The successive transmissions span an overall cross-track angular extent of about 150°, with 2 millisecond gaps between the pings for successive sectors.

The Knudsen 3260 SBP is 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° cone, which is directed downward by a 3.5-kHz transducer in the hull of the R/V *Langseth*. The nominal power output is 10 kilowatts, but the actual maximum radiated power is 3 kilowatts or 222 dB re: 1 μPa-m root mean square (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 5-second pause. The sub-bottom profiler is capable of reaching depths of 10,000 meters.

### 3.2 National Marine Fisheries Service's Proposed Incidental Harassment Authorization

On December 27, 2023, the Permits Division received a request from the L-DEO, owner and operator of the R/V *Langseth,* for an IHA on behalf of itself, NSF, University of Birmingham, University of Southampton, and University of Cambridge (the applicants).

On February 23, 2024, the Permits Division deemed the IHA application to be adequate and complete. The request was for the incidental (i.e., not intentional) harassment of small numbers of 25 species of marine mammals, including six ESA-listed species, by MMPA Level A and Level B harassment during the marine geophysical survey of the Reykjanes Ridge in the North Atlantic Ocean. The applicants and the Permits Division do not expect serious injury or mortality to result from the proposed activities; therefore, an IHA is appropriate. The proposed seismic surveys are not expected to exceed 1 year; hence, the Permits Division does not anticipate issuing subsequent IHAs for this action. The IHA will be valid for a period of 1 year from the date of issuance.

The Permits Division proposes to issue the final IHA by May 22, 2024, so the applicants will have the IHA prior to the start of the proposed survey activities. Appendix A (Section 18) contains a copy of the proposed IHA.

### 3.2.1 Proposed Incidental Harassment Authorization

The Permits Division is proposing to issue an IHA authorizing nonlethal "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*), Cape Verde Islands/Northwest Africa distinct population segment (DPS) humpback whale (*Megaptera novaeangliae*), 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 Permits Division does not expect the NSF and L-DEO's planned high-energy seismic survey to exceed 1 year and does not expect subsequent MMPA IHAs will be issued for this particular activity. Nevertheless, the Permits Division recognizes that delays in conducting the activity have the potential to occur and, as a result, may issue a one-year renewal of the IHA.

On a case-by-case basis, the 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 (89 FR 41850-41880) is planned; or (2) the activities as described in the description of the proposed activity section of the *Federal Register* notice (89 FR 41850-41880) will not be completed by the time the IHA expires and a second IHA (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, 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 May 13, 2024, Permits Division published a notice of proposed IHA and request for comments on the proposed IHA and possible renewal in the *Federal Register* (89 FR 41850-41880). The public comment period closed on June 12, 2024. The Permits Division did not receive any public comments. Appendix A (Section 18) contains the Permits Division's proposed IHA that could be renewed for a year. 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, the 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). 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 marine mammal species or stocks and their habitat, as well as subsistence uses, where applicable, the Permits Division carefully considers two primary factors:

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

In order to satisfy the MMPA's least practicable adverse impact standard, the Permits Division evaluated a suite of basic mitigation protocols for seismic surveys that are required regardless of the status of a stock. Additional or enhanced protections may be required for species whose stocks are in particularly poor health and/or subject to some significant additional stressor that lessens that stock's ability to weather the effects of the specified activities without worsening its status. The Permits Division reviewed seismic mitigation protocols required or recommended elsewhere (HESS 1999; Kyhn et al. 2011; Nowacek et al. 2013; JNCC 2017), recommendations received during public comment periods for previous actions, and the available scientific literature. The Permits Division also considered recommendations given in a number of review articles (Weir and Dolman 2007; Compton et al. 2008; Parsons et al. 2009; Wright and Consentino 2015). This exhaustive review and consideration of public comments regarding previous similar activities 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) in order for their action to result in the least practicable adverse impact on marine mammal species or stocks and to reduce the likelihood of adverse effects to ESA-listed marine species 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 and their habitat. 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 and their habitat are successful.

NSF and L-DEO indicated that they reviewed monitoring and conservation measures implemented during seismic surveys authorized by 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 incorporated a suite of monitoring and conservation measures into their proposed actions based on the above sources.

Under the MMPA, the 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 opinion:

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

- Reporting.

A summary table of the mitigation and monitoring protocols are in Table 1. Additional details for the mitigation and monitoring measures (e.g., shutdown and ramp-up procedures) as well as reporting can be found in Permits Division *Federal Register* notice of proposed IHA and possible renewal (89 FR 41850-41880) and Appendix A (Section 18).

**Table 1. Proposed Mitigation and Monitoring Protocols for the 36-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† | 500 meters (marine mammals) |
| Shutdown Zones† | 500 meters (marine mammals, except certain large assemblages)<br>1,500 meters (large whales with calves, and groups of 6 or more large whales) |
| Pre-Start Clearance and Ramp-Up Procedures | Required; 30-minute clearance period of the following zones:<br>• 1,000 meters (marine mammals)<br>Following detection within zone, animal must be observed exiting or additional period of 15 or 30 minutes |
| Ramp-Up Procedures | Required; duration ≥ 20 minutes |
| Shutdown Procedures | Shutdown required for marine mammals detected within defined shutdown zones; Exception for certain delphinids; 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 |

| Mitigation and Monitoring Protocols | High-Energy Airgun Array (36 Airguns with 108,154.6 cubic centimeters (6,600 cubic inches) |
|---|---|
| | vessel; maintain a minimum separation distance between species of concern; avoid vessel course changes in the vicinity of marine mammals. |

† Zone monitored by visual PSOs is 1,000 meters total (500-meter shut-down zone plus the 500-meter buffer zone).

### 3.3.1 Proposed Shutdown and Buffer Zones

The Permits Division will require, and the NSF and L-DEO will implement, shutdown and buffer zones around the R/V *Langseth* to minimize any potential adverse effects of the sound from the airgun array on MMPA and ESA-listed species. The shutdown zones are areas within which occurrence of a marine mammal triggers a shutdown of the airgun array, to reduce exposure of marine mammals to sound levels expected to have adverse effects on the species or their habitats. These shutdown zones are based upon modeled sound levels at various distances from the R/V *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 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 recognize that ensonified area/volume can be more technically challenging to predict because of the duration component in the new thresholds. As a result, 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 permanent threshold shifts (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 and this may result in PTS overestimates. However, when more sophisticated 3-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 (LGL 2024) and L-DEO's IHA application and Permits Division's proposed IHA and possible renewal (89 FR 41850-41880).

For behavioral harassment, the L-DEO conducted modeling on behalf of the NSF. Received sound levels were predicted by L-DEO's model (Diebold et al. 2010), which uses ray tracing for the direct wave traveling from the airgun array to the receiver and its associated source ghost (i.e., reflection at the air-water interface in the vicinity of the airgun array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). Using this model, L-DEO estimated the distances shown in Table 2 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) radii for a single 40 cubic inch airgun array (used during ramp-up) and 36-airgun array within the survey area's intermediate (100-1,000 meters deep) and deep waters (greater than 1,000 meters). For Level B harassment under the MMPA, and behavioral responses under the ESA, NMFS has historically relied on an acoustic threshold of 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 mammal species. This threshold also constitutes harassment under the ESA.

**Table 2. 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 Airgun and the 36-Airgun Array in Intermediate and Deep Water Depths for Marine Mammals during the Proposed MCS and OBS Refraction Surveys off southern Iceland**

| Source | Volume ($in^3$) | Water Depth (m) | Predicted Distance to Threshold (160 dB re: 1 µPa [rms]) (m) |
|---|---|---|---|
| 1 Airgun<br>Tow Depth: 12 m | 40 | 100-1,000 | 647 |
| | | >1,000 | 431 |
| 36 Airguns<br>Tow Depth: 12 m | 6,600 | 100-1,000 | 10,100 |
| | | >1,000 | 6,733 |

$in^3$=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 that may enter the shutdown zone. Shutdown and buffer zones for marine mammals are in Table 1. 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 appears within, enters, or appears on course to enter this zone, the airgun array will be powered-down or shut down, 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 cumulative sound exposure level ($SEL_{cum}$) and peak sound pressure level [SPL]), while also providing a consistent, reasonably observable zone within which PSOs will typically be able to conduct effective observations. Additionally, a 500-meter 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 is likely regularly attainable for PSOs using the naked eye during typical conditions.

NSF's draft environmental analysis and L-DEO's IHA application have detailed descriptions of the modeling for the R/V *Langseth*'s airgun arrays, as well as the resulting isopleths to behavioral thresholds for the various marine mammal hearing groups (Table 2). Predicted distances to PTS threshold isopleths for the proposed MCS and OBS refraction surveys, which vary based on marine mammal hearing group 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 3). NSF and L-DEO presented the PTS threshold distances based on a 50-meter shot interval used during the MCS reflection surveys because they are more conservative than the 400-meter shot interval used in the OBS seismic refraction surveys. For a discussion on how we evaluated and adopted the NSF and L-DEO's analysis, see Section 10.3.

**Table 3. PTS Threshold Distances for Different Marine Mammal Hearing Groups 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)**

| Threshold | Low Frequency Cetaceans (m) | Mid Frequency Cetaceans (m) | High Frequency Cetaceans (m) |
|---|---|---|---|
| Source – 36-Airgun Array, 50-meter shot interval | | | |
| $SEL_{cum}$ | **320.2** | 0 | 1.0 |
| Peak $SPL_{flat}$ | 38.9 | **13.6** | **268.3** |

m=meters

### *3.3.1.3 Shutdown Procedures*

The shutdown of the airgun array requires the immediate deactivation of all individual elements of the airgun array. Any PSO on duty will have the authority to delay the start of seismic survey activities or to call for shutdown of the airgun array if a marine mammal 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 one or more airguns are 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 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 and any dispute regarding a PSO shutdown must be resolved only following deactivation. Additionally, shutdown will occur whenever PAM alone (without visual sighting) confirms the presence of marine mammals in the shutdown zone. If the acoustic PSO cannot confirm presence within the shutdown zone, visual PSOs would be notified but shutdown is not required.

Following a shutdown, airgun array activity will not resume until the marine mammal has cleared the shutdown zone. The animal will be considered as having cleared the shutdown zone if:

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

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

In addition to the shutdown procedure described above, during the survey, the Permits Division's MMPA IHA will require the airgun array be shut down at a distance of 1,500 meters 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 six or more large whales is observed at any distance.

No buffer zone is required for the extended 1,500-meter zone.

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

### 3.3.2 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. Pre-start clearance is the only time observations of protected species in the buffer zone will prevent operations (i.e., the beginning of ramp-up). Ramp-up (sometimes referred to as "soft-start") means the gradual and systematic increase of emitted sound levels from an airgun array. The intent of ramp-up is to warn protected species of pending seismic survey actions (if the sound source is sufficiently aversive) and to allow sufficient time for those animals to leave the immediate vicinity prior to the sound source reaching full intensity. A ramp-up procedure, involving a step-wise increase in the number of airguns firing and an increase in total airgun array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the airgun array. Ramp-up begins by first activating a single airgun of the smallest volume, followed by doubling the number of active elements in stages until the full complement of airgun arrays are active. Two PSOs will 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).

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

### 3.3.3 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. The area to be scanned visually includes primarily the shutdown zones, but also the buffer zone, to implement the conservation measures discussed above.

The NSF and L-DEO must use at least five 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 mitigation requirements. The PSO resumes shall be provided to NMFS for approval as part of the IHA application process.

At least one of the visual and two 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 detailed in the MMPA IHA and the ITS are met. To the maximum extent practicable, experienced PSOs will be on duty with PSOs that have appropriate training but who have not yet gained relevant field experience.

During seismic survey activities (e.g., any day in which use of the airgun array is planned to occur, and whenever the airgun array is in the water, whether activated or not), a minimum of two visual PSOs must be on duty conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset) 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 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 for 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).
- 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).
- 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 (Section 18), which contains Permits Division's proposed IHA and possible renewal.

### 3.3.4 Passive Acoustic Monitoring

The Permits Division will require the use of PAM. PAM uses trained personnel, 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, because visual localization of animals is not always be possible. PAM is intended to further support visual monitoring (during daylight hours) in maintaining a shutdown zone around the airgun array that is clear of marine mammals. In cases where visual monitoring is not effective (e.g., due to weather, nighttime), PAM may be used to allow certain activities to occur, as further detailed below.

The PAM system will 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 long and the detachable hydrophone array is approximately 25 meters long. The hydrophones are fitted along the last 10 meters of towed hydrophone streamer with a depth gauge (with 100 meter capacity) attached to the free end. The hydrophone streamer is typically towed at a depth of less than 20 meters. The towed hydrophone streamer will 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 is 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 (Hz) to 250 kHz. The hydrophone array will consist of two low-frequency hydrophones (10 Hz-24 kHz), two mid-frequency hydrophones (200 Hz to 200 KHz), and two high-frequency hydrophones (2-200 kHz).

The PAM system must be monitored by a minimum of one on-duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times (day and night) during the use of the airgun array. When both acoustic and visual PSOs are on-duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs. 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 are expected to rotate through the acoustic and visual positions, although the most experienced with acoustics will be on duty at the PAM system more frequently.

The R/V *Langseth* will use a towed PAM system, which must be monitored by a minimum of one on-duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the airgun array.

At least two acoustic PSOs aboard the research vessel must have a minimum of 90 days at-sea experience working in that role during deep penetration or high-energy seismic surveys, with no more than 18 months elapsed since the conclusion of their at-sea experience.

When a vocalizing marine mammal is detected while visual monitoring is in progress, the acoustic PSO will 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 will be entered into an onboard 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 two hours.
- NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system.
- 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.

### 3.3.5 Vessel Strike Avoidance Measures

Vessel strike avoidance measures are intended to minimize the potential for collisions with marine mammals. 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 *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 *Langseth*) must maintain a minimum separation distance of 100 meters 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 of the vessel:
    - The vessel (R/V *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 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.

### 3.3.6 Reporting

In order to issue an IHA for an activity, section 101(a)(5)(D) of the MMPA states that 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 Permits Division will contribute improved understanding of one 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.

NSF and L-DEO must submit a draft comprehensive report to the Permits Division within 90 days of the completion of the seismic survey or expiration of the IHA, whichever comes sooner. The report will describe the seismic survey activities that were conducted. 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 marine mammal exposures that occurred within estimated harassment zones based on PSO observations, 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 arrays 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 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 (Section 18), which contains Permits Division's proposed IHA and possible renewal (Section 18).

# 4 POTENTIAL STRESSORS

The proposed action involves multiple activities, each of which can create stressors. Stressors are any physical, chemical, or biological entity or change in the environment that may affect an ESA-listed species or their 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, MBES, SBP, pingers, ADCP, OBSs, and seismic airgun array), and entanglement in towed seismic equipment (hydrophone streamers). Section 4 of OPR-2021-02539 (NMFS 2022) (https://doi.org/10.25923/wetp-dt20) provides a detailed overview of the acoustic stressors that will not be repeated here. The opinion, entitled, "Biological opinion on the Lamont-Doherty Earth Observatory's Marine Geophysical Survey by the R/V *Marcus G. Langseth* off Western Mexico in the Eastern Tropical Pacific 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" covers an action similar to that considered in this opinion.

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). Action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas (50 CFR 402.02).

The proposed marine seismic surveys will occur within an area bounded by ~56–63° North, ~24–34° West. Representative survey tracklines are shown in Figure 1. As described further in this document, some deviation in actual tracklines, including the order of survey operations, could occur because of data quality, inclement weather, or mechanical issues with the research vessel and/or equipment.

The survey is proposed in International Waters and within the EEZ of Iceland, in-water depths ranging from ~500–3,000 meters. The survey (tracklines or ensonified area) will not take place in the territorial waters of any country (Iceland). The closest approach of the survey lines to land is more than 100 kilometers.

Acquisition of wide-angle reflection/refraction seismic data using OBSs will occur along 2 major transects. MCS data will be acquired along transects P-A (~851 kilometers) and P-F (in 2 sections, 246.5 kilometers each); these transects will be acquired twice (once with OBS and once with MCS). The P-Fe2 and P-Fe3 lines will only be acquired once during MCS reflection surveys (i.e., no OBSs used on these lines).

The action area includes the survey tracklines and the adjacent area ensonified by the airgun array during the seismic survey and the path of the vessel transit to and from the survey area (discussed in more detail in the Ensonified Area section of the Exposure Analysis).

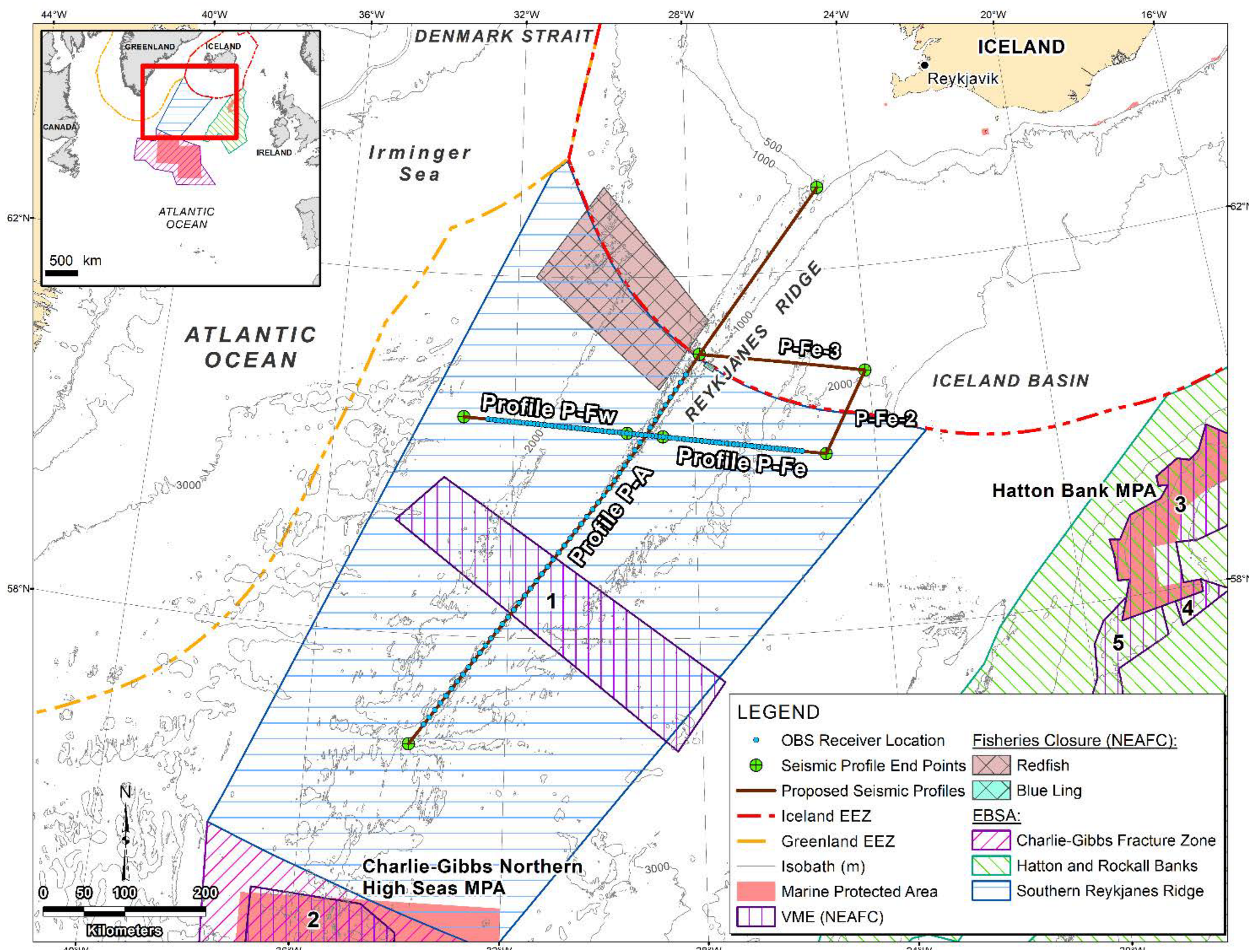


**Figure 1. Map of proposed seismic survey area in the North Atlantic Ocean near Iceland**

# 6 Endangered Species Act-Listed Species that May Be Affected by the Proposed Action

This section identifies the ESA-listed species that potentially occur within the action area (Section 5) and may be affected by the proposed actions (Table 5). These ESA-listed species co-occur with the potential stressors produced by the proposed actions in space and time (Section 4). The proposed action takes place in International Waters and Iceland's EEZ; thus, there is no designated or proposed critical habitat in the action area.

**Table 4. Threatened and endangered species that may be affected by the proposed action**

| Species | ESA Status | Critical Habitat | Recovery Plan |
|---|---|---|---|
| Marine Mammals – Cetaceans | | | |
| Blue Whale (*Balaenoptera musculus)* | E – 35 FR 18319 | -- -- | 07/1998<br>11/2020 - First Revision |
| Fin Whale (*Balaenoptera physalus)* | E – 35 FR 18319 | -- -- | 75 FR 47538<br>07/2010 |
| Humpback Whale (*Megaptera novaeangliae*) – Cape Verde Islands/Northwest Africa DPS | E – 81 FR 62259 | -- -- | 11/1991 |
| North Atlantic Right Whale (*Eubalaena glacialis*) | E – 73 FR 12024 | 81 FR 4837 | 70 FR 32293<br>08/2004 |
| Sei Whale (*Balaenoptera borealis*) | E – 35 FR 18319 | -- -- | 12/2011 |
| Sperm Whale (*Physeter macrocephalus*) | E – 35 FR 18319 | -- -- | 75 FR 81584<br>12/2010 |

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

# 7 Species Not Likely to be Adversely Affected

This section identifies the ESA-listed species 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 that may occur within the action area.

NMFS uses two criteria to identify the ESA-listed species 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 one or more potential stressors associated with the proposed activities and ESA-listed species. If we conclude that an ESA-listed species is not likely to be exposed to the proposed activities, we must also conclude that the species 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 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 in Section 6 and we summarize our results below.

We reach a "may affect, not likely to be adversely affected" finding for species 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. *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 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 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 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. 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 because any effects associated with the stressors were found to be wholly *beneficial, insignificant*, or *discountable*.

In Section 7.1, we evaluate the proposed action's stressors (Section 4) that are not likely to adversely affect any ESA-listed species. We also identify ESA-listed species that are not likely to be adversely affected by all stressors from the proposed action (Sections 7.2 and 7.3).

## 7.1 Stressors Not Likely to Adversely Affect Listed Species

Stressors that may affect, but are not likely to adversely affect the ESA-listed cetaceans considered in this opinion (see Table 5) include pollution, vessel strike, vessel noise and visual disturbance, gear entanglement and interaction, and acoustic noise from a SBP, MBES, ADCP, and OBS acoustic release. The following sections describe how we reached our effects determinations for these stressors.

### 7.1.1 Pollution

Pollution in the form of vessel exhaust, fuel or oil spills or leaks, and trash or other debris resulting from the use of vessels as part of the proposed action could result in impacts to ESA-listed marine mammals.

Exhaust (i.e., air pollution, including carbon dioxide, nitrogen oxides, and sulfur oxides) from the research vessel will be emitted during the entirety of the proposed actions during all vessel transit and operations, and could affect air-breathing ESA-listed marine mammals. The R/V *Langseth* uses marine fuel oil, which is considered a low sulfur fuel oil because its sulfur content is between 0.10 and 1.50% mass concentration (https://www.marineinsight.com/guidelines/aguide-to-marine-gas-oil-and-lsfo-used-on-ships/#Sulfur_Content_in_Marine_Gas_Oil). It is unlikely that vessel exhaust resulting from the operation of the R/V *Langseth* will have a measurable impact on ESA-listed marine mammals given the relatively short duration of the proposed action (~38 days), the brief amount of time that whales spend at the surface, and the various regulations to minimize air pollution from vessel exhaust, such as the NSF's compliance with the Act to Prevent Pollution from Ships (33 U.S.C. §§ 1901-1905). For these reasons, the effects that may result from vessel exhaust on ESA-listed marine mammals are considered insignificant.

Discharges into the water from the R/V *Langseth* in the form of wastewater or leakages of fuel or oil are possible, though effects of any spills to ESA-listed marine mammals considered in this opinion will be minimal, if they occur at all. 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. NSF has never had a fuel or oil spill over many years of conducting similar surveys. The R/V *Langseth* is a University-National Oceanographic Laboratory System (UNOLS)-designated vessel, meaning that it must adhere to UNOLS Research Vessel Safety Standards, which include requirements for pollution prevention (UNOLS 2021). Further, given the experience of the researchers and vessel operators in conducting activities in the action area, it is extremely unlikely that spills or discharges of pollutants will occur. Thus, we find that the risk from this potential stressor on ESA-listed marine mammals is discountable.

Wastewater from the vessel will be treated in accordance with U.S. Coast Guard standards (33 C.F.R. parts 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 marine mammals are not likely to be exposed to concentrations of contaminants from wastewater that could lead to adverse responses.

Trash or other debris resulting from the proposed action may affect ESA-listed marine mammals. Any marine debris (e.g., plastic, paper, wood, metal, glass) that might be released would be accidental. The NSF follows standard, established guidance on the handling and disposal of marine trash and debris during the seismic surveys (UNOLS 2021). The gear used in the proposed action may also result in marine debris. The OBSs will be released from the attached anchor and float to the surface for retrieval, leaving the anchor behind as debris on the ocean floor. There will be a total of 150 OBS anchors left behind. The OBS anchors will be made of steel or concrete. Although these anchors can be considered debris, we do not believe they pose an entanglement risk or other hazard to ESA-listed marine mammals. The small amount of debris created by the anchors because of the proposed action compared to the relative size of the available habitat used by ESA-listed marine mammals is insignificant. 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 marine mammals are discountable. The marine debris created by the OBSs will be so small in comparison to the area of seafloor as to be immeasurable; thus, we find that the effects from this potential stressor on ESA-listed marine mammals are insignificant.

Therefore, we conclude that pollution from vessel exhaust, wastewater, fuel or oil spills or leaks, and trash or other debris may affect, but is not likely to adversely affect ESA-listed marine mammals because the effects are either insignificant or discountable, and will not be analyzed further.

### 7.1.2 Vessel Strikes

Vessel traffic associated with the proposed action carries the risk of vessel strikes of ESA-listed marine mammals. In general, the probability of a vessel collision and the associated response depends, in part, on the size and speed of the vessel. The R/V *Langseth* has a length of 235 feet (72 meters) and the operating speed during seismic data acquisition is typically approximately 9.3 kilometers per hour (5 knots) during the OBS seismic refraction survey, and 7.6 kilometers per hour (4.1 knots) during the MCS seismic reflection survey. When not towing seismic survey gear, the R/V *Langseth* typically transits at 18.5 kilometers per hour (10 knots). Because of these slow speeds, the amount of noise produced by the propulsion system and the probability of vessel strike of large whales is reduced (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). The majority of vessel strikes of large whales occur when vessels are traveling at speeds greater than approximately 18.5 kilometers per hour (10 knots), with faster travel, especially of large vessels (80 meters or greater), being more likely to cause serious injury or death (Laist et al. 2001; Jensen and Silber 2004; Vanderlaan and Taggart 2007; Conn and Silber 2013).

Several conservation measures proposed by the Permits Division and/or NSF and L-DEO will minimize the risk of vessel strike to marine mammals, such as the use of PSOs, and ship crew keeping watch while in transit. In addition, the overall level of vessel activity associated with the proposed action is low relative to the large size of the action area, further reducing the likelihood of a vessel strike of an ESA-listed marine mammals.

While vessel strikes of marine mammals during seismic survey activities are possible, we are not aware of any definitive case of a marine mammal being struck by a vessel associated with NSF seismic surveys, including the R/V *Langseth*. The R/V *Langseth* will be traveling at generally low speeds, reducing the probability of a vessel strike for marine mammals (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Personnel on the vessel will maintain watch at all times while in transit. Our expectation of vessel strike being extremely unlikely to occur is due to the hundreds of thousands of kilometers the R/V *Langseth* has traveled without a reported vessel strike, general expected movement of marine mammals away from or parallel to the R/V *Langseth*, as well as the generally slow movement of the R/V *Langseth* during most of its travels (Holst and Smultea 2008; Hauser and Holst 2009; Holst 2010). In addition, adherence to observation and avoidance procedures is also expected to minimize the potential for vessel strikes of marine mammals. All factors considered, we have concluded vessel strike of ESA-listed marine mammals by the research vessel is extremely unlikely to occur and, thus, discountable. Therefore, we conclude that vessel strike may affect, but is not likely to adversely affect ESA-listed marine mammals and will not be analyzed further.

### 7.1.3 Acoustic Noise from the Sub-Bottom Profiler, Multibeam Echosounder, Acoustic Doppler Current Profiler, and Acoustic Release Transponders

Sounds emitted by the SBP, MBES, ADCP, and OBS acoustic release transponders have the potential to affect ESA-listed marine mammals.

Unlike vessels, which produce sound as a byproduct of their operations, MBES, SBP, ADCP, acoustic release transponders, and airgun arrays are designed to actively produce sound and, as such, the characteristics of these sound sources are deliberate and under control. The OBS have an acoustic release transponder that transmits a signal to the instrument at a frequency of 8-11 kHz and a response is received at a frequency of 11.5-13 kHz (operator selectable) to activate and release the instrument. The transmitting beam pattern is 55°. The sound source level is approximately 93 dB.

We do not expect masking of communication will occur to an appreciable extent in ESA-listed marine mammals due to the SBP, MBES, ADCP, and acoustic release transponders's signal directionality, low duty cycle, and brief period when an individual could be within their beam. Behavioral responses to the SBP, MBES, ADCP, and acoustic release transponders 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 SBP, MBES, ADCP, and acoustic release transponders would result in no more than one or two brief ping exposures of any individual cetacean or prey species, if any exposure were to occur. Boebel et al. (2006) and Lurton and DeRuiter (2011) concluded that SBP, MBES, ADCP, and acoustic release transponders similar to those to be used during the proposed seismic survey activities presented a low risk for cetaceans for auditory damage or any other injury.

In addition, we do not expect hearing impairment such as temporary threshold shifts (TTS) and other physical effects if the animal is in the area because 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.

We are unable to quantify the level of exposure of marine mammals to these sound sources, but do not expect any exposure at levels sufficient to cause more than avoidance of the sound source in some species capable of hearing frequencies produced by the SBP, MBES, ADCP, and acoustic release transponders. Thus, the response to exposure is expected to be minor and the effects insignificant. In terms of potential effects from these sound sources on ESA-listed species' prey, like zooplankton, studies of adverse effects on zooplankton from these sources have not been documented. In addition, ADCPs similar to that used in the proposed action have been used in prey mapping zooplankton species (Ochoa et al. 2013) (Parra et al. 2019), to no apparent ill effect. Fish that may exposed to these sound sources that are also prey species for ESA-listed marine mammals are unlikely to be affected, because the sound sources operate at frequencies outside the hearing range of fishes (i.e., above 1 kHz; see section 7.1.4 for more discussion).

We find that the risk from this potential stressor on ESA-listed marine mammals is insignificant. Therefore, we conclude that the SBP, MBES, ADCP, and acoustic release transponders may affect, but are not likely to adversely affect ESA-listed species.

### 7.1.4 Vessel Noise and Visual Disturbance

The research vessel associated with the proposed action may cause visual or auditory disturbances to ESA-listed marine mammals that spend time near the surface or in the upper parts of the water column that may generally disrupt their behavior. Assessing whether the sounds and visual disturbance may adversely affect ESA-listed marine mammals involves understanding the characteristics of the acoustic sources and visibility of the vessel and equipment, the species that may be present in the vicinity, and the effects that sound and visual disturbance may have on the physiology and behavior of those species. Although it is known that sound is important for marine mammal communication, navigation, and foraging (NRC 2003b; NRC 2005a), 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).

Studies have shown that vessel operations can result in changes in the behavior of marine mammals and schooling fishes that may serve as prey for ESA-listed marine mammals. In many cases, particularly when responses are observed at great distances, it is thought that marine mammals are likely responding to sound more than the visual presence of vessels (Evans et al. 1992; Blane and Jaakson 1994; Evans et al. 1994). At close distances, animals may not 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 presences of vessels from those to the sounds associated with those vessels. We consider the effects to marine mammals and prey species from the visual presence of vessels associated with the proposed action to be insignificant and focus on auditory disturbance in our discussion. Depending on the circumstances, exposure to anthropogenic sounds may result in auditory injury, changes in hearing ability, masking of important sounds, or behavioral responses, as well as other physical and physiological responses (see Section 10.4).

Sounds emitted by large vessels (i.e., similar in size to that of the R/V *Langseth*) 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 (Richardson et al. 1995a; Kipple and Gabriele 2007; McKenna et al. 2012).

All fish species can detect vessel noise due to its low-frequency content and their hearing capabilities. Therefore, fishes in the action area that can be prey for ESA-listed whales (e.g., herring [*Clupea spp*.], capelin [*Mallotus villosus*]) 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 visually or 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.

Misund (1997) found that fish (e.g., capelin, herring, cod, jack mackerel (*Trachurus symmetricus*), and haddock (*Melanogrammus aeglefinus*) ahead of a ship showed avoidance reactions at ranges of 50 to 350 meters. When the vessel passed over them, some fish responded with sudden escape responses that included movement away from the vessel laterally or through downward compression of the school. In an early study conducted by Chapman and Hawkins (1973), the authors observed avoidance responses of herring from the low-frequency sounds of large vessels or accelerating small vessels. Avoidance responses quickly ended within 10 seconds after the vessel departed.

The contribution of vessel noise by the R/V *Langseth* is likely small in the overall regional sound field. Brief interruptions in communication via masking are possible, but unlikely given the habits of marine mammals and fish to move away from vessels, either as a result of engine noise, the physical presence of the vessel, or both (Mitson and Knudsen 2003; Lusseau 2006). In addition, during research operations, the R/V *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 marine mammals, 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 risk from this potential stressor is insignificant. Therefore, we conclude that acoustic interference from engine noise may affect, but is not likely to adversely affect ESA-listed marine mammals, or their prey, and will not be analyzed further.

### 7.1.5 Gear Interaction

There is a variety of gear proposed for use during the action that might entangle, strike, or otherwise interact with ESA-listed marine mammals in the action area.

The towed hydrophone streamer could come in direct contact with ESA-listed marine mammals. However, the towed hydrophone streamer is rigid and, as such, will not encircle, wrap around, or in any other way entangle any of the marine mammals considered during this consultation. We expect the taut cables will prevent entanglement. Furthermore, marine mammals 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 marine mammals with the towed gear proposed for use in this action.

We do not expect ESA-listed marine mammals to be at the ocean bottom, so the concerns about equipment strike would primarily be as equipment is being deployed and dropping to the ocean floor. We expect an ESA-listed marine mammal to perceive the disturbance and be able to detect the OBSs, exhibit avoidance behavior, and move out of the way.

Although the towed hydrophone streamer or PAM array could come in direct contact with ESA-listed marine mammals, entanglements are extremely unlikely to occur. 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 likelihood of adverse effects to ESA-listed marine mammals to be discountable. Therefore, gear interactions may affect, but is not likely to adversely affect ESA-listed marine mammals, and will not be analyzed further.

#### 7.1.6 Stressors Considered Further

The only potential stressor that is likely to adversely affect some ESA-listed species within the action area is sound fields produced by the seismic airgun array. This stressor and sound sources associated with seismic survey activities, and the ESA-listed species that may be adversely affected are further analyzed and evaluated in Section 10.

### 7.2 Species Not Likely to be Adversely Affected

There are a number of ESA-listed species that could be in the action area and possibly be exposed to the stressors associated with the proposed action. As discussed previously, most of the stressors associated with the proposed action are not likely to adversely affect any of the listed species in the action area but acoustic sources (i.e., sound fields produced by the seismic airguns and the other equipment used in the survey) may result in adverse effects for some ESA-listed species. For others, the acoustic sources are not likely to result in adverse effects and these species are discussed below.

#### 7.2.1 North Atlantic Right Whales

The ESA-listed North Atlantic right whale may occur in the action area (Section 4) and may be affected by the sound fields generated by airguns associated with the NSF and L-DEO's high-energy seismic survey.

The North Atlantic right whale is a narrowly distributed baleen whale found in temperate and subpolar waters of the North Atlantic Ocean. There are currently two recognized populations of North Atlantic right whales, an eastern and a western population. Today, North Atlantic right whales are primarily found in the western North Atlantic Ocean, from their calving grounds in lower latitudes off the coast of the southeastern United States to their feeding grounds in higher latitudes off the coast of New England and Nova Scotia. In the eastern North Atlantic Ocean, sightings of North Atlantic right whales are rare. Very few individuals likely make up the population in the eastern Atlantic Ocean and the population is thought to be functionally extinct (Best et al. 2001). However, in recent years, a few known individuals from the western population have been seen in the eastern Atlantic Ocean, suggesting some individuals may have wider ranges than previously thought (Kenney 2009).

North Atlantic right whales have been historically recorded south of Greenland and in the Denmark Strait (i.e., the ocean passage between Greenland and Iceland), as well as in the eastern North Atlantic Ocean waters (Kraus and Rolland 2007) with possible historic calving grounds being located in the Mediterranean Sea (Rodrigues et al. 2018). More recently, North Atlantic right whales were acoustically detected in the region in July through October 2007 (Davis et al. 2017). North Atlantic right whale sightings are extremely rare in Iceland, with only 4 sightings since the 1980s, the most recent sighting having occurred in July 2018—a 10-year old male that had been previously sighted in Cape Cod Bay, Massachusetts.[1]

Therefore, based on the overall rarity of North Atlantic right whale in and near the proposed action area, exposure of North Atlantic right whales to the proposed airgun survey is extremely unlikely and thus discountable.

We conclude that the proposed seismic survey activities in the action area are not likely to adversely affect North Atlantic right whales.

# 8 Status of Species Likely to be Adversely Affected

This section identifies and examines the status of ESA-listed blue, fin, sei, sperm, and Cape Verde Islands/Northwest Africa DPS humpback whales that are expected to be adversely affected by acoustic stressors from the airgun array, 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. One factor affecting the range-wide status of cetaceans 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. There are currently four accepted subspecies of blue whale, *B. m. musculus*, which occurs in the Northern Hemisphere, and whose range includes the action area. The blue whale was originally listed as endangered on December 2, 1970 (35 FR 18319).

### 8.1.1 Life History

The average life span of blue whales is 80–90 years. They have a gestation period of 10–12 months, and calves nurse for 6–7 months. Blue whales reach sexual maturity at about 10 (between 5 and 15) years of age with an average calving interval of 2–3 years. Blue whales

[1] https://www.capecodtimes.com/story/news/2018/07/25/rare-right-whale-sighting-in/11266722007/; accessed February 21, 2024.

generally undertake annual migrations; wintering at low latitudes, where they mate, calve and nurse, and summering at high latitudes, where they feed. Blue whales forage almost exclusively on krill and can eat approximately 3,600 kilograms) daily. Feeding aggregations are often found at the continental shelf edge, where upwelling produces concentrations of krill at depths of 90–120 meters. In waters around Iceland, blue whales feed in summer (Akamatsu et al. 2014). Blue whales have been sighted in aerial surveys in June and July in the waters of western Iceland off the Snæfellsnes peninsula, slightly north of the action area, up to about 2001 (Pike et al.), and then mostly absent in more recent surveys in that area. In more recent shipboard surveys, blue whales have been observed more frequently in larger numbers further offshore in the area of the Denmark Strait off east Greenland (Pike et al. 2019).

### 8.1.2 Population Dynamics

The global estimate for mature blue whales in 1926 was approximately 140,000. Between 1868 and 1978, over 380,000 blue whales were killed as a result of commercial whaling. Today, estimates indicate approximately 5,000–15,000 mature blue whales globally (NMFS 2020a).

Based on the results of shipboard surveys from 2015 in the North Atlantic Ocean between the Faroe Islands and East Greenland, from latitude 52° to 72° North, an area roughly encompassing the action area, blue whale abundance is approximately 3,000 individuals (95% CI: 1,377-6,534; CV: 0.40) (Pike et al. 2019). There is no known population growth rate, but there is evidence to suggest that blue whale abundance in the waters around Iceland is increasing (Pike et al. 2009).

Genetic analysis of blue whales in the North Atlantic suggests a single, panmitic population, with low population structuring and high genetic diversity (Jossey et al. 2021; Jossey et al. 2024a). A comparative analysis of blue whale genetic samples from ancient Viking sites in Iceland to contemporary samples showed a decrease in the number of haplotypes in the modern, post-whaling population, from 13 to 3 unique haplotypes (Stacey 2022). Introgression (gene flow from one species into the gene pool of another) has been observed from fin whales to blue whales, and accounts for 3.5% of the North Atlantic blue whale's genome (Jossey et al. 2024b). Blue and fin whale hybrids have been observed in Icelandic waters, including a second generation adult hybrid (Pampoulie et al. 2021).

### 8.1.3 Vocalization and Hearing

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

Calls are short-duration sounds (2–5 seconds) that are transient and frequency-modulated, having a higher frequency range and shorter duration than song units and often sweeping down in frequency (80–20 Hz), with seasonally variable occurrence. Blue whale calls have high acoustic energy, with reports of source levels ranging from 180–195 decibels (dB) re: 1 μPa (referenced to a pressure of 1 microPascal) at 1 m (Cummings and Thompson 1971; Aburto et al. 1997;

Ketten 1998; McDonald et al. 2001; Clark and Gagnon 2004a; Berchok et al. 2006; 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 than 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), while deeper diving whales (greater than 50 meters) were likely feeding and calling less.

Although general characteristics of blue whale calls are shared in distinct regions (Thompson et al. 1996; McDonald et al. 2001; Mellinger and Clark 2003; Rankin et al. 2005), 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 (Mellinger and Clark 2003; Berchok et al. 2006; Samaran et al. 2010).

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 1–5 units (Payne and McVay 1971; Mellinger and Clark 2003). 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). In other ocean basins, there has been a documented decrease in blue whale song call frequency (McDonald et al. 2009) (Rice et al. 2022). The reason for this change is unknown, as is whether or not blue whale calls in the North Atlantic are exhibiting a similar decrease.

As with other baleen whale vocalizations, blue whale vocalization function is unknown, although numerous hypotheses exist (maintaining spacing between individuals, recognition, socialization, navigation, contextual information transmission, and location of prey resources) (Payne and Webb 1971; Thompson et al. 1992b; Edds-Walton 1997; Oleson et al. 2007b). 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. Short, rapid sequences of 30–90 Hz calls are associated with socialization and may be displays by males based upon call seasonality and structure. The low frequency sounds produced by blue whales can, in theory, travel long distances, and it is possible that such long distance communication occurs (Payne and Webb 1971; Edds-Walton 1997). The long-range sounds may also be used for echolocation in orientation or navigation (Tyack 1999).

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 (Richardson et al. 1995a; Ketten 1997). Based on vocalizations and anatomy, blue whales are assumed to predominantly hear low frequency sounds below 400 Hz (Croll et al. 2001b; Stafford and Moore 2005; Oleson et al. 2007c). In terms of functional hearing capability, blue whales belong to the low frequency group, which have a hearing range of 7 Hz–35 kHz (NOAA 2018). Recently, Southall et al. (2019) revised their marine mammal hearing groups, and there is evidence that blue whales, along with a few other mysticete species, are sensitive to very low frequencies and should be treated separately, as very low frequency, from the low frequency group.

#### 8.1.4 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 19$^{th}$ to mid-20$^{th}$ centuries. According to historical whaling records, from 1889 to 1915, an estimated 5,800 blue whales were harvested at a whaling station in west Iceland. From 1948 to 1985, the single whaling company in Iceland harvested 163 blue whales (Sigurjónsson 1988; Hamaguchi 2021).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.

#### 8.1.5 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover blue whale populations. These threats will be discussed in further detail in the Environmental Baseline of this consultation. NMFS defines nine blue whale management units in the Revised Recovery Plan (NMFS 2020b). The 2 main objectives for the blue whale for complete downlisting/delisting criteria are:

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

### 8.2 Fin Whale

The fin whale is a large, widely distributed baleen whale found in all major oceans (North Pacific Ocean, North Atlantic Ocean, and Southern Hemisphere) and is currently comprised of two recognized subspecies (recognized by the Society for Marine Mammalogy's Committee on Taxonomy): *B. p. physalus* in the North Atlantic Ocean, *B. p. velifera* in the North Pacific Ocean, and *B. p. quoyi* in the Southern Hemisphere. The *B. p. physalus* subspecies would be exposed during the proposed action. The fin whale was originally listed as endangered on December 2, 1970 (35 FR 18319).

### 8.2.1 Life History

Fin whales can live, on average, 80–90 years. They have a gestation period of less than 1 year, and calves nurse for 6–7 months. Sexual maturity is reached between 6 and 10 years of age with an average calving interval of 2–3 years. They mostly inhabit deep, offshore waters of all major oceans. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed, although some fin whales appear to be residential to certain areas (e.g., in the North Atlantic). Fin whales eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lance (NMFS 2010a).

### 8.2.2 Population Dynamics

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. In the North Atlantic Ocean, at least 55,000 fin whales were killed between 1910 and 1989. According to Pike et al. (2019) using data from surveys conducted between 1987 and 2015, the abundance estimate for fin whales in the waters surrounding Greenland, Iceland, and the Faroe Islands was 36,773 (CV=0.17; 95% CI 25,811-52,392).

Population trends for fin whales in the action area is not currently available, though there is some evidence for an overall increase in fin whale abundance in the wider North Atlantic (Pike et al. 2019).

In the North Atlantic Sightings Surveys that took place in and around the action area, fin whales were the most abundant species sighted. There was some observed seasonal differences in fin whale density, with densities being 3 times higher during fall surveys (late August and September) than the summer surveys (in June and July) (Pike et al. 2019).

### 8.2.3 Vocalizations and Hearing

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

The most common fin whale vocalization is what is called a 20 Hz pulse (or 20 Hz note), which is a downswept pulse (30–15 Hz) that lasts about 1 second, and can reach source levels of 189 ± 4 dB re: 1 µPa at 1 meter and can be detected tens of kilometers away (Watkins 1981; Watkins et al. 1987a; Watkins et al. 1987b; Edds 1988; Richardson et al. 1995a; Richardson et al. 1995b; Charif et al. 2002a; Charif et al. 2002b; Clark et al. 2002b; Clark et al. 2002a; Sirovic et al. 2007b; Sirovic et al. 2007a; Garcia et al. 2018). The 20 Hz 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 song is 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 Hz pulse, by the presence of doublets or triplets, or by the internote interval (also called the interpulse interval), or time between 20 Hz pulses. For example, in Massachusetts Bay and the New York Bight, internote interval varies throughout the year: a "short internote interval " season between September and January, and a "long internote interval " season between March and May, where months in between these seasons are transitional- internote interval months (Morano et al. 2012). Because these internote interval patterns are not different between Massachusetts Bay and the New York Bight, it is thought that these changes in internote interval, 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 internote interval s were significantly different, indicating two subpopulations.

Another less common fin whale vocalization is the 40 Hz pulse (75–40 Hz), which is also a downsweep lasting less than 1 second. Fin whale 40 Hz pulses has a similar, but slightly lower, source level as 20 Hz pulses (Wiggins and Hildebrand 2020). It has been noted that fin whale 40 Hz pulses were generally produced by animals in groups, in foraging contexts such as surface feeding or foraging dives (Watkins 1981; Watkins et al. 1987a; Watkins et al. 1987b; Edds 1988; Richardson et al. 1995a; Richardson et al. 1995b; Croll et al. 2001a; Charif et al. 2002a; Charif et al. 2002b; Clark et al. 2002b; Clark et al. 2002a; Sirovic et al. 2007b; Sirovic et al. 2007a; Garcia et al. 2018). Fin whale 40 Hz pulses were strongly influenced by prey biomass (unlike season for the reproductive-context 20 Hz pulses) (Romagosa et al. 2021). Thus, fin whale 40 Hz pulses are thought to be produced in a foraging context.

Some researchers have also recorded moans of 14–118 Hz, with a dominant frequency of 20 Hz, tonal and upsweep vocalizations of 34–150 Hz, and songs of 17–25 Hz (Watkins 1981; Edds 1988; Cummings and Thompson 1994; Garcia et al. 2018). In general, sound source levels for fin whale vocalizations are 140–200 dB re: 1 μPa at 1 meter (as compiled by Erbe 2002c; as compiled by Erbe 2002b; see also Clark and Gagnon 2004a; see also Clark and Gagnon 2004b). The source depth of calling fin whales has been reported to be about 50 m (164 ft) (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 frequency) and are likely most sensitive to this frequency range (Richardson et al. 1995a; Ketten 1997). 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 Hz and 12 kHz. In the examined fin whale calf skull, a maximum sensitivity to sounds in the 1–2 kHz 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 Hz–35 kHz (NOAA 2018). Wiggins and Hildebrand (2020) report a less common fin whale vocalization: a 40 Hz pulse (75–40 Hz), which is also a downsweep lasting less than 1 second. Fin whale 40 Hz pulses has a similar, but slightly lower, source level as 20 Hz pulses. Fin whale 40 Hz pulses were strongly influenced by prey biomass (unlike season for the reproductive-context 20 Hz pulses (Romagosa et al. 2021). Thus, fin whale 40 Hz pulses are thought to be produced in a foraging context.

Recently, Southall et al. (2019) revised their marine mammal hearing groups, and there is evidence that fin 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.

### 8.2.4 Status

The fin whale is endangered because of past commercial whaling. Prior to commercial whaling, hundreds of thousands of fin whales existed. According to historical whaling records, from 1889 to 1915, an estimated 8,100 fin whales were harvested at a whaling station in west Iceland. From 1948 to 1985, the single whaling company in Iceland harvested 8,887 fin whales (Sigurjónsson 1988; Hamaguchi 2021). Fin whales may be killed under "aboriginal subsistence whaling" in Greenland and due to 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 sound. The species' overall large population size may provide some resilience to current threats, but trends are largely unknown.

In waters around Iceland and the action area, fin whales are the most commonly sighted cetacean species during vessel surveys, with density highest in areas west of Iceland (Pike et al. 2019).

### 8.2.5 Recovery Goals

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

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

## 8.3 Humpback Whale—Cape Verde Islands/Northwest Africa DPS

The humpback whale is a widely distributed baleen whale found in all major oceans. The humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde

Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico).

NMFS identifies two DPSs of humpback whales that may occur in the action area: Cape Verde Islands/Northwest Africa and the West Indies (not listed under the ESA).

### 8.3.1 Life History

Humpback whales can live on average 50 years. They have a gestation period of 11–12 months, and calves nurse for 1 year. Sexual maturity is reached between 5–11 years of age with an average calving interval of 2–3 years. Humpback whales mostly inhabit coastal and continental shelf waters. They winter at lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales exhibit a wide range of foraging behaviors and feed on a range of prey types, including: small schooling fishes, euphausiids, and other large zooplankton (Bettridge et al. 2015). Capelin is considered the primary prey for humpback whales in the North Atlantic (Johnson and Wolman 1984).

### 8.3.2 Population Dynamics

The global, pre-exploitation estimate for humpback whales is 1,000,000 individuals (Roman and Palumbi 2003). The current abundance of the Cape Verde Islands/Northwest Africa DPS of humpback whales is unknown (81 FR 62259). Ryan et al. (2014) states that the best abundance estimate for the Cape Verde Islands/Northwest Africa DPS of humpback whales is 171–260 animals, which is higher than the 99 animals previously reported by Punt et al. (2006). Wenzel et al. (2020b) have reanalyzed the population size of the Cape Verde Islands/Northwest Africa DPS of humpback whales from 2010 through 2018 and state the abundance estimate is just under approximately 300 animals (approximately 272 individuals). A population growth rate is currently unavailable for the Cape Verde Islands/Northwest Africa DPS of humpback whales. Based on the abundance estimates developed by Pike et al. (2019), there are about 9,867 humpback whales in the waters near Greenland, Iceland, and the Faroe Islands (95% CI 4,854-20,058). These surveys occurred in June and July, and late August to September, and the densities for humpback whales in summer and fall were similar.

For humpback whales, DPSs that have a total population size of 2,000–2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Distinct population segments 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. Population 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.

The Cape Verde Islands/Northwest Africa DPS consists of humpback whales whose breeding range includes waters surrounding the Cape Verde Islands as well as undetermined breeding area in the tropical eastern Atlantic Ocean, and possibly the Caribbean Sea. Evidence shows that some humpback whales using eastern North Atlantic Ocean feeding areas that migrate to the Cape Verde Islands (Reiner et al. 1996; Wenzel et al. 2009; Stevick et al. 2016) as four have been photographed and identified in both the Cape Verde Islands and the Caribbean Sea (Stevick et al. 2016). Cape Verde Islands/Northwest Africa DPS humpback whales feed in the North Atlantic Ocean, as do humpback whales from the non-listed West Indies DPS. A mother-calf pair from the West Indies was identified on an Icelandic feeding ground (Basran et al. 2023). An individual sighted near the Cape Verde Islands was later identified in a feeding area off West Greenland (Chosson et al. 2024).

Some low-level movement between geographically different breeding areas separated by an ocean basin with some level of individual interchange is not unusual for humpback whales (e.g., North Pacific Ocean, Australia/Oceania). Preliminary results from whaling records, photo-identification, and genetic analysis studies suggest that the Cape Verde Islands/Northwest Africa DPS is reproductively isolated from other populations (e.g., West Indies DPS) breeding in other locations in the North Atlantic Ocean (Ryan et al. 2014). Twelve humpback whales were identified in both Cape Verde Islands and in Iceland (Wenzel et al. 2020a). An examination of photo-identification records of humpback whales on three feeding grounds in the region—West Greenland, East Greenland, and Husavik, Iceland—indicated that there is very little movement between these 3 feeding grounds (Morin 2019). Other studies have also noted a limited amount of movement between North Atlantic feeding grounds (Palsbøll et al. 1997).

During cetacean surveys in the area, humpback whales were most commonly sighted to the north and northwest of Iceland, with no sightings to the south of Iceland (i.e., the area where the proposed action will occur). Single individuals were sighted most frequently, with groups of up to seven whales observed rarely (Pike et al. 2019). Humpback whales have consistently been observed in areas of high capelin density in the summer and fall, as well as into the winter, especially to the north and northwest of Iceland (Pike et al. 2019). Humpback whale singing has been recorded throughout January and March in northeast Iceland (Magnúsdóttir and Lim 2019).

### 8.3.3 Vocalizations and Hearing

Among the most-well-studied whale vocalizations are those of humpback whales. Humpback whale vocalizations are generally divided into song and non-song (or social) calls (Payne and McVay 1971; Mellinger and Clark 2003; Dunlop et al. 2008b). Different vocalizations correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008a). These vocalizations range from 20 Hz–12 kHz: humpback whale song, produced by males usually while in low-latitude breeding areas, generally occurs across a frequency range of 20 Hz–4 kHz with estimated source levels from 144–195 dB re: 1 μPa (Winn et al. 1970; Richardson et al. 1995a; Au and Green 2000; Frazer and Mercado 2000). Males also produce sounds associated with aggression, which are generally characterized by frequencies between 50 Hz–10 kHz with most energy below 3 kHz (Tyack 1983; Silber 1986). Such sounds can be heard up to 9 kilometers (4.9 nautical miles) away (Tyack 1983). Other social sounds from 50 Hz–10 kHz (most energy below 3 kHz) are also produced in breeding areas (Tyack 1983; Richardson et al. 1995a). While in northern feeding areas, both sexes vocalize in grunts (25 Hz–1.9 kHz), pulses (25–89 Hz) and songs (ranging from 30 Hz–8 kHz but dominant frequencies of 120 Hz–4 kHz), which can be very loud (175–192 dB re: 1 µPa at 1 m) (Payne 1985; Thompson et al. 1986; Richardson et al. 1995a; Au and Green 2000; Erbe 2002a). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995a).

Humpback whale song is the best-known vocalization produced by humpback whales. Humpback whale song is highly stereotyped and repetitive, and have a hierarchical structure comprised of themes, which consist of different repeated phrases, which in turn are composed of song units (Payne and McVay 1971; Mellinger and Clark 2003). Song is thought to function in a reproductive context (reproductive display, sexual selection) on winter breeding grounds, as song is only produced by adult males (Schevill et al. 1964; Helweg et al. 1992; Gabriele and Frankel. 2002; Clark and Clapham 2004; Smith et al. 2008). Although song is most common on breeding grounds during the winter and spring months, song has been recorded in other regions (feeding areas and on migration) and seasons (Mcsweeney et al. 1989; Gabriele and Frankel. 2002; Clark and Clapham 2004). Guazzo et al. (2020) observed an increase in song source levels when background noise levels increased. All male humpback whales in a population sing the same song, although changes in the pattern a population's song occurs approximately each year or few years through cultural evolution (Winn and Winn 1978). All singers adopt those changes; however, cultural transmission (i.e., song-sharing) has also been observed between different populations (Noad et al. 2000; Garland et al. 2011; Garland et al. 2013; Schulze et al. 2022). Humpback whales' non-song call (known as 'calls' or 'social calls') repertoire is complex and varied, can be stable or variable through time, and even incorporated into song (Dunlop et al. 2007); (Rekdahl et al. 2013). Calls are produced by males, females, and juveniles (Dunlop et al. 2007). Calls are produced in a variety of contexts, including during feeding, migrating, mating, and other social contexts (Dunlop et al. 2007; Fournet et al. 2015). Calls are generally of shorter duration than song (seconds versus minutes to hours), and are also produced at a lower source level than song (113–157 dB re: 1 µPa at 1 meter [rms]; (Fournet et al. 2018b). However, during migration, recorded calls are more similar in source level to song (128–184 dB re: 1 µPa at 1 meter [rms]; (Fournet et al. 2018b). Calls generally range from 9 Hz–10 kHz, with dominant frequencies below 3 kHz (D'Vincent et al. 1985; Silber 1986; Simao and Moreira 2005; Dunlop et al. 2008a). Female vocalizations appear to be simple; Simao and Moreira (2005) noted little complexity.

Of the non-song calls, only one call has been definitively linked to foraging (D'Vincent et al. 1985; Silber 1986; Simao and Moreira 2005; Dunlop et al. 2008a); (Fournet et al. 2018a). The "feeding call" is a highly stereotyped tonal call with a peak frequency of approximately 500 Hz (D'Vincent et al. 1985; Thompson et al. 1986). So far, this call has only been documented among groups of humpback whales, engaged in cooperative or synchronized foraging events on Pacific herring (*Clupea pallasii*) in Alaska (D'Vincent et al. 1985; Thompson et al. 1986). (Stimpert et al. 2007) also documented calls they termed "megapclicks", which resemble the high-frequency echolocation clicks of odontocetes, but at a lower frequency range (800 Hz–1.7 kHz). These megapclicks were recorded in the northwest Atlantic Ocean has been documented with DTAGs, which can record sound and body orientation (Stimpert et al. 2007). Based on the recorded body orientation, (Stimpert et al. 2007) concluded that tagged humpback whales were lunging underwater, which is associated with nocturnal feeding at depth, and that the recorded megapclicks were associated with this foraging behavior. Received levels at the DTAGs were 143–154 dB re: 1 µPa, with the majority of acoustic energy below 2 kHz.

NMFS categorizes humpback whales in the low-frequency cetacean functional hearing group, with an applied frequency range between 7 Hz and 35 kHz (NMFS 2018). Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hz–10 kHz, with maximum relative sensitivity between 2 kHz and 6 kHz (Ketten and Mountain 2014). Research by Au et al. (2001) and Au et al. (2006) indicated the presence of high frequency harmonics in vocalizations up to and beyond 24 kHz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpback whales can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpback whales to hear frequencies around 3 kHz may have been demonstrated in a playback study. Maybaum (1990) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kHz at 219 dB re: 1 µPa at 1 m or frequency sweep of 3.1–3.6 kHz. In addition, the system had some low frequency components (below 1 kHz) which may have been an artifact of the acoustic equipment. This possible artifact may have affected the response of the whales to both the control and sonar playback conditions.

### 8.3.4 Status

Humpback whales were originally listed as endangered because of past commercial whaling, and the five DPSs that remain listed (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, Arabian Sea, and Mexico) have likely not yet recovered from this. According to historical whaling records, from 1889 to 1915, an estimated 2,800 humpback whales were harvested at a whaling station in west Iceland. From 1948 to 1985, the single whaling company in Iceland harvested 6 humpback whales (Sigurjónsson 1988; Hamaguchi 2021). We have no way of knowing the degree to which a specific DPS of humpback whale was affected by historical whaling. However, it is likely that individuals from the Cape Verde Islands/Northwest Africa DPS were taken, based on where the whalers were hunting off Iceland (i.e., one of the purported feeding grounds for this population segment). Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (IUCN 2012). Humpback whales may be killed under "aboriginal subsistence whaling" and "scientific permit whaling" provisions of the International Whaling Commission in Greenland. Additional threats include fisheries interactions (including entanglement), energy development, and harassment from whaling watching noise, harmful algal blooms, disease, parasites, and climate change. Due to on-going threats, and the purported low population size, the Cape Verde Islands/Northwest Africa DPS still faces a risk of extinction.

### 8.3.5 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover humpback whale populations. These threats will be discussed in further detail in the Environmental Baseline of this consultation. See the 1991 Final Recovery Plan for the humpback whale (NMFS 1991a) for the complete downlisting/delisting criteria for each of the four following recovery goals:

1. Maintain and enhance habitats used by humpback whales currently or historically.
2. Identify and reduce direct human-related injury and mortality.
3. Measure and monitor key population parameters.
4. Improve administration and coordination of recovery program for humpback whales.

## 8.4 Sei Whale

The sei whale is a widely distributed baleen whale found in all major oceans. Two sub-species of sei whale are recognized, *B. b. borealis* in the Northern Hemisphere (found within the action area) and *B. b. schlegellii* in the Southern Hemisphere. The sei whale was originally listed as endangered on December 2, 1970 (35 FR 18319).

### 8.4.1 Life History

Sei whales life span is about 60 years (Wiles 2017). They have a gestation period of approximately 10.5 months, calves nurse for 6–9 months, and the average calving interval is 2–3 years. Sexual maturity is thought to be reached between 8–10 years of age; however, a more recent study on age determination, based on growth layers in earplugs, of sei whales in the western North Pacific Ocean found that age at sexual maturity was 6.7 for males, and 6.9 for females (Bando and Maeda 2020).

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

### 8.4.2 Population Dynamics

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. Pike et al. (2019) developed an estimate of 9,737 sei whales (95% CI 4,189-19,665) in the waters of the North Atlantic near Greenland, Iceland, and the Faroe Islands.

Population growth rates for sei whales are not available due to a lack of information in the region.

Based on genetic analyses, there appears to be some differentiation between sei whale populations in different ocean basins. The North Atlantic and North Pacific populations showing significant genetic divergence, with no significant genetic deviations between samples taken from North Atlantic sei whales (Huijser et al. 2018).

Based on historic whaling records, sei whale presence in the waters off western Iceland showed a peak in late August and September. Sei whales tend to congregate at ocean fronts to feed on euphausiids and copepods, which are ephemeral and can explain seasonal differences in annual distribution (Pike et al. 2019).

### 8.4.3 Vocalizations 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 six 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 Hz, 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 Hz. (Calderan et al. 2014) also documented downsweep and upsweep calls in the Southern Ocean: all calls were between 34 and 87 Hz and lasted on average 1.1 second. Off the Falkland Islands, 5 categories of calls were described including downsweeps (100 to 30 Hz or 160 to 30 Hz, some occurring in doublets or with a short initial upsweep "hook"), upsweeps (roughly 20 to 70 Hz 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 Ocean and North Atlantic Ocean are downsweep calls. There are two types of downsweeps that have been recorded, one that is generally 100 to 30 Hz and are just over 1 second long, and 1 that is generally lower-frequency (40 or 50 Hz to 20 or 30 Hz) 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., (Tremblay et al. 2019); (Español-Jiménez 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 to 44 Hz over 1 second, and downsweeps 39 to 21 Hz over 1.3

seconds. In the southeastern Pacific (downsweeps 93 to 42 Hz and 1.6 seconds long occurring mostly in pairs but also triplets and singlets (Español-Jiménez et al. 2019), in the mid-Atlantic Ocean (downsweeps 100 to 37 Hz and 1.2 seconds; (Romagosa et al. 2015), and in the western North Atlantic Ocean (downsweeps 82 to 34 Hz and 1.4 seconds long occurring mostly as a single call with some pairs and rare triplets; and downsweeps 50 to 30 Hz 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 Ocean based on the repetition of certain patterns of calls. Source levels for downsweeps recorded in the mid-Atlantic Ocean 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 (Richardson et al. 1995a; Ketten 1997). 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 Hz to 35 kHz (NOAA 2018). Recently, (Southall et al. 2019) revised their marine mammal hearing groups, and there is evidence that sei 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.

### 8.4.4 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). From 1948 to 1985, the single whaling company in Iceland harvested 2,574 sei whales (Sigurjónsson 1988; Hamaguchi 2021). Now, only a few individuals are taken each year by Japan; however, Iceland has expressed an interest in targeting sei whales, although recent whaling efforts have focused on fin and minke (*Balaenoptera acutorostrata*) 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.

### 8.4.5 Recovery Goals

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

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

## 8.5 Sperm Whale

The sperm whale is a widely distributed species found in all major oceans. Sperm whales were first listed under the precursor to the ESA, the Endangered Species Conservation Act of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 FR 18319, December 2, 1970).

### 8.5.1 Life History

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

The average lifespan of sperm whales is estimated to be at least 50 years (Whitehead 2009a). They have a gestation period of one to one and a half years, and calves nurse for approximately 2 years. Sexual maturity is reached between 7 and 13 years of age for females with an average calving interval of 4 to 6 years. Male sperm whales reach full sexual maturity in their twenties. Sperm whales have a strong preference for waters deeper than 1,000 meters (3281 feet; Watkins 1977; Reeves and Whitehead 1997), although Berzin (1971) reported that they are restricted to waters deeper than 300 meters (984 feet). While deep water is their typical habitat, sperm whales are occasionally found in waters less than 300 meters (984 feet) in depth (Clarke 1956; Rice 1989). When they are found relatively close to shore, sperm whales are usually associated with sharp increases in topography where upwelling occurs and biological production is high, implying the presence of a good food supply (Clarke 1956). Such areas include oceanic islands and along the outer continental shelf. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed primarily on squid; other prey includes octopus and demersal fish (including teleosts and elasmobranchs).

### 8.5.2 Population Dynamics

The sperm whale is the most abundant of the large whale species, with an estimated global population of 844,761 individuals (CV= 0.209); pre-whaling global population estimates a population size of 1,949,698 (CV= 0.178) sperm whales (Whitehead and Shin 2022).

Based on the North Atlantic Sightings Surveys which took place in and near the action area from 1987-2015, there are an estimated 7,257 sperm whales (CV=0.35; 95% CI 3,461-15,215) (Pike et al. 2019). Taking into account other survey estimates in the region, Pike et al. (2019) estimated there are likely more than 30,000 sperm whales occupying the central and eastern North Atlantic Ocean in summer.

Ocean-wide genetic studies indicate sperm whales have low genetic diversity, suggesting a recent bottleneck, but strong differentiation between matrilineally related groups (Lyrholm and

Gyllensten 1998). Sperm whales from the Gulf of Mexico, the western North Atlantic, the North Sea, and the Mediterranean Sea all have been shown to have low levels of genetic diversity (Engelhaupt et al. 2009). Sperm whales in the North Atlantic are genetically differentiated from populations in the Mediterranean Sea (Violi et al. 2023). 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.

There is no clear population trend available for sperm whales in the action area, or globally. Sperm whale populations in the Gulf of Mexico, eastern Caribbean, and Mediterranean Sea are thought to be in decline, but there is uncertainty about the available data to support these observations (Whitehead and Shin 2022).

In cetacean surveys of waters surrounding Greenland, Iceland, and the Faroe Islands, sperm whales were found throughout the area, with the greatest number of sightings between Iceland and the Faroe Islands (i.e., to the east and south of the action area). Nearly all of the sightings were individual sperm whales (presumably males). Only male sperm whales have been captured or stranded in Iceland, reflecting what is thought to be a sexual segregation of sperm whales, with males occurring in more northern latitudes, and females with young staying further south (Pike et al. 2019). Acoustic detections off Iceland indicate seasonal occurrence of sperm whales, with low rates of detection in February and March, increasing detections in spring, to a peak in June through August (Dutro 2023). Adult male sperm whales are known to migrate high-latitude areas. At high Arctic locations off northern and western Svalbard, Norway, sperm whales were detected in late summer through January, with no detections in February, March, and April (Pöyhönen et al. 2024). The timing of these detections, and the detections off Iceland, indicate that sperm whales are migrating through the action area to reach these northern areas.

### 8.5.3 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 1999b). Sperm whales typically produce short duration repetitive broadband clicks with frequencies below 100 Hz to greater than 30 kHz (Watkins 1977) and dominant frequencies between 1-6 kHz and 10-16 kHz. Another class of sound, "squeals," are produced with frequencies of 100 Hz to 20 kHz (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 (Weilgart and Whitehead 1993; Goold and Jones 1995; Weilgart and Whitehead 1997; Mohl et al. 2003). Most of the energy in sperm whale clicks is concentrated at around 2-4 kHz and 10-16 kHz (Weilgart and Whitehead 1993; Goold and Jones 1995). The clicks of neonate sperm whales are very different from typical clicks of adults in that they are of low directionality, long duration, and low frequency (between 300 Hz and 1.7 kHz) with estimated source levels between 140-162 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 (Whitehead and Weilgart 1991; Weilgart and Whitehead 1993; Goold and Jones 1995; Weilgart and Whitehead 1997; Miller et al. 2004). 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 (Miller et al. 2004; Laplanche et al. 2005). 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 (Weilgart and Whitehead 1997; Rendell and Whitehead 2004). 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 (Weilgart and Whitehead 1997; Pavan et al. 2000). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean Sea and those in the Pacific Ocean (Weilgart and Whitehead 1997). Three coda types used by male sperm whales have recently been described from data collected over multiple years: these codas are associated with dive cycles, socializing, and alarm (Frantzis and Alexiadou 2008).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potentials were recorded (Carder and Ridgway 1990). From this whale, responses support a hearing range of 2.5-60 kHz and highest sensitivity to frequencies between 5-20 kHz. 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 and Schevill 1975b; Watkins et al. 1985a). In the Caribbean Sea, Watkins et al. (1985a) observed that sperm whales exposed to 3.25-8.4 kHz pulses (presumed to be from submarine sonar) interrupted their activities and left the area. Similar reactions were observed from artificial sound generated by banging on a boat hull (Watkins et al. 1985a). André et al. (1997) reported that foraging whales exposed to a 10 kHz 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. Thode et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel's propeller (110 dB re: 1 $\mu Pa^2$-s between 250 Hz and 1 kHz) 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 Hz and 160 kHz (NOAA 2018).

### 8.5.4 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. According to historical whaling records, from 1889 to 1915, an estimated 8,100 fin whales were harvested at a whaling station in west Iceland. From 1948 to 1985, the single whaling company in Iceland harvested 2,886 sperm whales (Sigurjónsson 1988; Hamaguchi 2021). Sperm whales are no longer targeted by commercial whaling in Iceland or elsewhere in the North Atlantic, however, based on unconfirmed reports of non-IWC members (e.g., Indonesia and Japan), hunting of sperm whales may occur at biologically unsustainable levels (NMFS 2015a). Continued threats to sperm whale populations include ship strikes, entanglement in fishing gear, competition for resources due to overfishing, loss of prey and habitat due to climate change, and noise.

### 8.5.5 Recovery Goals

See the 2010 Final Recovery Plan for the sperm whale (NMFS 2010b) for complete downlisting/delisting criteria for both of the following recovery goals:

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

# 9 ENVIRONMENTAL BASELINE

The *"environmental baseline"* refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (89 FR 24268). In this section, we discuss the environmental baseline within the action area as it applies to species that are likely to be adversely affected by the proposed action.

A number of human activities have contributed to the status of populations of ESA-listed marine mammals (blue, fin, Cape Verde Islands/Northwest Africa DPS humpback, sei, and sperm whale) in the action area. Some human activities are ongoing and appear to continue to affect marine mammal 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, vessel interactions (vessel strike), 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 endangered individuals that occur in the action area that are likely to be adversely affected by the high-energy seismic survey activities considered in this 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 action.

## 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 (Powell 2017; Lynas et al. 2021). 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 resources. NOAA's climate information portal provides basic background information on these and other measured or anticipated climate change effects (see https://www.climate.gov).

Over the last 150 years, the world has warmed as humans have continued to add heat-trapping greenhouse gases to the atmosphere (Figure 2) (Hayhoe et al. 2018; IPCC 2022). This warming has triggered many changes in the earth's climate. Numerous independent lines of evidence have documented these changes, from the atmosphere to the ocean to the poles. This warming, primarily in response to human activities, is causing widespread effects in the physical environment, including more intense storms, melting glaciers, disappearing snow cover, shrinking sea ice, rising sea levels, changes in rainfall patterns, and shifting droughts (Wuebbles et al. 2017). Globally, surface temperatures have increased by 0.99°C in recent decades (2001-2020) compared to the pre-industrial average from 1850-1900 (IPCC 2022). This warming has occurred over nearly the entirety of the earth's surface. Precipitation has also increased as the earth's atmosphere warms and contains more water vapor. However, the changes in precipitation are uneven, with patterns of wetting and drying interspersed around the planet. As the earth warms, melting ice from land surfaces and expanding ocean volume has resulted in global mean sea levels to rise by 0.20 meters between 1901 and 2018 (IPCC 2022).

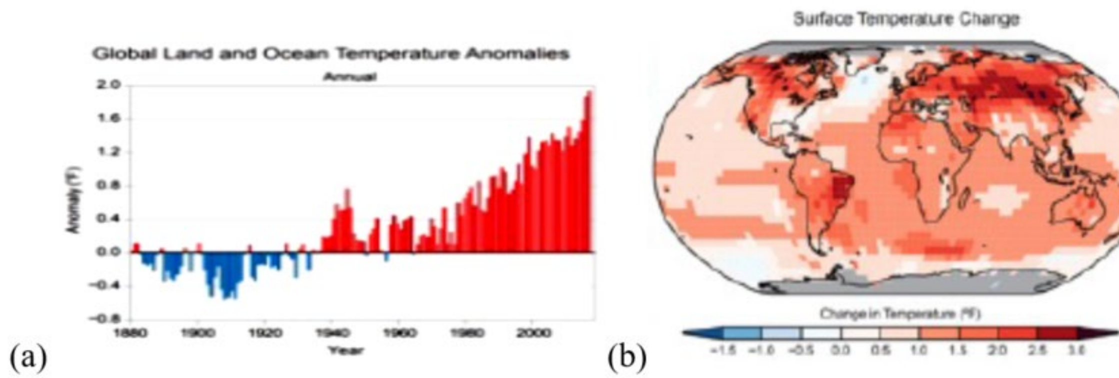


**Figure 2. Global annual average temperature (a) Red bars show temperatures above the 1901-1960 average, and blue bars indicate temperatures below the average. (b) From 1986 -2016 global average surface temperature increased by 0.7° Celsius compared to 1901-1960 (Wuebbles et al. 2017) and by 0.99° Celsius from 2001-2020 compared to 1850-1900 (IPCC 2022).**

Evidence shows that the Arctic is warming faster than the rest of the globe. Compared to 1961-1990 mean temperatures in Iceland, the periods 1991-2000 and 2001-2010 were up to 1.25°C warmer on average (Crochet and Jóhannesson 2011). In Iceland, the recent warming trend of 0.47°C/decade since 1980 is 3 times as fast as global warming average over the same time (NLSI 2018). Observed and projected air temperature in the Arctic (i.e., areas above 60°N, partially encompassing the action area) is twice the global mean (Overland et al. 2019).

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.

Several of the most important threats contributing to the extinction risk of proposed and ESA-listed species, particularly those with a calcium carbonate skeleton such as corals and mollusks, as well as species like ESA-listed sea turtles for which these animals serve as prey or habitat, are related to global climate change. The main concerns regarding impacts of global climate change on coral reefs and other calcium carbonate habitats generally, and on proposed and ESA-listed corals and mollusks in particular are the magnitude and the rapid pace of change in greenhouse gas concentrations (e.g., carbon dioxide and methane) and atmospheric warming since the Industrial Revolution in the mid-19th century. These changes are increasing the warming of the global climate system and altering the carbonate chemistry of the ocean (ocean acidification; IPCC 2014). As carbon dioxide concentrations increase in the atmosphere, more carbon dioxide is absorbed by the oceans, causing lower pH and reduced availability of calcium carbonate. Because of the increase in carbon dioxide and other greenhouse gases in the atmosphere since the Industrial Revolution, ocean acidification has already occurred throughout the world's oceans, and is predicted to increase considerably between now and 2100 (IPCC 2014).

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 ESA-listed species including marine mammals. Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012).

Similarly, climate-related changes in important prey species populations are likely to affect predator populations. Pecl and Jackson (2008) predicted climate change will likely result in squid that hatch out smaller and earlier, undergo faster growth over shorter life-spans, and mature younger at a smaller size. This could have negative consequences for species such as sperm whales, whose diets can be dominated by cephalopods. For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperatures regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott 2009).

Even if global warming is limited to 2°C, feedback loops caused by increasing sea ice loss, glacier sea ice loss, less snow, more rain, melting permafrost, and rising ocean temperatures will result in an average temperature increase of around 4°C (Overland et al. 2019; IPCC 2022). In the marine environment, these feedback loops will result in a warmer, less saline ocean, altering habitat conditions for zooplankton, causing cascading effects for the entire food web (Thomas et al. 2022). For example, the boreal copepod, *Calanus finmarchicus*, has recently shifted its distribution towards the pole, and can complete its life cycle in the Arctic due to warmer conditions brought on by climate change. The formerly local Arctic copepod species, *C. glacialis* and *C. hyperoeus*, have shifted further north. The young of the year boreal fish species like capelin, Atlantic cod, and mackerel (*Scomber scombrus*), eat eggs of *C. finmarchicus*, and these fish are found in increasing abundance in the Arctic (e.g., the Barents Sea) (Tarling et al. 2022). Since these are prey for ESA-listed baleen whales, these whales may expand into the region as a consequence of the warming marine environment.

Macleod (2009) estimated that, based upon expected shifts in-water temperature, 88% of cetaceans would be affected by climate change, 47% would be negatively affected, and 21% would be put at risk of extinction. Changes in core habitat area means some species are predicted to experience gains in available core habitat and some are predicted to experience losses (Hazen et al. 2012). Such range shifts could affect marine mammal foraging success (Pike 2013; Silber et al. 2017).

## 9.2 Vessel Activity

Potential sources of impacts to marine mammals in the action area include operations of vessels, anchor and propeller damage and accidental groundings. Vessel operations do present the potential for some level of interaction with ESA-listed whales in the action area.

Reykjavik is the principal seaport of Iceland, and the country's main hub for cargo and cruise ships. From 2012-2019, the annual number of cruise ships increased at the Port of Reykjavik to almost 200. The numbers presented here for "cruise ship" include cruise ships and smaller expedition ships used for tourism. Following a decline in 2020 and 2021 due to restrictions from the COVID-19 pandemic, cruise ship calls are increasing again, with a total of 270 ship calls in 2023.[2]

Similarly, cargo ship activity in Iceland has increased over roughly the same time period. Modern cargo ships can carry at least 24,000 twenty-foot equivalent units (TEU). Cargo throughput is measured in TEUs so, by examining these data, we can approximate cargo ship activity. From 2008 to 2020 (the most recent year for which data are available), container port throughput averaged 238,723 TEU annually, with a high in 2018 of 352,300 TEU. Compared to cargo ship activity from other countries in the region, Icelandic container throughput is less. For example, the United Kingdom container port throughput was 9,844,540 TEU in 2021, and 881,238 TEU in Norway in 2021.[3]

Commercial and recreational vessel traffic can have adverse effects on ESA-listed marine mammals via propeller injuries and boat strike injuries. There is a lack of available information about ESA-listed whales and vessel strike in the action area, but we aware of some relevant information in the broader region and with non-ESA-listed species. Researchers have evaluated large whale ship strike risk in nearby Western Europe, and identified hotspots of co-occurrence of cetaceans and ship activity in the English Channel and the southern North Sea. Fin whales are considered to be the large whale most at risk for vessel strike in the region. One analysis estimated that 972 fin whales per year could be involved in a ship strike, possibly resulting in a mortality (Robbins 2022). For killer whales (*Orcinus orca*) in coastal Icelandic waters, 13 individuals were identified to have scars consistent with boat strike, or 3.24% of the Icelandic killer whale population (Lionnet 2020).

NMFS did not find records of vessel collisions with ESA-listed whales in the action area but, because of shipping traffic in the action area, limited local reports of vessel strike, and risk assessments of vessel strike elsewhere in the area, there is a possibility of vessel collision, some of which may be unreported. Although there may be comparatively less vessel traffic in the action area than places where there are more reports of vessel strike, given the expected density of ESA-listed whales (Pike et al. 2019), we must assume that vessel strike poses some risk for ESA-listed whales in the action area.

### 9.3 Whaling

Modern commercial whaling in Iceland began in the late 19th century. Between 1863 and 1915, over 17,000 whales were harvested by Iceland, and this figure is thought to be an underestimate (Tønnessen and Johnsen 1982). Fin whales were the species most heavily harvested, with

[2] https://www.faxafloahafnir.is/en/cruise-statistics/ Accessed March 7, 2024.
[3] https://www.ceicdata.com/en/indicator/iceland/container-port-throughput Accessed March 7, 2024.

humpback, blue, sei, and sperm whales also comprising the catch. Commercial whaling operations did not necessarily stay within the bounds of the whaling country, with numerous countries in the region engaging in commercial whaling, impacting whale populations across the North Atlantic. Other countries in the region like Norway, Denmark (Greenland, the Faroe Islands), and the United Kingdom (Hebrides and the Shetlands), had commercial whaling operations over the same time period. From 1868 to 1916, over 51,000 whales were harvested in the Norwegian Sea by these countries, yielding nearly 1.5 million barrels of oil (Tønnessen and Johnsen 1982). Commercial whaling was placed under a national ban in Iceland in 1915, and briefly resumed in 1935 by a single company for 5 years. The industry was re-established in 1948. The single Icelandic whaling company, Hvalur hf, harvested fin, sei, sperm, humpback, and blue whales commercially from 1948 to 1985 (Table 6). In Iceland, blue whales were harvested until 1960. Undersized fin and sei whales were harvested by Iceland and exported to Japan between 1977 and 1983 (Tønnessen and Johnsen 1982).

**Table 5. Whales Harvested by Iceland, 1948-1985. Data from Hamaguchi (2021) and Sigurjónsson (1988).**

| Species | Number Harvested |
|---|---|
| Fin Whale | 8,887 |
| Sperm Whale | 2,886 |
| Sei Whale | 2,574 |
| Blue Whale | 163 |
| Humpback Whale | 6 |

After a few unsuccessful attempts, the IWC established a global moratorium (temporary ban) on commercial whaling in 1986. No commercial whaling occurred in Iceland from 1986 to 2005 (Pike et al. 2019). However, whaling by special permit, also known as scientific whaling, was not subject to the moratorium, and was carried out by Iceland during that time. Iceland currently has a reservation to the moratorium that allowed it to continue commercial whaling from 2006 to 2023. Whales were not taken in every year during that time period (Table 7). In June 2023, Iceland's Ministry of Fisheries suspended the fin whale hunt, just before the season was set to begin, but whaling was permitted to resume after the ban ended at the end of August. Iceland was set to end its commercial whaling in 2024, citing decreased demand and economic benefits[4]. However, in early June, Iceland issued a license to the country's only whaling company for the

[4] https://www.theguardian.com/environment/2022/feb/04/iceland-to-end-whaling-in-2024-demand-dwindles; and https://polarjournal.ch/en/2023/09/28/does-iceland-end-whaling-in-2024/#:~:text=But%20Iceland%20will%20end%20its,the%20left%2Dgreen%20minister%20wrote. Accesed February 26, 2024

2024 hunting season to harvest 128 fin whales.[5] Fin whales are the most heavily harvested whales in Iceland, followed by minke whales and sei whales. Sei whales have not been harvested by Iceland since 1988. Iceland has harvested 1,292 fin whales and 70 sei whales since 1986 (Table 7). Commercial whaling, either under special permit or reservation has occurred in the region, carried out by Norway or Denmark (in Greenland waters). Humpback whales have been harvested in low numbers (one or two a year) in western Greenland waters under the IWC aboriginal subsistence catch authorization, as have fin whales more rarely. There are no records of blue whales or sperm whales having been harvested by whalers in the region. In 2009, the IWC noted that all future catches of fin whales would be assumed to be taken from western Iceland waters, given expected commercial whaling operations (IWC 2009). The expectation was due to the depletion of fin whales in eastern Iceland waters, thought to be a result of past over-harvest in that region.

**Table 6. Whales harvested by Iceland's Whaling Operations, 1986-2022.**

| Year | Whaling Type | Number of Fin Whales Harvested | Number of Sei Whales Harvested |
|---|---|---|---|
| 1986 | Special Permit Coastal | 76 | 40 |
| 1987 | Special Permit Coastal | 80 | 20 |
| 1988 | Special Permit Coastal | 68 | 10 |
| 1989 | Special Permit Coastal | 68 | 0 |
| 2006 | Whaling Reservation Coastal | 7 | 0 |
| 2009 | Whaling Reservation Coastal | 125 | 0 |
| 2010 | Whaling Reservation Coastal | 148 | 0 |
| 2013 | Whaling Reservation Coastal | 134 | 0 |
| 2014 | Whaling Reservation Coastal | 137 | 0 |
| 2015 | Whaling Reservation Coastal | 155 | 0 |
| 2018 | Whaling Reservation Coastal | 146 | 0 |
| 2022 | Whaling Reservation Coastal | 148 | 0 |
| **Total** | | **1,292** | **70** |

[5] https://www.bbc.com/news/articles/c2ll8d00kzgo Accessed June 21, 2024.

The effects of current and historical whaling had a devastating effect on population abundance of ESA-listed whales. Although modern whaling in the action area has been curtailed in recent years, and may cease altogether in the near future, ESA-listed whales have been harvested more or less continuously since 1948, preventing recovery of these long-lived species.

## 9.4 Fisheries

Globally, 6.4 million tons of fishing gear is lost in the oceans every year (Wilcox et al. 2015). Marine mammal entanglement and bycatch is a global problem that every year results in the death of hundreds of thousands of animals worldwide. Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in cetaceans (see Dietrich et al. 2007). Materials entangled tightly around a body part may cut into tissues, enable infection, and severely compromise an individual's health (Derraik 2002). Entanglements also make animals more vulnerable to additional threats (e.g., predation and vessel strikes) by restricting agility and swimming speed. 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% of entanglement is caused by derelict fishing gear (Baulch and Perry 2014). In Iceland, one coastal survey found that, of 32,600 marine debris items, about half came from the fishing industry, with most fishing debris being buoys or fishing gear (trawls, gillnets, or monofilament line) (Kienitz 2013).

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

In addition to these direct impacts, cetaceans may also be subject to indirect impacts from fisheries. 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 (Garcia et al. 2003). There are significant Icelandic fisheries targeting capelin, herring, and mackerel (ICES 2021) that could cause indirect effects to ESA-listed whales in the action area. However, the effects of fisheries on whales through changes in prey abundance remain largely unknown in the action area.

Fisheries are an important industry in Iceland, with about 1,750 fishing vessels operating in Icelandic waters (ICES 2021). Half of these vessels are less than 10 meters in length, and operate in coastal waters. Gillnet, longline, and handline fisheries occur in shallow waters closer to shore, mostly directed at cod, and also lumpfish (*Cyclopterus lumpus*). Pelagic trawling and purse seining for capelin, herring, mackerel, and blue whiting (*Micromesistus poutassou*) account for the largest catches by weight, and while bottom trawl fisheries for cod, haddock, saithe (*Pollachius virens*), and redfish (*Sebastes norvegicus*) on the continental shelf are the most commercially valuable (ICES 2021).

The gillnet fisheries are the sources of the highest rates of incidental bycatch of marine mammals, mostly harbor porpoises (*Phocoena phocoena*), dolphins, and seals (Basran and Sigurðsson 2021; ICES 2021). Fin whales and humpback whales are also reported as incidental bycatch in Icelandic fisheries. In comparisons of fishermen's logs and observer reports, cetacean bycatch in Iceland is considered to be grossly under-reported (Basran and Sigurðsson 2021). Scar-based analysis indicates that 25% of Icelandic humpback whales have scars consistent with entanglement (Basran 2021).

Because of the noted lack of consistent reporting, it is difficult to assess the degree to which ESA-listed whales are affected by fisheries bycatch in the action area, but, based on the limited available information, it is occurring for fin and humpback whales. Most fishing effort in Icelandic waters takes place in waters less than 500 meters deep (ICES 2021), so, considering their preferred habitat, sperm whales and blue whales may be at less risk for incidental bycatch than other species such as humpback whales, whose range overlaps more with fisheries (Basran and Rasmussen 2020).

## 9.5 Pollutants

Coastal and stormwater runoff, marina and dock construction, dredging, persistent organic pollutant loading, and groundwater and other discharges can degrade marine habitats. The development of marinas and docks in inshore waters can negatively impact nearshore habitats. An increase in the number of docks built increases boat and vessel traffic. Fueling facilities at marinas can sometimes discharge oil, gas, and sewage into sensitive estuarine and coastal habitats. Bioaccumulation of contaminants has been observed in coastal marine species in Iceland (Skarphedinsdottir et al. 2010). Persistent organic pollutants have been found in Icelandic whales such as long-finned pilot whales (*Globicephala melas*) and killer whales (Remili et al. 2021; Xuereb et al. 2023). While organophosphate flame retardants (a constituent of plastic and thought to possibly cause harm to marine fauna) have been found in fin whales and their krill prey, *Meganyctiphanes norvegica*, bioaccumulation was not found in the adult fin whales (Garcia-Garin et al. 2020). ESA-listed whales in the action area and their prey may be exposed to and accumulate these contaminants during their life cycles, but more research is needed to understand the effects of these pollutants on marine life.

## 9.6 Aquatic Nuisance Species

Aquatic nuisance species are aquatic and terrestrial organisms, introduced into new habitats throughout the U.S. and other areas of the world that produce harmful impacts on aquatic ecosystems and native species (http://www.anstaskforce.gov). They are also referred to as invasive, alien, or non-indigenous species. Invasive species have been referred to as 1 of the top 4 threats to the world's oceans (Raaymakers and Hilliard 2002; Raaymakers 2003; Terdalkar et al. 2005; Pughiuc 2010). Introduction of these species is cited as a major threat to biodiversity, second only to habitat loss (Wilcove et al. 1998). A variety of vectors are thought to have introduced non-native species including, but not limited to aquarium and pet trades, recreation, hull fouling, and ballast water discharges from ocean-going vessels. Common impacts of invasive species are alteration of habitat and nutrient availability, as well as altering species composition and diversity within an ecosystem (Strayer 2010). Shifts in the base of food webs, a common result of the introduction of invasive species, can fundamentally alter predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002), potentially affecting prey availability and habitat suitability for ESA-listed species. Currently, there is little information on the level of aquatic nuisance species and the impacts of these invasive species may have on marine mammals in the action area through the duration of the project but the presence of marine facilities makes it likely that aquatic nuisance species are present because of vessel traffic.

While aquatic nuisance species can be a threat to ESA-listed species and their habitat, we are unable to quantify or specify the degree of impact in the action area. Therefore, the level of risk and degree of impact to ESA-listed marine mammals is unknown.

## 9.7 Marine Debris

Marine debris is an ecological threat 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. Marine mammals often become entangled in marine debris, including fishing gear (Baird et al. 2015). 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.

Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it (Gall and Thompson 2015). Entanglement in marine debris can lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and mortality for ESA-listed species in the action area. Entanglement can also result in drowning for air breathing marine species including marine mammals. The ingestion of marine debris has been documented to result in blockage or obstruction of the digestive tract, mouth, and stomach lining of various species and can lead to serious internal injury or mortality (Derraik 2002). In addition to interference with alimentary processes, plastics lodged in the alimentary tract could facilitate the transfer of pollutants into the bodies of whales and dolphins (Derraik 2002).

Data on marine debris in the action area is largely lacking; therefore, it is difficult to draw conclusions as to the extent of the problem and its impacts on populations of ESA-listed species in the North Atlantic Ocean, but we assume similar effects from marine debris documented within other ocean basins could also occur to species from marine debris.

Cetaceans are also impacted by marine debris, which includes: plastics, glass, metal, polystyrene foam, rubber, and derelict fishing gear (Baulch and Perry 2014). Over half of cetacean species (including sperm whales) are known to ingest marine debris (mostly plastic), with up to 31% of individuals in some populations containing marine debris in their guts, and marine debris is implicated as the cause of death for up to 22% of individuals found stranded on shorelines from one study looking at global trends (Baulch and Perry 2014). An examination of the stomach contents of fin whales feeding off western Iceland near the action area estimated a daily intake of synthetic particles ranging from 38,646 ± 43,392 to 77,292 ± 86,784 particles per day (Garcia-Garin et al. 2021).

Plastic debris is a major concern because it degrades slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law et al. 2010). A survey of marine debris in northern coastal Iceland found that 95.4% of all items contained plastic (Kienitz 2013). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants. Marine mammals, sea turtles, and fish can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. It is expected that marine mammals may be exposed to marine debris within the action area, although the risk of ingestion or entanglement and the resulting impacts are uncertain at the time of this consultation.

### 9.8 Anthropogenic Sound

The ESA-listed species that occur in the action area are regularly exposed to several sources of natural and anthropogenic sounds. A wide variety of anthropogenic and natural sources contribute to ocean noise throughout the world's oceans. Anthropogenic sources of noise that are most likely to contribute to increases in ocean noise are vessel noise from commercial shipping and general vessel traffic, oceanographic research, oil, gas and mineral exploration, underwater construction, geophysical (seismic) surveys, Naval and other sources of sonar, and underwater explosions (Richardson et al. 1995d; Hatch and Wright 2007b).

Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other individuals.

There is a large and variable natural component to the ambient noise level as a result of events such as earthquakes, rainfall, waves breaking, and lightning hitting the ocean as well as biological noises such as those from snapping shrimp, other crustaceans, fishes, and the vocalizations of marine mammals (Crawford and Huang 1999; Patek 2002; Hildebrand 2004b). However, several studies have shown that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (NRC 1994; Richardson et al. 1995d; NRC 2000; NRC 2003a; Jasny et al. 2005; NRC 2005b). Much of this increase is due to increased shipping as ships become more numerous and of larger tonnage (NRC 2003a). Commercial fishing vessels, cruise ships, transport boats, airplanes, helicopters and recreational boats all contribute sound into the ocean (NRC 2003a), as does military training and testing activities. Generally the most energetic regularly operated sound sources are seismic airgun arrays from approximately 90 vessels with typically 12-48 individual guns per array, firing about every 10 seconds (Hildebrand 2004b).

### 9.8.1 Seismic Surveys

Similar to the proposed action, offshore seismic airgun surveys involve the use of high-energy sound sources operated in the water column to probe below the seafloor. Numerous seismic airgun surveys have been conducted in the North Atlantic over the past several decades. Seismic airgun surveys conducted in the action area are primarily for scientific research, to identify possible seafloor or shallow-depth geologic hazards, and to better understand phenomena surrounding earthquake risk. Due to various geological features of interest and tectonic activity in the region, much of the seismic activity near Iceland is focused on scientific research, although seismic airgun activity associated with oil and gas development does occur throughout the region (Basran and Rasmussen 2020). There is also interest in using other seismic techniques like side-scan sonar and multibeam echosounders to explore for sources of offshore geothermal energy near Iceland (Atkins and Audunsson 2013).

For past scientific research seismic surveys in the action area, NMFS issued authorizations for take of marine mammals. MMPA and ESA permits specify the conditions under which researchers can operate seismic sound sources, such as airguns, including mitigation measure to minimize adverse effects to protected species. Near the action area, other past seismic surveys include one in 2003 (in the Norwegian Sea), and another in 2018 (north of Newfoundland), both of which resulted in a no jeopardy determination in the biological opinions issued for the actions.

### 9.8.2 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 source level. Sonar systems can be divided into categories, depending on their primary frequency of operation; low frequency for 1 kHz and less, mid frequency for 1-10 kHz; high frequency for 10-100 kHz; and very high frequency for greater than 100 kHz (Hildebrand 2004a). Low frequency systems are designed for long-range detection (Popper et al. 2014). The effective source level of an low-frequency active array, when viewed in the horizontal direction, can be 235 dB re 1µPa-m or higher (Hildebrand 2004a). 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 (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 sounding, and sub-bottom profiling. They typically generate sound at frequencies of 3-200 kHz, with source levels ranging from 150-235 dB re 1µPa-m (Hildebrand 2004a). 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.

Iceland does not have a navy; its defense forces consist of the Icelandic Coast Guard, which does include ships and aircraft. Iceland does have security agreements with Norway, whose navy does use low-frequency active and mid-frequency active sonar like that described here, and has operated it in the region (Doksæter 2011).

### 9.8.3 Vessel Sound and Commercial Shipping

The action area is subject to commercial vessel traffic that is a source of anthropogenic noise falling within the hearing range of ESA-listed whales in the action area. For a discussion on the amount of vessel activity that may occur in the action area, see Section 9.2.

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 10-50 Hz and range from 195 dB re: $\mu Pa^2$-s at 1 meter for fast-moving (greater than 20 knots) supertankers to 140 dB re: $\mu Pa^2$-s at 1 meter for smaller vessels (NRC 2003a). Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels above 2 kHz, which may interfere with important biological functions of cetaceans (Holt 2008). At frequencies below 300 Hz, ambient sound levels are elevated by 15-20 dB when exposed to sounds from vessels at a distance (McKenna et al. 2013).

Much of the increase in sound in the ocean environment over the past several decades is due to increased shipping, as vessels become more numerous and of larger tonnage (NRC 2003a; Hildebrand 2009; McKenna et al. 2012). Shipping traffic constitutes a major source of low-frequency (5 to 500 Hz) sound in the ocean (Hildebrand 2004a), particularly in the Northern Hemisphere where the majority of vessel traffic occurs. While commercial shipping contributes a large portion of oceanic anthropogenic noise, other sources of maritime traffic can also impact the marine environment. These include recreational boats, whale-watching boats, research vessels, and fishing vessels.

Vessel noise can result from several sources including propeller cavitation, vibration of machinery, flow noise, structural radiation, and auxiliary sources such as pumps, fans and other mechanical power sources. Kipple and Gabriele (2007) measured sounds emitted from 38 vessels ranging in size from 14-962 feet at speeds of 10 knots and at a distance of 500 yards from the hydrophone. Sound levels ranged from a minimum of 157 to a maximum of 182 dB re 1 µPa-m, with sound levels showing an increasing trend with both increasing vessel size and with increasing vessel speed. Vessel sound levels also showed dependence on propulsion type and horsepower. McKenna et al. (2012) measured radiated noise from several types of commercial ships, combining acoustic measurements with ship passage information from Automatic Identification System (AIS). On average, container ships and bulk carriers had the highest estimated broadband source levels (186 dB re 1 μPa, 20-1000 Hz), despite major differences in size and speed. Differences in the dominant frequency of radiated noise were found to be related to ship type, with bulk carrier noise predominantly near 100 Hz while container ship and tanker noise was predominantly below 40 Hz. The tanker had less acoustic energy in frequencies above 300 Hz, unlike the container and bulk carrier.

Sound emitted from large vessels, such as shipping and cruise ships, is the principal source of low frequency noise in the ocean today, and marine mammals are known to react to or be affected by that noise (Richardson et al. 1995c; Foote et al. 2004; Hildebrand 2005; Hatch and Wright 2007a; Holt et al. 2008; Melcon et al. 2012; Anderwald et al. 2013; Kerosky et al. 2013; Erbe et al. 2014; Guerra et al. 2014; May-Collado and Quinones-Lebron 2014; Williams et al. 2014). Several studies have demonstrated short-term effects of disturbance on humpback whale behavior (Hall 1982; Baker et al. 1983; Krieger and Wing 1984; Bauer and Herman 1986), but the long-term effects, if any, are unclear or not detectable. Carretta et al. (2001) and Jasny et al. (2005) identified the increasing levels of anthropogenic noise as a habitat concern for whales and other cetaceans because of its potential effect on their ability to communicate. Significant changes in odontocete behavior attributed to vessel noise have been documented up to at least 5.2 kilometers away from the vessel (Pirotta et al. 2012).

Commercial shipping traffic is a major source of low frequency (5-500 Hz) human generated sound in the world's oceans (Simmonds and Hutchinson 1996; NRC 2003a). The radiated noise spectrum of merchant ships ranges from 20-500 Hz and peaks at approximately 60 Hz. Ross (Ross 1976) estimated that between 1950 and 1975 shipping had caused a rise in ambient ocean noise levels of 10 dB; based on his estimates, Ross predicted a continuously increasing trend in ocean ambient noise of 0.55 dB per year. Chapman and Price (2011) recorded low frequency deep ocean ambient noise in the Northeast Pacific Ocean from 1976-1986 and reported that the trend of 0.55 dB per year predicted by Ross (1976) persisted until at least around 1980; afterward, the increase per year was significantly less, about 0.2 dB per year.

### 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 Atlantic Ocean, some of which extend into portions of the action area for the proposed action. Marine mammals 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 in the action area from a variety of research activities. There have been numerous research permits issued since 2009 under the provisions of both the MMPA and ESA authorizing scientific research on marine mammals, including for research in the action area.

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

### 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., whaling, vessel strikes, incidental bycatch, and entanglement), whereas others result in more indirect (e.g., fishing that affects prey availability), or nonlethal (e.g., vessel noise) 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. 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). 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 environmental baseline is impacting species in different ways. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the activities described of 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 limiting their recovery. However, it 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.

## 10 Effects of the Action

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 but that are not part of the 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 (89 FR 24268).

This effects analysis section is organized following the stressor, exposure and response assessment framework described in Section 2. In this section, we further describe the probability of individuals of ESA-listed whales (blue whale, fin whale, Cape Verde Island/Northwest Africa DPS humpback whale, sei whale, and sperm whale) 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 expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment considers 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 Stressor 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 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 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 Permits Division's conservation measures to minimize or avoid exposure are described in more detail 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 subpopulation(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 noise from 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 Permits Division estimated exposure to the sounds from the airgun array that would result in ESA "harm" and "harassment" of ESA-listed cetaceans.

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 policy 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 behavioral responses by 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, MMPA exposure estimates do not differentiate behavioral response from TTS, nor do they provide information regarding the potential fitness or other biological consequences of the responses on the affected individuals. In our response analysis (Section 10.4), we consider the best available scientific evidence to determine the likely nature of 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 low- and 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 to inform our response analysis. 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 for ESA-Listed Cetaceans

As discussed in the Status of Species Likely to be Adversely Affected (Section 8), the ESA-listed cetacean species that are likely to be adversely affected by the proposed actions are blue whale, fin whale, Cape Verde Island/Northwest Africa DPS humpback whale, sei whale, and sperm whale. Blue whale, fin whale, Cape Verde Island/Northwest Africa DPS humpback whale, and sei whale are classified in the low-frequency hearing group. Sperm whales are classified in the mid-frequency hearing group (NOAA 2018).

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). In this section, we describe the NSF, L-DEO, and 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 Total Ensonified Area for ESA-Listed Cetaceans*

As noted in Section 3, the 36-airgun survey will consist of 1,662 kilometers tracklines of 2-dimensional MCS seismic reflection data and 1,092 kilometers tracklines of OBS refraction data. Most (~78%) of the effort for the survey will take place in-water depths greater than 1,000 meters. The remainder of the survey will occur in waters 100-1,000 meters deep. Details on LDEO's approach to modeling the ensonified area emanating from these tracklines are presented in Sections 3.3.1 and 3.3.3 and are further discussed in NSF's draft environmental assessment/analysis (LGL 2024) and L-DEO's IHA application. 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 2.

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 590.1 square kilometers for intermediate water depths and 2,082.5 square kilometers for deep water. 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 720 square kilometers for intermediate water depths, and 2,511.1 square kilometers for deep water. 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 2), along a planned trackline that will be surveyed in 1 day (approximately 182 kilometers during the MCS survey and 222 kilometers during the OBS survey). The daily ensonified area is multiplied by the total number of survey days (9 days for the MCS survey, and 5 days for the OBS survey). The product is multiplied by 1.25 to account for an additional 25% 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 6,638.6 square kilometers (1,935 square nautical miles) and 23,428.1 square kilometers for intermediate and deep waters, respectively, when accounting for overlap and using endcaps (Table 7). Also, when accounting for the same criteria, the total area ensonified at 160 dB re: 1 µPa (rms) for the OBS survey is 4,500.2 square kilometers and 15,694.4 square kilometers for intermediate and deep waters, respectively (Table 7).

**Table 7. 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 Seismic Survey off Iceland**

| Criteria (Water Depth) | Daily Trackline Distance (km) | Daily Ensonified Area (km²)* | Survey Days | Ensonified Area (km²) | Total Ensonified Area with 25% Increase (km²)* |
|---|---|---|---|---|---|
| **Sound Source – 36-Airgun Array MCS** | | | | | |
| 160 dB re: 1 µPa (rms) (greater than 1,000 m) | 182 | 2,082.5 | 9 | 18,742.5 | 23,428.1 |
| 160 dB re: 1 µPa (rms) (100-1,000 m) | 182 | 590.1 | 9 | 5,310.9 | 6,638.6 |
| **Sound Source – 36-Airgun Array (OBS)** | | | | | |
| 160 dB re: 1 µPa (rms) (greater than 1,000 m) | 222 | 2,511.1 | 5 | 12,555.5 | 15,694.4 |
| 160 dB re: 1 µPa (rms) (100-1,000 m) | 222 | 720 | 5 | 3,600 | 4,500.2 |

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

### *10.3.1.2 ESA-Listed Cetacean Occurrence—Density Estimates*

We reviewed available cetacean densities and group dynamics with the NSF, L-DEO, and the Permits Division and agreed on densities that constituted the best available scientific information for each ESA-listed cetacean species. The Permits Division adopted these estimates for use in their proposed IHA and we have adopted them for our ESA exposure analysis for blue, fin, Cape Verde Islands/Northwest Africa DPS humpback, sei, and sperm whales.

There is a lack of recent marine mammal density for the action area. Though there have been marine mammal surveys in and around the action area in the recent past that developed densities (e.g., (Pike et al. 2019)), these surveys did not contain densities for each of the marine mammals expected to be present in the action area during the survey. Through coordination with the NSF, L-DEO, and the Permits Division, we determined that 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. (2023) was the best option for calculating exposure of marine mammals during the proposed action. Because the Roberts et al. (2023) does not directly cover the action area, the NSF, L-DEO, and the Permits Division used the latitude in the survey area corresponding to the densities available in the Roberts et al. (2023) data.

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. (2023) 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). The Roberts et al. (2016) model was 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. (2023) updated Roberts et al. (2016) by expanding the model to utilize over 2.8 million linear kilometers 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/AFTT/. The habitat-based density models consisted of 5 kilometer by 5-kilometer GIS raster grid cells. 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 buffer) were averaged for each species for each of two water depth categories (intermediate and deep water depths) to determine monthly mean density values for each species. If available, the mean monthly density was chosen for each species for the month of June; if a monthly density was not available for a species, whatever available density was used (e.g., an annual estimate).

Data sources and density calculations are described in detail in NSF's draft environmental assessment/analysis (LGL 2023) and L-DEO's IHA application. There is uncertainty about the representativeness of the density data and the assumptions used to estimate exposures. For some cetacean species that are part of the IHA application, 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 blue, fin, Cape Verde Islands/Northwest Africa DPS humpback, sei, and sperm whales are found in Table 8. The approach used here is based on the best available data.

The number of blue, fin, Cape Verde Islands/Northwest Africa DPS humpback, sei, and sperm whales that can be exposed to the sounds from the airgun array on one or more occasions is estimated for the seismic survey area using expected seasonal density of animals in the area (Table 8). Summing exposures along all of the tracklines yields the total exposures of blue, fin, Cape Verde Islands/Northwest Africa DPS humpback, sei, and sperm whales for the proposed action of the 36-airgun array configurations for the seismic survey activities and Permits Division's proposed issuance of an IHA and possible renewal.

**Table 8. Densities used for calculating exposure of ESA-listed whales. From Roberts et al. (2023).**

| Species | Density (#/km$^{2*}$) |
|---|---|
| Blue Whale | 0.0000201 |
| Fin Whale | 0.0016925 |
| Humpback Whale | 0.0016342 |
| Sei Whale | 0.0023141 |
| Sperm Whale | 0.0042599 |

*km$^2$=square kilometers

Humpback whales in the action area could come from the non-listed West Indies DPS, or the endangered Cape Verde Islands/Northwest Africa DPS. We used the available density from Roberts et al. (2023) to calculate the number of individuals exposed, and then relied on NMFS (2021) to determine the number of humpback whales from each DPS exposed.

#### *10.3.1.3 Cetacean Exposures as a Percentage of Population*

Blue whales, fin whales, Cape Verde Islands/Northwest Africa humpback 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 (likely in June or July), we expect that most animals would be on or migrating to/from their feeding grounds. Blue whales, fin whales, Cape Verde Islands/Northwest Africa humpback 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 solitary and expected to be further north in the higher latitudes (poleward of about 40 to 50° latitude, broadly encompassing the action area) of their range in the Atlantic Ocean. Therefore, we expect a male bias to sperm whale exposure. We would normally assume that sex distribution is even for blue whales, fin whales, Cape Verde Islands/Northwest Africa humpback whales, sei whales, and sexes are exposed at a relatively equal level.

It should be noted that the exposure numbers are expected to be conservative for several reasons. First, estimated exposure was increased by 25%, in the form of the ensonified area over the operational seismic survey days, 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, fin, Cape Verde Islands/Northwest Africa humpback, sei, 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, fin, Cape Verde Islands/Northwest Africa humpback, sei, and sperm whales) considered in this consultation represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS's 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's 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 deepwater densities (Table 8) by the total ensonified area with a 25% increase (Table 7).

**Blue Whale –** The estimated exposure of the regional summertime population (approximately 3,000 animals) of blue whales is one animal, which is approximately 0.03% of the stock or regional population. For reasons previously described, this estimate is conservative, that is, it is likely higher than the actual exposures and a fewer number are not likely to be exposed given the conservation and monitoring measures that will be implemented or that the same animal may be exposed multiple times, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there will be multiple exposures of a smaller number of individuals that will occur within the action area.

**Fin Whale —** The estimated exposure of the regional population of fin whales (approximately 36,773 individuals) of fin whales is 85 animals, which is approximately 0.23% of the stock or regional population. For reasons previously described, this estimate is conservative, that is, it is likely higher than the actual exposures and a fewer number are not likely to be exposed given the conservation and monitoring measures that will be implemented or that the same animal may be exposed multiple times, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there will be multiple exposures of a smaller number of individuals that will occur within the action area.

**Cape Verde Islands/Northwest Africa DPS Humpback Whale —** The estimated exposure of the Cape Verde Islands/Northwest Africa DPS humpback whales is two animals, which is approximately 0.7% of the DPS. The L-DEO modeling calculated 83 humpback whales as being potentially exposed to the airgun array. The available information indicates that 2.6% of humpback whales found on Icelandic feeding areas are from the Cape Verde Islands/Northwest Africa DPS, the rest being from the non-listed West Indies DPS (NMFS 2021). We used this figure to estimate the number of exposed humpback whales from the Cape Verde Islands/Northwest Africa DPS. For reasons previously described, this estimate is conservative, that is, it is likely higher than the actual exposures and a fewer number are not likely to be exposed given the conservation and monitoring measures that will be implemented or that the same animal may be exposed multiple times, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there will be multiple exposures of a smaller number of individuals that will occur within the action area.

**Sei Whale —** The estimated exposure of the regional population (approximately 9,737 individuals) of sei whales is 117 animals, which is approximately 1.2% of the stock or regional population. For reasons previously described, this estimate is conservative, that is, it is likely higher than the actual exposures and a fewer number are not likely to be exposed given the conservation and monitoring measures that will be implemented or that the same animal may be exposed multiple times, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there will be multiple exposures of a smaller number of individuals that will occur within the action area.

**Sperm Whale –** The estimated exposure of the regional population (approximately 7,257 individuals) of sperm whales is 214 animals, which is approximately 2.9 % of the stock or regional population. For reasons previously described, this estimate is conservative, that is, it is likely higher than the actual exposures and a fewer number are likely to be exposed given the conservation and monitoring measures that will be implemented or that the same animal may be exposed multiple times, resulting in effects to fewer individuals. Because of the large range of this species compared to the relatively small size of the action area, combined with the relatively short duration of the seismic survey activities, it is more likely that there may be multiple exposures of a smaller number of individuals that will occur within the action area.

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

The response analysis evaluates the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. The response analysis also considers information on the potential effects on the prey of ESA-listed marine mammals that are likely to be adversely affected in the action area.

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

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

In their *Federal Register* notice of the proposed IHA and request for comments and possible renewal, the Permits Division stated that they did not expect sound emanating from non-airgun sources to exceed levels produced by the airgun array. Therefore, the Permits Division did not expect additional exposure to sound sources other than the airgun array. We agree with this assessment and similarly focus our analysis on exposure to the airgun array. The SBP, MBES, ADCP, and OBS acoustic release transponders 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 7.1.3).

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

As discussed in *The Assessment Framework* (Section 2) of this opinion, response analyses determine how ESA-listed resources are likely to respond after exposure to an action's effects on the environment, on designated critical habitat, or directly on ESA-listed species themselves. For the purposes of consultation, our assessments try to detect potential lethal, sublethal (or physiological), or behavioral responses that might result in reduced fitness of ESA-listed individuals. Response analyses will consider and weigh evidence of adverse consequences, as well as evidence suggesting the absence of such consequences.

During the proposed actions, ESA-listed whales may be exposed to sound from the airgun array. We evaluated the estimates of the expected number of whales exposed to received levels greater than or equal to 160 dB re: 1 μPa (rms) for the airgun array sound sources. Blue whales, fin whales, Cape Verde Island/Northwest Africa DPS humpback whales, sei whales and sperm whales exposed to these sound levels could 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 blue whales, fin whales, Cape Verde Island/Northwest Africa DPS humpback whales, sei whales, and sperm whales 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 permanent hearing impairment.
2. The area or volume of water that will be ensonified above these levels in a day.
3. The density or occurrence of ESA-listed species within these ensonified areas.
4. The number of days of seismic survey activities.

Using the above acoustic thresholds, we evaluated the exposure and take estimates of ESA-listed whales associated with the sounds from the airgun array (Section 10.3.1.3).

As discussed in more detail below, depending on the severity of TTS, there could potentially be injury (i.e., tissue damage) to marine mammals and sea turtles (Houser 2021). If this is the case, the type of ESA "take" for those instances of TTS resulting in injury would be reclassified as "harm" instead of "harassment." However, at this time, we do not have sufficient information to determine whether (or at what level) TTS with injury is occurring as a result of the proposed actions. It is believed that no ESA harm or PTS would be incurred in these marine mammals as a result of the seismic survey activities, because of the constant movement of both the R/V *Langseth* and of the marine mammals in the action area, the fact that the research vessel is not expected to remain in any one area in which individual marine mammals and will be expected to concentrate for an extended period of time (i.e., since the duration of exposure to loud sounds will be relatively short), and the implementation of conservation measures. Also, as described more below, we expect that marine mammals would be likely to move away from a sound source that represents an aversive stimulus, especially at levels that will be expected to result in PTS, given sufficient notice of the R/V *Langseth*'s approach due to the research vessel's relatively slow speed when conducting seismic survey activities.

### 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 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 (Schlundt 2000; Kastak 2005; Ketten 2012).

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. Blue whales, fin whales, Cape Verde Island/Northwest Africa DPS humpback whales, and sei whales have an estimated generalized hearing range of 7 Hz to 35 kHz. Sperm whales have an estimated generalized functional hearing frequency range of 150 Hz to 160 kHz (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.

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

In terms of exposure to the R/V *Langseth*'s airgun array, an individual needs to be within a few meters of the largest airgun to experience a single pulse greater than 219 or 230 dB re: 1 μPa (Peak SPL; Caldwell and Dragoset 2000). If an individual experienced exposure to several airgun pulses of approximately 230 dB re: 1 μPa (Peak SPL) for mid-frequency cetaceans and 219 dB re: 1 μPa (Peak SPL) for low-frequency cetaceans, PTS could occur. Cetaceans have to be within certain modeled radial distances specified in Table 2 and Table 3 from the R/V *Langseth*'s 36-airgun array to be within the ESA harm threshold isopleth, or risk a TTS or other measurable behavioral responses.

Only ESA harassment of ESA-listed whales is expected during the seismic survey. Ranges to some behavioral impacts include distances exceeding 100 kilometers, 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 shutdown zone during the 36-airgun array operations, which is beyond the distances believed to have the potential for PTS for ESA-listed whales, 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, we do not expect animals to be exposed to sound levels that can cause PTS; if there are animals exposed to sound levels that can cause TTS, we expect TTS will be temporary, and animals will 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 and, to some extent, sperm whales. The seismic survey could mask sperm whale calls at some of the lower frequencies for this species. This could affect communication between individuals, 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 2-4 kHz and 10-16 kHz 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 *Langseth*'s airgun array is below 200 Hz (2-188 Hz). Any masking that might occur will be temporary because acoustic sources from the seismic surveys are not continuous and the research vessel will continue to transit through the area. In addition, the seismic airgun activities on the R/V *Langseth* will occur over the course of approximately 14 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). Nieukirk et al. (2012) analyzed

10 years of recordings from the Mid-Atlantic Ridge. When several surveys were recorded simultaneously, whale sounds were masked (drowned out), and the airgun noise became the dominant component of background noise levels. The R/V *Langseth*'s airgun array will emit an approximately 0.01 second pulse when fired approximately every 10 seconds for the high-energy seismic survey, while sperm whale calls last 0.5-1 second. Therefore, pulses will not "cover up" the vocalizations of sperm whales to a significant extent (Madsen et al. 2002b). We address the response of sperm whales stopping vocalizations because of sound from the airgun array in Section 10.4.1.3.

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, empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking sound (Bain et al. 1993; Bain 1993; Bain and Dahlheim 1994; 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 et al. 1974; Au 1974; Au 1975; Moore 1990; Thomas 1990; Romanenko and Kitain 1992; Romanenko 1992; Lesage 1999). A few marine mammal species increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Dahlheim 1987; Au 1993; Lesage 1993; Lesage 1999; Terhune 1999; Foote 2004; Parks et al. 2007; Holt et al. 2009; Parks 2009).

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 kHz, in contrast to the pronounced effect at higher frequencies. Studies have noted directional hearing at frequencies as low as 0.5-2 kHz 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 mid-frequency cetaceans may also alter components of their vocalizations in response to anthropogenic noise. 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 (blue whales, fin whales, humpback 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.

#### *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. ESA-listed whales 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 (NRC 2005a; Francis and Barber 2013; New et al. 2014; Costa et al. 2016; Fleishman et al. 2016). Although some studies are available that address responses of ESA-listed whales considered in this consultation directly, additional studies of other related whales (such as bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*), and North Atlantic right whales) are relevant in determining the responses expected by blue, fin, humpback, sei, and sperm whales. Therefore, we consider studies from non-ESA-listed species in the action area and listed and non-listed 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 (89 FR 41850-41880), as well as scientific reviews (e.g., Southall et al. 2007b; Gomez et al. 2016).

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 (Richardson et al. 1986a; McDonald et al. 1993; McDonald et al. 1995; Greene Jr et al. 1999; Madsen et al. 2002a; Tyack et al. 2003; Nieukirk et al. 2004; Smultea et al. 2004; Jochens et al. 2006). Some blue whales, fin whales, and sperm whales stopped calling for short and long periods apparently in response to airguns (Bowles et al. 1994; McDonald et al. 1995; Clark and Gagnon 2006). 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. 2012b). Dunn and Hernandez (2009) tracked blue whales during a seismic survey on the R/V *Maurice Ewing* in 2007 and did not observe changes in call rates or find evidence of anomalous behavior that they could directly ascribe to the use of airguns at sound levels of approximately less than 145 dB re: 1 μPa (rms) (Wilcock et al. 2014). Blue whales may 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 approximate 94 dB re: 1 $\mu Pa^2$-s over the course of 10 minutes (Blackwell et al. 2015). Once sound levels exceeded approximately 127 dB re: 1 $\mu Pa^2$-s over 10 minutes, call rates began to decline and, at approximately 160 dB re: 1 $\mu Pa^2$-s over 10 minutes, bowhead whales appeared to cease calling all together (Blackwell et al. 2015). While we are not aware of data documenting changes in

North Atlantic right whale vocalization in association with seismic surveys, as mentioned previously, they do shift calling frequencies and increase call amplitude over both long- and short-term periods due to chronic exposure to vessel sound (Parks and Clark 2007; Parks et al. 2007; Parks et al. 2009; 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; McCall Howard 1999; Madsen et al. 2002a).

Some exposed ESA-listed whales may cease calling or otherwise alter their vocal behavior in response to the R/V *Langseth*'s airgun array during the seismic survey activities. The effect is expected to be temporary and brief given the 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 *Langseth*'s airgun array once the acoustic stressor has diminished.

There are numerous studies of the responses of some baleen whales to airgun arrays. Although 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 opinion to determine the extent of acoustic effects for marine mammals) as the received sound level to cause behavioral responses other than vocalization changes (Richardson et al. 1995b).

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

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

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

Gray whales respond similarly to seismic survey sounds as bowhead whales. Gray whales discontinued feeding and/or moved away at received sound levels of 163 dB re: 1 μPa (rms) (Malme et al. 1984a; Malme and Miles 1985; Malme et al. 1986; Malme et al. 1987; Würsig et al. 1999; Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007a; Meier et al. 2007; 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 et al. 1984b; Malme and Miles 1985). As with bowhead whales, habitat continues to be used despite frequent seismic survey activity, but long-term effects have not been identified, if they are present at all (Malme et al. 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 subsequent research in the area from 2002 through 2005.

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, and showed an avoidance response at 7 to 12 kilometers from the acoustic source (McCauley et al. 1998; McCauley et al. 2000a). A startle response occurred as low as 112 dB re: 1 μPa (rms). Closest approaches were generally limited to 3 to 4 kilometers, although some individuals (mainly males) approached to within 100 meters on occasion where sound levels were 179 dB re: 1 μPa (rms). Changes in course and speed generally occurred at estimated received sound levels of 157 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 at levels of 140 dB re: 1 $\mu Pa^2$-second. A recent study examining the response of migrating humpback whales to a full 51,291.5 cubic centimeters (3,130 cubic inch) airgun array found that humpback whales exhibited no abnormal behaviors in response to the active airgun array and, while there were detectible changes in respiration and diving, these were similar to those observed when baseline groups (i.e., not exposed to active sound sources) were joined by another humpback whale (Dunlop et al. 2017). While 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 (Dunlop et al. 2017). Feeding humpback whales appear to be somewhat more tolerant to noise exposure. Humpback whales off the coast of Alaska startled at 150 to 169 dB re: 1 μPa (rms) and no clear evidence of avoidance was apparent at received 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 2008b).

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 and sei whale sighting data indicate similar sighting rates during seismic versus non-seismic periods, but sightings tended to be further away and individuals remained underwater longer (Stone 2003; Stone and Tasker 2006; Stone et al. 2017). Other studies have found at least small differences in sighting rates (lower during seismic survey activities), as well as whales being more distant from the seismic vessel during seismic survey activities (Moulton and Miller 2005a). When spotted at the average sighting distance, individuals will have likely been exposed to approximately 169 dB re: 1 μPa (rms) (Moulton and Miller 2005b).

Sperm whale response to airguns has thus far included mild behavioral disturbance (temporarily disrupted foraging, avoidance, cessation of vocal behavior) or no reaction. Several studies have found sperm whales in the Atlantic Ocean to show little or no response (Davis et al. 2000; Stone 2003; Moulton and Miller 2005a; Madsen et al. 2006; Stone and Tasker 2006; Weir 2008a; Miller et al. 2009; Stone et al. 2017). Detailed study of sperm whales in the Gulf of Mexico suggests some alteration in foraging from less than 130-162 dB re: 1 μPa peak-to-peak, although other behavioral reactions were not noted by several authors (Gordon et al. 2004; Gordon et al. 2006; 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 (Mate et al. 1994; Jochens 2003; Jochens and Biggs 2004). The intensity and the frequency of the disturbance created by the airguns seems to have bearing on the effects to exposed sperm whales. The persistent, high-level disturbance caused by exposure to underwater noise associated with oil and gas activities in the Gulf of Mexico was predicted to cause significant reductions in fitness, especially for reproductive female sperm whales due to lost foraging opportunities, to the point of starvation(Farmer et al. 2018a). An individual sperm whale's resilience to foraging disturbance depends on its size and daily energetic demands; pregnant and nursing sperm whales are thus most vulnerable (Farmer et al. 2018b). The amount of time between disturbances to foraging behavior matters because sperm whales need time to replenish lost reserves. Thus, intermittent disturbances to foraging behavior are less impactful than continuous disruption.

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 (Watkins and Schevill 1975a; Watkins et al. 1985b; Goold 1999a). 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 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 were available to assess potential displacement within 5 kilometers (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. 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 Hz) pulses produced by seismic airguns (Richardson et al. 1995b). Sperm whales are exposed to considerable energy above 500 Hz during the course of seismic surveys (Goold and Fish 1998), so, even though this species generally hears at higher frequencies, this does not mean that it cannot hear airgun sounds. Breitzke et al. (2008) found that source levels were approximately 30 dB re: 1 μPa lower at 1 kHz and 60 dB re: 1 μPa lower at 80 kHz compared to dominant frequencies during a seismic source calibration. 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 2010b).

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

#### *10.4.1.3 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; Zimmer and Tyack 2007; Tal et al. 2015), 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 sperm whales 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 (Thomson and Geraci 1986; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Gulland et al. 1999; Gregory and Schmid 2001; Busch and Hayward 2009). 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 (Thomson and Geraci 1986; Kaufman and Kaufman 1994; Dierauf and Gulland 2001; Cattet et al. 2003; Elftman et al. 2007; Fonfara et al. 2007; Noda et al. 2007; Mancia et al. 2008; Busch and Hayward 2009; Dickens et al. 2010; Costantini et al. 2011). 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; Herraez et al. 2007; Cowan 2008). 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 (St. Aubin et al. 1996; Gardiner and Hall 1997; Hunt et al. 2006; Keay et al. 2006; Romero et al. 2008). 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 brief. 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. 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 sperm whales 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 14 days (of airgun activity); 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 sperm whales to be transiting through.

#### *10.4.1.4 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 2007). In September

2002, two Cuvier's beaked whales (*Ziphius cavirostris*) stranded in the Gulf of California, Mexico. The R/V *Maurice Ewing* had been operating a 20-airgun array (139,126.2 cubic centimeters [8,490 cubic inches]) 22 kilometers 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 (Fair and Becker 2000; Moberg 2000; Kerby et al. 2004; Romano et al. 2004; Creel 2005). 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 whales to strand because of the high-energy seismic survey. If exposed to seismic survey activities, we expect sperm whales 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 North Atlantic Ocean with no documented strandings.

### 10.4.2 Potential Responses of Marine Mammal Prey to Acoustic Sources

Seismic surveys may have indirect, adverse effects on ESA-listed marine mammals 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, and cephalopods. Studies described herein provide extensive support for this, which is the basis for later discussion on implications for ESA-listed marine mammals. 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 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, and cephalopods) of ESA-listed marine mammals considered in this consultation will react in manners similar to those fish and invertebrates described herein.

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 whales 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.

Fish or invertebrate mortality may occur from exposure to airguns, but will be limited to close-range exposure to high amplitudes (Falk and Lawrence 1973; Kostyuchenko 1973; Holliday et al. 1987; La Bella et al. 1996; D'Amelio 1999; Santulli et al. 1999; McCauley et al. 2000a; McCauley et al. 2000b; Bjarti 2002; Hassel et al. 2003; McCauley et al. 2003; Popper et al. 2005). Lethal effects, if any, are expected within a few meters of the airgun array (Dalen and Knutsen 1986; Buchanan et al. 2004). 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 (Fewtrell 2013a; Davidsen et al. 2019). During airgun studies in which the received sound levels were not reported, Fewtrell (2013a) observed caged *Pelates* spp., pink snapper (*Pagrus auratus*), and trevally (*Caranx ignobilis*) to generally exhibit startle, displacement, and/or grouping responses upon exposure to airguns. This effect generally persisted for several minutes, 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 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.

There are reports showing sublethal effects to some fish species from airgun arrays. Several species at various life stages have been exposed to high-intensity sound sources (220-242 dB re: 1 μPa) at close distances, with some cases of injury (Booman et al. 1996; McCauley et al. 2003). Effects from TTS were not found in whitefish at received levels of approximately 175 dB re: 1 $\mu Pa^2$-second, but pike did show 10-15 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 165-209 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 eggs at close range to airguns did not produce differences in mortality compared to control groups (Payne 2009). Salmonid swim bladders were reportedly damaged by received sound levels of approximately 230 dB re: 1 μPa (Falk and Lawrence 1973).

Startle responses were observed in rockfish at received airgun levels of 200 dB re: 1 μPa 0-to-peak and alarm responses at greater than 177 dB re: 1 μPa 0-to-peak (Pearson et al. 1992). Fish also tightened schools and shifted their distribution downward. Normal position and behavior resumed 20-60 minutes after firing of the airgun ceased. A downward shift was also noted by Skalski et al. (1992) at received seismic sounds of 186-191 dB re: 1 μPa 0-to-peak. Caged European sea bass (*Dichentrarchus labrax*) showed elevated stress levels when exposed to airguns, but levels returned to normal after 3 days (Skalski 1992). These fish also showed a startle response when the seismic survey vessel was as much as 2.5 kilometers 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 185-192 dB re: 1 µPa) despite airgun activity (Chapman and Hawkins 1969). Whiting may also flee from sounds from airguns (Dalen and Knutsen 1986). Hake (*Merluccius* spp.) may re-distribute downward (La Bella et al. 1996). Lesser sand eels (*Ammodytes tobianus*) exhibited initial startle responses and upward vertical movements before fleeing from the seismic survey area upon approach of a vessel with an active source (Hassel et al. 2003; Hassel et al. 2004).

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

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 163-191 dB re: 1 µPa 0-to-peak (Turnpenny and Nedwell 1994). Similarly, European sea bass apparently did not leave their inshore habitat during a 4-5 month seismic survey (Pickett et al. 1994). La Bella et al. (1996) found no differences in trawl catch data before and after seismic survey activities and echosurveys of fish occurrence did not reveal differences in pelagic biomass. However, fish kept in cages did show behavioral responses to approaching operating airguns.

Squid are important prey for sperm whales. 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 (McCauley et al. 2000a; McCauley et al. 2000b; Fewtrell 2013b). The authors also noted some movement upward. During ramp-up, squid did not discharge ink but alarm responses occurred when received sound levels reached 156-161 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 246-252 dB after 3-11 minutes. Andre et al. (2011) exposed four cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*) to 2 hours of continuous sound from 50-400 Hz at 157±5 dB re: 1 μPa. They reported lesions to the sensory hair cells of the statocysts of the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low-frequency sound. The received sound pressure level was 157 ± 5 dB re: 1 μPa, with peak levels at 175 dB re: 1 μPa. Guerra et al. (2004) suggested that giant squid mortalities were associated with seismic surveys based upon coincidence of carcasses with the seismic surveys in time and space, as well as pathological information from the carcasses.

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

Based on the available data, we anticipate seismic survey activities will result in temporary and minor reduction in the availability of prey for ESA-listed species near the airgun array during and immediately following the use of active seismic sound sources. This may be due to changes in prey distributions (i.e., due to avoidance) or abundance (i.e., due to mortality) or both. We do not expect indirect effects from airgun array operations through reduced feeding opportunities for ESA-listed marine mammals to reach a measurable level. Effects are likely to be temporary and, if displaced, marine mammals and their prey will re-distribute back into the action area once seismic survey activities have passed or concluded. As described above, we believe that, in most cases, ESA-listed blue, fin, Cape Verde Islands/Northwest Africa DPS humpback, sei, or sperm whales 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 and the quantity of available prey compared to prey that may suffer mortality is high.

## 10.5 Summary of Effects

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

We expect up to one blue whale, 85 fin whales, two Cape Verde Islands/Northwest Africa DPS humpback whales, 117 sei whales, and 214 sperm whales, to be exposed to the airgun array within the 160 dB re: 1 μPa (rms) ensonified areas during the seismic survey activities and exhibit responses in the form of ESA behavioral harassment or TTS (Section 10.3.1.3).

Because of the requirements in the Permits Division's proposed IHA, and the nature of the seismic survey activities, 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 or TTS, to blue, fin, Cape Verde Islands/Northwest Africa DPS humpback, sei, or sperm whales. Harassment is not expected to have more than short-term effects on individual ESA-listed marine mammal species (blue, fin, Cape Verde Islands/Northwest Africa DPS humpback, sei, or sperm whales) and is not expected to reduce individual fitness. Harm under the ESA is not expected to occur given the conservation measures (e.g., shutdown and buffer zones, shutdown procedures, pre-start clearance and ramp-up procedures, vessel-based visual monitoring by NMFS-approved PSOs, passive acoustic monitoring, vessel strike avoidance measures, and additional conservation measures) in place for the seismic survey activities to protect ESA-listed species.

Given that individual blue whales, fin whales, Cape Verde/Northwest Africa humpback, sei whales, and sperm whales may experience temporary behavioral responses from the seismic survey activities and those exposures are a small percentage of the regional populations. Specifically, we estimate effects to 0.03% of blue whales, 0.23% of fin whales, 0.7% Cape Verde/Northwest Africa humpback whales, 1.2% of sei whales, and 2.9% of sperm whales.

The estimates of the number of individuals exhibiting measureable responses (Section 10.3.1.3) 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 conservative assumptions in our effects analysis and the conservation measures that will be implemented; Section 10.3). Because of the large ranges of the affected ESA-listed marine mammals compared to the relatively small size of the portion of the action area where seismic surveys will occur, combined with the relatively short duration of the seismic survey activities, there may be multiple exposures of a small number of individuals in the action area. We do not expect the effects of ESA harassment of these individuals, which will be temporary, will have population-level effects.

# 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 activity, whaling, fisheries (fisheries interactions), pollutants, aquatic nuisance species, marine debris, anthropogenic sound (vessel sound and commercial shipping, sonar, seismic surveys), military activities, and scientific research activities to continue into the future with continuing impacts to marine mammals. 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 ESA-listed species will continue to be impacted. Different aspects of vessel activity can impact ESA-listed species, such as vessel noise, disturbance, and the risk of vessel strike causing injury or mortality to marine mammals, especially large whales. The reduction commercial whaling in Iceland is a gradual benefit to large whales, especially fin whales, in the action area, although the previous decades of commercial whaling will have a lasting impact on ESA-listed whales throughout the region.

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.

Future state, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives and fishing permits. Some activities occurring in the action area are those conducted under state management. These actions may include changes in ocean policy and increases and decreases in the types of activities currently seen in the action area, including changes in the types of fishing activities, resource extraction, and designation of marine protected areas, any of which could influence the status of listed species in the action area in the future. Government actions are subject to political, legislative and fiscal uncertainties. As a result, any analysis of cumulative effects is difficult, particularly when taking into account the geographic scope of the action area, the various authorities involved in the action, and the changing economies of the region.

# 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).

Some ESA-listed species could be within the action area but are not expected to be adversely affected by the proposed actions. Some seismic survey activities evaluated individually were determined to have insignificant or discountable effects and thus to be not likely to adversely affect some ESA-listed species (Section 7).

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.

## 12.1 Jeopardy Analysis

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 because of these activities pose to ESA-listed species over the approximately 14 days of the seismic survey. These summaries integrate our exposure and response analyses from the Effects of the Action (Section 10).

### 12.1.1 Blue Whale

Adult, juvenile, and calf blue whales are present in the action area and are expected to be exposed 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 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 19$^{th}$ to mid-20$^{th}$ centuries. 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 estimate for mature blue whales in 1926 was approximately 140,000. Today, estimates indicate approximately 5,000–15,000 mature blue whales globally (NMFS 2020a). Blue whales are separated into populations by ocean basin in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere. A population estimate for blue whales in the North Atlantic Ocean between the Faroe Islands and East Greenland, from latitude 52° to 72° North is approximately 3,000 individuals (Pike et al. 2019).

An overall population growth rate for the species or growth rates for the regional population of blue whales in the North Atlantic Ocean is not available at this time.

No reduction in the distribution of blue whales from the North Atlantic Ocean off Iceland 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 and possible renewal.

No reduction in reproduction is anticipated as part of the proposed actions. Therefore, no reduction in numbers is expected because of the proposed actions. Non-lethal take of one individual, whether an adult, juvenile, or calf, is expected because of the seismic survey activities. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging 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 reproductiont. Because we do not anticipate a reduction in numbers or reproduction of blue whales due to of the seismic survey activities and the NMFS Permits

Division's issuance of an IHA and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2020 Recovery Plan for the blue whale (NMFS 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 and possible renewal will impede the recovery objectives for blue whales. In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of blue whales in the wild by reducing the reproduction, numbers, or distribution of the species.

### 12.1.2 Fin Whale

Adult, juvenile, and calf fin whales are present in the action area and are expected to be exposed 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 fin whale is endangered because of past commercial whaling. Prior to commercial whaling, hundreds of thousands of fin whales existed. In the North Atlantic Ocean, at least 55,000 fin whales were killed between 1910 and 1989. 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. The abundance estimate for fin whales in the North Atlantic Ocean in the waters surrounding Greenland, Iceland, and the Faroe Islands was 36,773 individuals (Pike et al. 2019).

Population trends for the North Atlantic Ocean fin whale population is not currently available.

No reduction in the distribution of fin whales from the North Atlantic Ocean off Iceland 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 and possible renewal.

No reduction in reproduction is anticipated as part of the proposed actions. Therefore, no reduction in numbers is expected because of the proposed actions. Non-lethal take of 85 individuals, whether adults, juveniles, and/or calves, is expected as a result of the seismic survey activities. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging 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. 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 and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2010 Final Recovery Plan (NMFS 2010c) 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 and possible renewal will impede the recovery objectives for fin whales. In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of fin whales in the wild by reducing the reproduction, numbers, or distribution of the species.

### 12.1.3 Cape Verde Islands/Northwest Africa DPS Humpback Whale

Adult and juvenile Cape Verde Islands/Northwest Africa DPS humpback whales are present in the action area and are expected to be exposed to noise from the seismic survey activities. The severity of an individual's response to noise associated with the seismic survey will depend on the duration and severity of the exposure.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Cape Verde Islands/Northwest Africa DPS is approximately 272 animals (Wenzel et al. 2020a). A population growth rate is currently unavailable for the Cape Verde Islands/Northwest Africa DPS of humpback whales.

We expect that two adults and/or juveniles may be affected by take in the form of harassment from sound sources associated with the seismic survey. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging opportunities, loss of mating opportunities, masking, alteration of vocalizations, and stress) with some potential for TTS, with individuals returning to normal shortly after the exposure has ended, and thus do not anticipate any delay in reproduction. No reduction in the distribution of Cape Verde Islands/Northwest Africa DPS of humpback whales from the North Atlantic Ocean is expected because of the NSF and L-DEO's seismic survey activities and the Permits Division's issuance of an incidental harassment authorization.

No reduction in reproduction is expected because of the proposed actions. Therefore, no reduction in numbers is anticipated due to the proposed actions. There are expected to be three individuals harassed, adults and/or juveniles, because of the proposed seismic surveys. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging 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. Because we do not anticipate a reduction in numbers or reproduction of Cape Verde Islands/Northwest Africa of humpback whales as a result of the proposed seismic survey activities and the Permits Division's issuance of an incidental harassment authorization, a reduction in the species' likelihood of survival is not expected.

The 1991 Final Recovery Plan for the humpback whale lists recovery objectives for the species (NMFS 1991b). The following recovery objectives are relevant to the impacts of the proposed actions:

- Maintain and enhance habitats used by humpback whales currently or historically.
- Identify and reduce direct human-related injury and morality.
- Measure and monitor key population parameters.
- Improve administration and coordination of recovery program for humpback whales.

Because no mortalities or effects on the distribution of Cape Verde Islands/Northwest Africa DPS of humpback whales are expected as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits Division's issuance of an incidental harassment authorization will impede the recovery objectives for Cape Verde Islands/Northwest Africa DPS of humpback whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of Cape Verde Islands/Northwest Africa of DPS of humpback whales in the wild.

#### 12.1.4 Sei Whale

Adult, juvenile, and calf sei whales are present in the action area and are expected to be exposed 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 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. 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.

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. In the North Atlantic Ocean near Greenland, Iceland, and the Faroe Islands, there are an estimated 9,737 sei whales (Pike et al. 2019). 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.

No reduction in the distribution of sei whales from the North Atlantic Ocean off Iceland 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 and possible renewal.

No reduction in reproduction is anticipated as part of the proposed actions. Therefore, no reduction in numbers is expected because of the proposed actions. Non-lethal take of 117 individuals, whether adults, juveniles, and/or calves, is expected as a result of the seismic survey activities. We anticipate temporary behavioral responses (e.g., avoidance, discomfort, loss of foraging 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. 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 and possible renewal, a reduction in the species' likelihood of survival is not expected.

The 2011 Final Recovery Plan for the sei whale (NMFS 2011) 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 and possible renewal will impede the recovery objectives for sei whales. In conclusion, we believe the non-lethal effects associated with the proposed actions will not appreciably reduce the likelihood of survival and recovery of sei whales in the wild by reducing the reproduction, numbers, or distribution of the species.

### 12.1.5 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 2009b). The higher estimates may be approaching population sizes prior to commercial whaling, the reason for ESA-listing. It is estimated that 761,523 sperm whales were killed between 1900 and 1999 (NMFS 2015b).

Sperm whales are listed as endangered throughout their range. There are no reliable estimates for sperm whale abundance across the entire North Atlantic Ocean. According to abundance estimates for sperm whales in the North Atlantic Ocean, there are 7,257 sperm whales (Pike et al. 2019). No trend analysis has been conducted for the North Atlantic stock.

No reduction in the distribution of sperm whales from the North Atlantic Ocean in the waters around Iceland or changes to the geographic range of the species are expected because of the NSF and L-DEO's seismic survey activities and the Permits Division's issuance of an IHA.

No reduction in reproduction is anticipated as part of the proposed actions. Therefore, no reduction in numbers is expected because of the proposed actions. Non-lethal take of 214 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, masking, alteration of vocalizations, and stress) with some potential for TTS to be the form of ESA take, with individuals returning to normal shortly after the exposure has ended. Because we expect the responses to be temporary, we do not anticipate any delay in reproduction. Because we do not anticipate a reduction in numbers or reproduction of sperm whales due to the seismic survey activities and the Permits Division's issuance of an IHA, a reduction in the species' likelihood of survival in the wild is not expected.

The 2010 Final Recovery Plan for the sperm whale (NMFS 2010d) 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 Permits Division's issuance of an IHA will impede the recovery objectives for sperm whales. In conclusion, we believe the nonlethal 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.

# 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's biological opinion that the proposed actions are not likely to jeopardize the continued existence of: blue whale, fin whale, Cape Verde Island/Northwest Africa DPS humpback whale, and sperm whale.

NMFS also concluded that the actions are not likely to adversely affect the North Atlantic right whale.

# 14 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (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, 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) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

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 incidental take statement 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 June

2024 through June 2025 (valid for a period of one 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 incidental take statement pursuant to section 7(b)(4) and 7(o)(2).

### 14.1 Amount or Extent of Take

Section 7(b)(4) and its implementing regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions while the extent of take specifies the impact, i.e., the amount or extent of such incidental taking on the species, which may be used if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (see 80 FR 26832).

If the amount or location of tracklines during the seismic survey changes, or the number of seismic survey days is increased, then incidental take for marine mammals may be exceeded. As such, if more tracklines are conducted during the seismic survey, an increase in the number of days beyond the 25% contingency, greater estimates of sound propagation, and/or increases in airgun array source levels occur, reinitiation of consultation will be necessary.

#### 14.1.1 Marine Mammals

We anticipate the high-energy seismic survey in the North Atlantic Ocean near Iceland is likely to result in the incidental take of ESA-listed marine mammals by harassment. Behavioral harassment is expected to occur at received levels at or above 160 dB re: one μPa (rms) for airgun array operations for ESA-listed marine mammals. For all species of ESA-listed marine mammals, this incidental take will result from exposure to acoustic energy during airgun array operations and will be in the form of ESA harassment, and is not expected to result in the death or injury of any individuals that will be exposed. Specifically, we anticipate the take of marine mammals in the action area as detailed in Table 9 below.

**Table 9. Estimated amount of incidental take of ESA-listed marine mammals exempted in the North Atlantic Oceant.**

| Species | Exempted Incidental Take by Harassment (Potential Temporary Threshold Shift and Behavioral) by Seismic Survey Activities |
|---|---|
| Blue Whale | 1 |
| Fin Whale | 85 |
| Cape Verde Island/Northwest Africa DPS Humpback Whale | 2 |
| Sei Whale | 117 |

| | |
|---|---|
| Sperm Whale | 214 |

## 14.2 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the amount or extent of incidental take (50 C.F.R. §402.02). The measures described below are nondiscretionary, and must be undertaken by the NSF and the 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, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and 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 incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA. Reasonable and prudent measures refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (89 FR 24268).

NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on the ESA-listed marine mammals discussed in detail in this opinion:

1. The Permits Division must ensure that the NSF implements a program to mitigate and report the potential effects of seismic survey activities as well as the effectiveness of mitigation measures incorporated as part of the proposed incidental harassment authorization for the incidental taking of blue, fin, Cape Verde Island/Northwest Africa DPS humpback, sei, and sperm whales pursuant to section 101(a)(5)(D) of the MMPA (i.e., the monitoring requirements). In addition, the Permits Division must ensure that the provisions of the incidental harassment authorization are carried out, and inform the NMFS ESA Interagency Cooperation Division 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 NSF, L-DEO and Permits Division must comply with the following terms and conditions, which implement the RPMs described above. These include the take minimization, monitoring and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)). If the NSF and Permits Division fail to ensure compliance with these terms and conditions to implement the RPMs applicable to the authorities of the agencies, the protective coverage of section 7(o)(2) may lapse.

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

1. A copy of the draft comprehensive report on all seismic survey activities and monitoring results must be provided to the ESA Interagency Cooperation Division within 90 days of the completion of the seismic survey, or expiration of the incidental harassment authorization, whichever comes sooner. Send report to nmfs.hq.esa.consultations@noaa.gov, with the subject line, "NSF Iceland Seismic Survey Draft Report."
2. Any reports of injured or dead ESA-listed species must be provided by the Permits Division or NSF to the ESA Interagency Cooperation Division within 24 hours to Tanya Dobrzynski, Chief, ESA Interagency Cooperation Division by email at tanya.dobrzynski@noaa.gov, and nmfs.hq.esa.consultations@noaa.gov, with the subject line, "NSF Iceland Seismic Survey: Dead/Injured ESA-listed Species Report."

# 15 Conservation Recommendation

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 recommend the following discretionary conservation recommendations that we believe are consistent with this obligation and therefore may be considered by NSF and the 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 promote and fund research examining the potential effects of seismic surveys on prey species for ESA-listed marine mammals.
2. We recommend that the NSF 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 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 exclusion zones prior to starting seismic survey activities.
4. We recommend that the Permits Division develop a flow chart with decision points for mitigation and monitoring measures to be included in future MMPA incidental take authorizations for seismic surveys.
5. We recommend the NSF use (and Permits Division require in MMPA incidental take authorizations) thermal imaging cameras, in addition to binoculars (Big-Eye and handheld) and the naked eye, for use during daytime and nighttime visual observations and test their effectiveness at detecting ESA-listed species.

6. We recommend the NSF use the Marine Mammal Commission's recommended method for estimating the number of cetaceans in the vicinity of seismic surveys based on the number of groups detected for post-seismic survey activities take analysis and use in monitoring reports.
7. We recommend the NSF and 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.
8. We recommend the NSF and Permits Division consider using the potential standards for towed array PAM in the *Towed Array Passive Acoustic Operations for Bioacoustic Applications: ASA/JNCC Workshop summary March 14-18, 2016 Scripps Institution of Oceanography, La Jolla, California, USA* (Thode 2017).
9. We recommend the NSF use real-time cetacean sighting services such as the WhaleAlert application (http://www.whalealert.org/). We recognize that the research vessel may not have reliable internet access during operations far offshore, but nearshore, where many of the cetaceans considered in this opinion are likely found in greater numbers, we anticipate internet access may be better. Monitoring such systems will help plan seismic survey activities and transits to avoid locations with recent ESA-listed cetacean sightings, and may also be valuable during other activities to alert others of ESA-listed cetaceans within the area, which they can then avoid.
10. We recommend the NSF 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.
11. We recommend the vessel operator and other relevant vessel personnel (e.g., crewmembers) on the R/V *Langseth* take the U.S. Navy's marine species awareness training available online at: https://www.youtube.com/watch?v=KKo3r1yVBBA in order to detect ESA-listed species and relay information to PSOs.

In order for NMFS's Office of Protected Resources ESA Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, the NSF and/or Permits Division should notify the ESA Interagency Cooperation Division of any conservation recommendations they implement in their final action.

# 16 Reinitiation Notice

This concludes formal consultation for the NSF's and the Permits Division's actions. Consistent with 50 C.F.R. §402.16, reinitiation of formal consultation is required and shall be requested by the Federal agency, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and:

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

If the amount of tracklines, location of tracklines, number of seismic survey days, acoustic characteristics of the airgun arrays, timing of the 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 incidental take statement of this opinion, then one or more of the reinitiation triggers above may be met and reinitiation of consultation may be necessary.

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# 18 Appendix A

INCIDENTAL HARASSMENT AUTHORIZATION

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

1. This incidental harassment authorization (IHA) is valid for one year from the date of issuance.

2. This IHA is valid only for geophysical survey activity at the Reykjanes Ridge in the Northwest Atlantic Ocean, as specified in L-DEO's IHA application.

3. General Conditions

   (a) A copy of this IHA must be in the possession of L-DEO, the vessel operator, the lead protected species observer (PSO), and any other relevant designees of 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 appear within or enter the Level B harassment zone (Table 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, marine mammal monitoring protocols, operational procedures, and IHA requirements are clearly understood.

4. Mitigation Requirements

   a. L-DEO must use independent, dedicated, trained visual and acoustic PSOs, meaning that the PSOs must be employed by a third-party observer provider, must not have tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course appropriate for their designated task (visual or acoustic). Individual PSOs may perform acoustic and visual PSO duties (though not at the same time).

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

c. Visual Observation

i. During survey operations (e.g., any day on which use of the airgun array is planned to occur, and whenever the airgun array is in the water, whether activated or not), a minimum of two visual 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) and 30 minutes prior to and during ramp-up of the airgun array.

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

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

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

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

d. Acoustic Monitoring

i. The 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 five 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 acoustic source, but without an operating PAM system, do not exceed a cumulative total of five hours in any 24-hour period.

e. Shutdown zones and buffer zones

i. Except as provided in 4(e)(ii), the PSOs must establish and monitor a 500-m shutdown zone and additional 500-m buffer zone (total 1000 m). The 1000-m zone must serve to focus observational effort but not limit such effort; observations of marine mammals beyond this distance shall also be recorded as described in 5(d) below and/or trigger shutdown as described in 4(g)(iii) below, as appropriate. The shutdown zone encompasses the area at and below the sea surface out to a radius of 500 m from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself) (0–500 m). The buffer zone encompasses the area at and below the sea surface from the edge of the shutdown zone, out to a radius of 1000 meters from the edges of the airgun array (500–1000 m). During use of the acoustic source, 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 acoustic source. PSOs must monitor the shutdown zone and buffer zone for a minimum of 30 minutes prior to ramp-up (i.e., pre-start clearance).

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

f. Pre-start clearance and Ramp-up

i. A ramp-up procedure must be followed at all times as part of the activation of the airgun array, except as described under 4(f)(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 pinnipeds, 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 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. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances.

vi. If the acoustic source 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 visual and/or acoustic observation and no visual or acoustic 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., BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-start clearance watch is not required.

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

g. Shutdown requirements

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

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

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

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

1. If a dolphin of these genera is visually and/or acoustically detected and localized within the shutdown zone, no shutdown is required unless the acoustic PSO or a visual PSO confirms the individual to be of a species 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 pinnipeds, and 30 minutes for mysticetes and all other odontocetes) with no further observation of the marine mammal(s).

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

h. Vessel strike avoidance

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

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

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

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

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

vi. 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.

5. Monitoring Requirements

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

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

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

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

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

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

v. Compass (plus backup)

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

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

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

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

ii. NMFS must review and approve PSO resumes.

iii. NMFS shall have one week to approve PSOs from the time that the necessary information is submitted, after which PSOs meeting the minimum requirements shall automatically be considered approved.

iv. One visual PSO with experience as shown in 4(b) shall be designated as the lead for the PSO team. The lead must coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. (Note that the responsibility of coordinating duty schedules and roles may instead be assigned to a shore-based, third-party monitoring coordinator.) To the maximum extent practicable, the lead PSO must devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

v. 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.

vi. 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.

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

d. Data Collection

i. PSOs must use standardized 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 acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source. 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 and call sign;

2. PSO names and affiliations;

3. Date and participants of PSO briefings (as discussed in General Requirement);

4. Dates of departure and return to port with port name;

5. Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;

6. Vessel location (latitude/longitude) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;

7. Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;

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

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

10. Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (i.e., pre-start clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.).

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

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

2. PSO who sighted the animal;

3. Time of sighting;

4. Vessel location at time of sighting;

5. Water depth;

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

7. Direction of animal's travel relative to the vessel;

8. Pace of the animal;

9. Estimated distance to the animal and its heading relative to vessel at initial sighting;

10. 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;

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

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

13. 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);

14. 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);

15. Animal's closest point of approach (CPA) and/or closest distance from any element of the acoustic source;

16. Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and

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

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

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

2. Date 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);

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

6. Reporting

(a) L-DEO must submit a draft comprehensive report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. A final report must be submitted within 30 days following resolution of any comments on the draft report. The draft report must include the following:

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

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

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

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

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

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

(vii) Raw observational data.

(b) Reporting Injured or Dead Marine Mammals

(i) Discovery of Injured or Dead Marine Mammal – In the event that personnel involved in the survey activities covered by the authorization discover an injured or dead marine mammal, L-DEO must report the incident to the Office of Protected Resources (OPR) (301-427-8401) and NMFS as soon as feasible. The report must include the following information:

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

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

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

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

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

6. General circumstances under which the animal was discovered.

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

1. Time, date, and location (latitude/longitude) of the incident;
2. Species identification (if known) or description of the animal(s) involved;
3. Vessel's speed during and leading up to the incident;
4. Vessel's course/heading and what operations were being conducted (if applicable);
5. Status of all sound sources in use;
6. Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;
7. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;
8. Estimated size and length of animal that was struck;
9. Description of the behavior of the marine mammal immediately preceding and following the strike;
10. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;
11. Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and
12. To the extent practicable, photographs or video footage of the animal(s).

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

8. Renewals
On a case-by-case basis, NMFS may issue a one-time, one-year Renewal IHA following notice to the public providing an additional 15 days for public comments when (1) up to

another year of identical, or nearly identical, activities are planned or (2) the specified activities would not be completed by the time this IHA expires and a Renewal would allow for completion of the activities, provided all of the following conditions are met:

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

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

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

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

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

__________________________ _________________________________

Kimberly Damon-Randall, Date

Director, Office of Protected Resources,

National Marine Fisheries Service.

**Table 1. Authorized take numbers, by species**

| Species | Authorized Take | |
|---|---|---|
| | Level B | Level A |
| Humpback whale | 80 | 3 |
| Minke whale | 84 | 3 |
| Fin whale | 82 | 3 |
| Sei whale | 113 | 4 |
| Blue whale | 1 | 0 |
| Sperm whale | 214 | 0 |
| Northern bottlenose whale | 2 | 0 |
| Cuvier's beaked whale | 229 | 0 |
| Blaineville's beaked whale | 13 | 0 |
| Sowerby's beaked whale | 13 | 0 |
| Risso's dolphin | 916 | 0 |
| Atlantic white-sided dolphin | 4,060 | 0 |
| Bottlenose dolphin | 976 | 0 |
| Striped dolphin | 148 | 0 |
| White-beaked dolphin | 46 | 0 |
| Common dolphin | 13,468 | 0 |
| Long-finned pilot whale | 1,022 | 0 |
| Killer whale | 24 | 0 |
| Harbor porpoise | 1,181 | 45 |
| Hooded seal | 2,851 | 0 |
| Harp seal | 2,851 | 0 |
| Bearded seal | 59 | 0 |
| Gray seal | 59 | 0 |
| Harbor seal | 59 | 0 |

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

| Airgun Configuration | Survey type | Level A harassment zone (m) | | | |
|---|---|---|---|---|---|
| | | LF cetaceans | MF cetaceans | HF cetaceans | Phocid pinnipeds |
| 36 airgun array (6600 in$^3$) | MCS | 320.1 | 13.6 | 268.3 | 43.7 |
| | OBS | 103.6 | 13.6 | 268.3 | 43.7 |

**Table 3. Modeled Radial Distances (m) to Isopleths Corresponding to Level B Harassment Threshold.**

| Airgun Configuration | Water Depth (m) | Level B harassment zone (m) |
|---|---|---|
| 36 airgun array (6600 in$^3$) | >1000m | 6,733 |
| | 100-1000m | 10,100 |