DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[RTID 0648–XD803]

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine Geophysical Survey of the Reykjanes Ridge in the North Atlantic Ocean

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; proposed incidental harassment authorization; request for comments on proposed authorization and possible renewal.

SUMMARY: NMFS received a request from the Lamont-Doherty Earth Observatory of Columbia University (L–DEO) for authorization to take marine mammals incidental to a marine geophysical survey at the Reykjanes Ridge in the North Atlantic Ocean. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an incidental harassment authorization (IHA) to incidentally take marine mammals during the specified activities. NMFS is also requesting comments on a possible one-time, 1-year renewal that could be issued under certain circumstances and if all requirements are met, as described in Request for Public Comments at the end of this notice. NMFS will consider public comments prior to making any final decision on the issuance of the requested MMPA authorization and agency responses will be summarized in the final notice of our decision.

DATES: Comments and information must be received no later than June 12, 2024.

ADDRESSES: Comments should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service and should be submitted via email to *ITP.wachtendonk@noaa.gov.* Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities.* In case of problems accessing these documents, please call the contact listed below.

Instructions: NMFS is not responsible for comments sent by any other method, to any other address or individual, or received after the end of the comment period. Comments, including all attachments, must not exceed a 25-megabyte file size. All comments received are a part of the public record and will generally be posted online at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities* without change. All personal identifying information (*e.g.,* name, address) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

FOR FURTHER INFORMATION CONTACT: Rachel Wachtendonk, Office of Protected Resources, NMFS, (301) 427–8401.

SUPPLEMENTARY INFORMATION:

Background

The MMPA prohibits the ''take'' of marine mammals, with certain exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce (as delegated to NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are proposed or, if the taking is limited to harassment, a notice of a proposed IHA is provided to the public for review.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Further, NMFS must prescribe the permissible methods of taking and other ''means of effecting the least practicable adverse impact'' on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of the species or stocks for taking for certain subsistence uses (referred to in shorthand as ''mitigation''); and requirements pertaining to the mitigation, monitoring and reporting of the takings are set forth. The definitions of all applicable MMPA statutory terms cited above are included in the relevant sections below.

National Environmental Policy Act

To comply with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq.*) and NOAA Administrative Order (NAO) 216–6A, NMFS must review our proposed action (*i.e.,* the issuance of an IHA) with respect to potential impacts on the human environment.

Accordingly, NMFS plans to adopt the National Science Foundation's (NSF) Environmental Assessment (EA), as we have preliminarily determined that it includes adequate information analyzing the effects on the human environment of issuing the IHA. While not directly funding the research, NSF would provide funding support for the vessel and environmental compliance support as part of a ship barter agreement with the United Kingdom's Natural Environmental Research Council (NERC). NSF's draft EA is available on the project web page at *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities.*

Summary of Request

On December 27, 2023, NMFS received a request from L–DEO for an IHA to take marine mammals incidental to conducting a marine geophysical survey of the Reykjanes Ridge in the North Atlantic Ocean. NMFS received a final, revised version of L–DEO's application on February 26, 2024, which was deemed adequate and complete on February 27, 2024. L–DEO's request is for take, by harassment, of 25 marine mammal species by Level B harassment, and for a subset of 5 of these species, by Level A harassment. Neither L–DEO nor NMFS expect serious injury or mortality to result from this activity and, therefore, an IHA is appropriate.

Description of Proposed Activity

Overview

Researchers from the University of Birmingham, University of Southampton and University of Cambridge, with funding from the NERC, propose to conduct a high-energy seismic survey using airguns as the acoustic source from the research vessel (R/V) *Marcus G. Langseth* (Langseth), which is owned and operated by L–DEO. The proposed survey would occur at the Reykjanes Ridge, off southern Iceland, in the northwestern Atlantic Ocean during summer 2024. The proposed survey would occur within Iceland's Exclusive Economic Zone (EEZ) and high seas. The survey would occur in water depths ranging from approximately 600 to 3,000 meters (m), with most of the survey effort (~78 percent) occurring in deep water (considered here to be depths greater than 1000 m). To complete this survey, the R/V Langseth would tow a 36-airgun

array with a total discharge volume of ~6,600 cubic inches (in^3) at a depth of 10 to 12 m. The airgun array receiving systems for the different survey segments would consist of a 15 kilometer (km) long solid-state hydrophone streamer and approximately 150 deployments using a total of 50 Ocean Bottom Seismometers (OBS). The airguns would fire at a shot interval of 50 m (~24 seconds (s)) during 2-dimensional (2–D) multi-channel seismic (MCS) reflection surveys with the hydrophone streamer and at a 154.4 m (~60 s) interval during OBS seismic refraction surveys. Approximately 2,754 km of total survey trackline are proposed, including 1,662 km of MCS seismic reflection data and 1,092 km of OBS refraction data.

The purpose of the proposed survey is to collect data in support of a research proposal entitled 'IMPULSE: Taking the Pulse of the Icelandic Mantle Plume'. IMPULSE would make the first definite test of the Thermal Plume Pulsing (TPP) model, the shortest predicted time period of transient mantle convections, which has been suggested as a primary driver of some of the most remarkable perturbations to global climate, ecosystems, and the carbon cycle in Earth's history. The North Atlantic V-shaped Ridges (VSR) are the basis for the TPP model, and the proposed survey would acquire the first ever full crustal seismic profiles across multiple complete VSR cycles.

Additional data would be collected using a multibeam echosounder (MBES), a sub-bottom profiler (SBP), and an Acoustic Doppler Current Profiler (ADCP), which would be operated from R/V Langseth continuously during the seismic surveys, including during transit. No take of marine mammals is expected to result from use of this equipment.

Dates and Duration

The proposed survey is expected to last for approximately 38 days, with 9 days of MCS seismic operations, 5 days of OBS seismic operations, 17 days of OBS deployment and retrieval, 3 days of streamer deployment and retrieval, and 4 days of transit. R/V Langseth would likely leave from and return to port in Reykjavik, Iceland during summer 2024.

Specific Geographic Region

The proposed survey would occur within approximately 56–63° N, 24–34° W, within Iceland's EEZ and on the high seas, in water depths ranging from approximately 600 to 3,000 m. The closest approach of the proposed survey lines to land off the south coast of Iceland is ~130 km from Eldey and ~145 km from mainland Iceland. The region where the survey is proposed to occur is depicted in figure 1; the tracklines could occur anywhere within the polygon shown in figure 1. Representative survey tracklines are shown; however, some deviation in actual tracklines, including the order of survey operations, could be necessary for reasons such as science drivers, poor data quality, inclement weather, or mechanical issues with the research vessel and/or equipment.

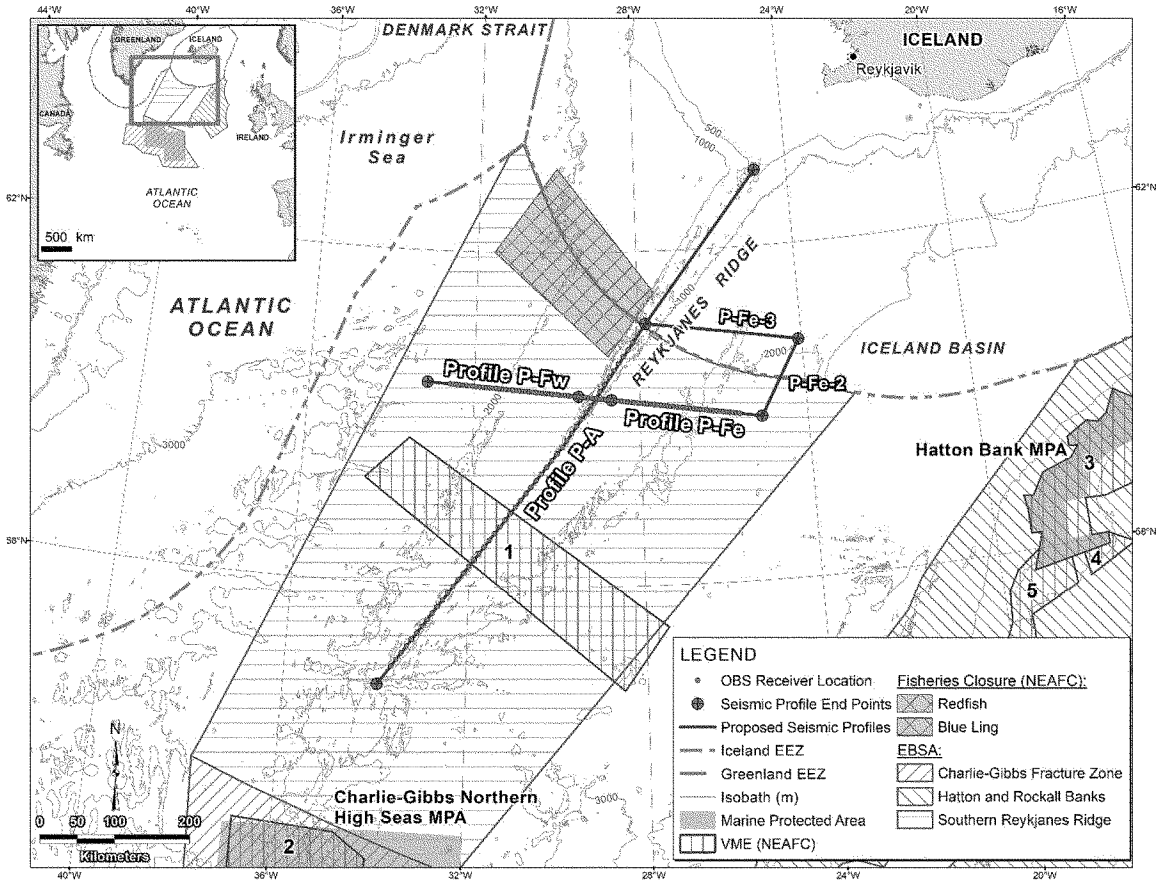

Figure 1. Location of the Proposed Reykjanes Ridge Seismic Surveys in the Northwest Atlantic Ocean

Representative survey tracklines are included in the figure; however, the tracklines could occur anywhere within the survey area. Numbered sites correspond to the following Vulnerable Marine Ecosystems (VMEs): (1) Northern Mid-Atlantic Ridge, (2) Mid Mid-Atlantic Ridge, (3) Hatton Bank, (4) Hatton Bank Area 1, and (5) Hatton Bank Area 2. EBSA; Ecologically or Biologically Significant Marine Areas. MPA; Marine Protected Area. NEAFC; North East Atlantic Fisheries.

Detailed Description of the Specified Activity

The procedures to be used for the proposed surveys would be similar to those used during previous seismic surveys by L–DEO and would use conventional seismic methodology. The survey would involve one source vessel, R/V Langseth, which is owned and operated by L–DEO. During the high-energy MCS seismic reflection and OBS seismic refraction surveys, R/V Langseth would tow 4 strings with 36 airguns, consisting of a mixture of Bolt 1500LL and Bolt 1900LLX. During the survey, all 4 strings, totaling 36 active airguns with a total discharge volume of 6,600 in^3, would be used. The four airgun strings would be spaced 16 m apart, distributed across an area of approximately 24 m x 16 m behind the R/V Langseth, and would be towed approximately 140 m behind the vessel. The airgun array configurations are illustrated in figure 2–11 of NSF and the U.S. Geological Survey's (USGS) Programmatic Environmental Impact Statement (PEIS; NSF–USGS, 2011). (The PEIS is available online at: *https://www.nsf.gov/geo/oce/envcomp/usgs-nsf-marine-seismic-research/nsf-usgs-final-eis-oeis_3june2011.pdf*). The receiving system would consist of a 15-km long solid-state hydrophone streamer and 50 OBSs. As the airgun arrays are towed along the survey lines, the hydrophone streamer would transfer the data to the on-board processing system for the MCS survey, and the OBSs would receive and store the returning acoustic signals internally for later analysis.

Approximately 2,754 km of seismic acquisition are proposed (1,662 km of 2–D MCS seismic reflection data and 1,092 km of OBS refraction data). The survey would take place in water depths ranging from 600 to 3,000 m, with most of the effort (~78 percent) taking place in deep water (≤1000 m) and the remainder taking place in intermediate water depths (100–1000 m); no effort would occur in shallow water (<100 m deep). OBS refraction data will be acquired along both profiles (figure 1). Up to 50 OBSs would be deployed at a time, then recovered, serviced, and redeployed on a subsequent profiles. In addition to the operations of the airgun array, the ocean floor would be mapped with the Kongsberg EM 122 MBES and a Knudsen Chirp 3260 SBP. A Teledyne RDI 75 kilohertz (kHz) Ocean Surveyor ADCP would be used to measure water current velocities, and acoustic pingers would be used to retrieve OBSs. Take of marine mammals is not expected to occur incidental to use of the MBES, SBP, and ADCP, whether or not the

airguns are operating simultaneously with the other sources. Given their characteristics (*e.g.,* narrow downward-directed beam), marine mammals would experience no more than one or two brief ping exposures, if any exposure were to occur. NMFS does not expect that the use of these sources presents any reasonable potential to cause take of marine mammals.

Proposed mitigation, monitoring, and reporting measures are described in detail later in this Notice (please see Proposed Mitigation and Proposed Monitoring and Reporting).

Description of Marine Mammals in the Area of Specified Activities

Sections 3 and 4 of the application summarize available information regarding status and trends, distribution and habitat preferences, and behavior and life history of the potentially affected species. NMFS fully considered all of this information, and we refer the reader to these descriptions, instead of reprinting the information. Additional information about these species (*e.g.,* physical and behavioral descriptions) may be found on NMFS' website (*https://www.fisheries.noaa.gov/find-species*). NMFS refers the reader to the aforementioned source for general information regarding the species listed in table 1.

The populations of marine mammals found in the survey area do not occur within the U.S. EEZ and therefore, are not assessed in NMFS' Stock Assessment Reports (SARs). For most species, there are no stocks defined for management purposes in the survey area, and NMFS is evaluating impacts at the species level and ranges for most species evaluated here are considered to be the North Atlantic. As such, information on potential biological removal level (PBR; defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population) and annual levels of serious injury and mortality from anthropogenic sources are not available for these marine mammal populations. Abundance estimates for marine mammals in the survey location are lacking; therefore, the modeled abundances presented here are based on a variety of proxy sources, including the U.S Navy Atlantic Fleet Training and Testing Area Marine Mammal Density (AFTT) model (Roberts et al., 2023) and the North Atlantic Marine Mammal Commission (NAMMCO; NAMMCO 2023). The modeled abundance is considered the best scientific information available on the abundance of marine mammal populations in the area.

Table 1 lists all species that occur in the survey area that may be taken as a result of the proposed survey and summarizes information related to the population, including regulatory status under the MMPA and Endangered Species Act (ESA).

TABLE 1—SPECIES LIKELY IMPACTED BY THE SPECIFIED ACTIVITIES

Common name	Scientific name	Stock	ESA/MMPA status; Strategic (Y/N) [1]	Modeled abundance [2]
Order Artiodactyla—Cetacea—Mysticeti (baleen whales)				
Family Balaenopteridae (rorquals):				
Blue Whale	*Balaenoptera musculus*	NA	E, D, Y	191
Fin Whale	*Balaenoptera physalus*	NA	E, D, Y	11,672
Humpback Whale	*Megaptera novaeangliae*	NA	-, -, N [3]	4,990
Minke Whale	*Balaenoptera acutorostrata*	NA	-, -, N	13,784
Sei Whale	*Balaenoptera borealis*	NA	E, D, Y	19,530
Odontoceti (toothed whales, dolphins, and porpoises)				
Family Physeteridae:				
Sperm Whale	*Physeter macrocephalus*	NA	E, D, Y	64,015
Family Ziphiidae (beaked whales):				
Blainville's Beaked Whale	*Mesoplodon densirostris*	NA	-, -, N	[4] 65,069
Cuvier's Beaked Whale	*Ziphius cavirostris*	NA	-, -, N	[4] 65,069
Northern Bottlenose Whale	*Hyperoodon ampullatus*	NA	-, -, N	1,056
Sowerby's Beaked Whale	*Mesoplodon bidens*	NA	-, -, N	[5] 65,069
Family Delphinidae:				
Killer Whale	*Orcinus orca*	NA	-, -, N	972
Long-Finned Pilot Whale	*Globicephala melas*	NA	-, -, N	[6] 264,907
Atlantic White-Sided Dolphin	*Lagenorhynchus acutus*	NA	-, -, N	175,299
Bottlenose Dolphin	*Tursiops truncatus*	NA	-, -, N	418,151
Risso's Dolphin	*Grampus griseus*	NA	-, -, N	78,205
Common Dolphin	*Delphinus delphis*	NA	-, -, N	473,260
Striped Dolphin	*Stenella coeruleoalba*	NA	-, -, N	412,729
White-Beaked Dolphin	*Lagenorhynchus albirostris*	NA	-, -, N	2,627
Family Phocoenidae (porpoises):				
Harbor Porpoise	*Phocoena phocoena*	NA	-, -, N	94,583
Order Carnivora—Pinnipedia				
Family Phocidae (earless seals):				
Bearded Seal	*Erignathus barbatus barbatus*	NA	-, -, N [7]	NA
Gray Seal	*Halichoerus grypus*	NA	-, -, N	NA
Harbor Seal	*Phoca vitulina*	NA	-, -, N	NA
Harp Seal	*Pagophilus groenlandicus*	NA	-, -, N	NA

TABLE 1—SPECIES LIKELY IMPACTED BY THE SPECIFIED ACTIVITIES—Continued

Common name	Scientific name	Stock	ESA/MMPA status; Strategic (Y/N) [1]	Modeled abundance [2]
Hooded Seal	*Cystophora cristata*	NA	-, -, N	NA

[1] ESA status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.

[2] Modeled abundance value from U.S Navy Atlantic Fleet Training and Testing Area Marine Mammal Density (AFTT) (Roberts *et al.,* 2023).

[3] Two humpback whale distinct population segments (DPSs) could occur in the proposed survey area: the West Indies DPS, which is not listed under the ESA; and the Cape Verde Islands/Northwest Africa DPS, which is listed as endangered under the ESA.

[4] Beaked whale guild.

[5] 2017 estimate for the U.K., Iceland, and Faroe Islands (NAMMCO 2023).

[6] Pilot whale guild.

[7] There are two concurrently recognized subspecies of the bearded seal. Only the Pacific subspecies is listed under the ESA and MMPA.

All 25 species in table 1 temporally and spatially co-occur with the activity to the degree that take is reasonably likely to occur. All species that could potentially occur in the proposed survey area are listed in section 3 of the application; however, 3 species are omitted from further analysis as they have been infrequently sighted in the survey area or their temporal and/or spatial occurrence is such that take is not expected to occur. They are not discussed further beyond the explanation provided here. In addition to what is included in sections 3 and 4 of the application, and NMFS' website, further detail informing the baseline for select species of particular or unique vulnerability (*i.e.,* information regarding current Unusual Mortality Events (UME); ESA listed species) is provided below.

Blue Whale

The blue whale has a cosmopolitan distribution and tends to be pelagic, only coming nearshore to feed and possibly to breed (Jefferson et al. 2015). The distribution of the species, at least during times of the year when feeding is a major activity, occurs in areas that provide large seasonal concentrations of euphausiids (Yochem and Leatherwood 1985). Blue whales are most often found in cool, productive waters where upwelling occurs (Reilly and Thayer 1990). Generally, blue whales are seasonal migrants between high latitudes in summer, where they feed, and low latitudes in winter, where they mate and give birth (Lockyer and Brown 1981). Their summer range in the North Atlantic extends from Davis Strait, Denmark Strait, and the waters north of Svalbard and the Barents Sea, south to the Gulf of St. Lawrence and the Bay of Biscay (Rice 1998). Although the winter range is mostly unknown, some occur near Cape Verde at that time of year (Rice 1998). Blue whales are listed as endangered under the ESA.

Numerous blue whale sightings have been made in the waters around Iceland, including several sightings within the proposed survey area (Sigurnjónsson and Vikingsson 1997; Sigurnjónsson et al. 1989; Vikingsson et al. 2002; Gunnlaugsson et al. 2004; Pike et al. 2019a). A blue whale was tracked traveling through the survey area off southern Iceland after being tagged in the Azores (Silva et al. 2013). Blue whales were seen during a survey along the Mid-Atlantic Ridge between 40° and 40° N during summer 2004 (Waring et al. 2008). Blue whale sightings have also been made during summer aerial surveys off western Iceland, north of the proposed survey area (Pike et al. 2005, 2009a). Whaling ships also made catches of blue whales between June and September off southwest Iceland, north of the proposed survey area (Sigurnjónsson and Gunnlaugsson 1990). In the OBIS database, there is one blue whale record for the proposed survey area that was made during the summer (OBIS 2023). There are an additional three records north of the proposed survey area for summer (OBIS 2023).

Fin Whale

The fin whale is widely distributed in all the World's oceans (Gambell 1985), although it is most abundant in temperate and cold waters (Aguilar and García-Vernet 2018). Nonetheless, its overall range and distribution are not well known (Jefferson *et al.* 2015). Fin whales most commonly occur offshore but can also be found in coastal areas (Jefferson *et al.* 2015). Most populations migrate seasonally between temperate waters where mating and calving occur in winter, and polar waters where feeding occurs in summer (Aguilar and García-Vernet 2018). Fin whales are listed as endangered under the ESA and depleted under the MMPA.

In the North Atlantic, fin whales are found in summer from Baffin Bay, Spitsbergen, and the Barents Sea, south to North Carolina and the coast of Portugal (Rice 1998). In winter, they have been sighted from Newfoundland to the Gulf of Mexico and the Caribbean, and from the Faroes and Norway south to the Canary Islands (Rice 1998). Based on geographic differences in fin whale calls, Delarue et al. (2014) suggested that there are four distinct stocks in the Northwest Atlantic, including a central North Atlantic stock that extends south along the Mid-Atlantic Ridge. The four feeding stocks in the Northwest Atlantic currently recognized by the North Atlantic Marine Mammal Commission (NAMMCO 2023) are located off West Iceland (in the Central Atlantic), Eastern Greenland, Western Greenland, and Eastern Canada; there are an additional three stocks in the eastern Atlantic.

In the western North Atlantic, higher densities are typically found north of 35N especially during spring and summer, with lower densities south of 35N (Edwards et al. 2015). Edwards et al. (2015) reported fin whale sightings in the survey area and the waters around Iceland during June to August. A fin whale was tracked traveling through the survey area off southern Iceland after being tagged in the Azores; it did not appear to be foraging while migrating northward (Silva et al. 2013). Possible fin whale sightings were made near 60N and 27W during the summer 2023 Reykjanes Mantle Convection and Climate IODP Expedition 395 (B. Stockmaster, IODP, pers. comm., 4 December 2023). Waring et al. (2008) reported fin whale sightings south of the proposed survey area during a survey of the Mid-Atlantic Ridge during summer 2004. Additional sightings have been made during the summer in the waters around Iceland, including within the

survey area (Sigurnjónsson et al. 1985, 1989, 1991; Víkingsson et al. 2002, 2009b, 2015; Pike et al. 2004, 2005, 2008b, 2019a; NAMMCO 2023). Summer aerial surveys have documented sightings off western Iceland, north of the proposed survey area (Pike et al. 2005, 2008a, 2009a, 2019b; Gunnlaugsson et al. 2012; Víkingsson et al. 2015). Whaling catches were also reported off western Iceland, north of the proposed survey area, during June to September (Sigurnjónsson and Gunnlaugsson 1990; Víkingsson et al. 2015). In the OBIS database, there are several thousand whaling records for the waters around Iceland, with several records located within the proposed survey area (OBIS 2023).

Humpback Whale

In the western North Atlantic, the humpback whale occurs from Greenland to Venezuela (Würsig *et al.* 2000). Humpback whales were previously listed as endangered under theESA at the species level. NMFS re-evaluated the status of the species in 2015, and on September 8, 2016, NMFS divided the species into 14 distinct population segments (DPS), removed the current species-level listing, and listed 4 DPSs as endangered and 1 DPS as threatened (81 FR 62259, September 8, 2016). The remaining nine DPSs were not listed. Two DPSs could occur in the proposed survey area: the West Indies DPS, which is not listed under the ESA; and the Cape Verde Islands/Northwest Africa DPS, which is listed as endangered under the ESA.

For most North Atlantic humpbacks, the summer feeding grounds range from the northeast coast of the U.S. to the Barents Sea (Katona and Beard 1990; Smith *et al.* 1999). In the winter, the majority of humpback whales migrate to wintering areas in the West Indies (Smith *et al.* 1999; Bettridge *et al.* 2015). Some individuals from the North Atlantic migrate to Cape Verde to breed (*e.g.,* Wenzel *et al.* 2009); however, a small proportion of the Atlantic humpback whale population remains in high latitudes in the eastern North Atlantic during winter (*e.g.,* Christensen *et al.* 1992).

Several humpback sightings have been recorded during summer in the proposed survey area, but most records are north of the survey area (Sigurnjónsson *et al.* 1985, 1989, 1991; Pike *et al.* 2002, 2005, 2010a, 2019a; Víkingsson *et al.* 2002; Gunnlaugsson *et al.* 2004; Paxton *et al.* 2009; Smith and Pike 2009; Vigness-Raposa *et al.* 2010; NAMMCO 2023). From 1987–1995, 32 sightings were recorded for Icelandic and adjacent waters north of 60° during summer (Sigurjónsson and Vikingsson 1997). Aerial surveys off western Iceland documented additional sightings north of the proposed survey area (Pike *et al.* 2005, 2008a, 2009a, 2010a, 2019b; Paxton *et al.* 2009; Gunnlaugsson *et al.* 2012). There are also whaling records for the summer off southwestern Iceland, north of the proposed survey area (Sigurnjónsson and Gunnlaugsson 1990). Waring *et al.* (2008) recorded humpback whales during a summer survey along the Mid-Atlantic Ridge south of the proposed survey area at ~53° N and 40° W, and Hansen *et al.* (2018) reported sightings off southeast Greenland from August to September. In the Ocean Biodiversity Information System (OBIS) database, there are numerous records of humpback whales in the waters around Iceland for June to October; however, there are no records in the OBIS database within the proposed survey area (OBIS 2023).

Since January 2016, elevated humpback whale mortalities have occurred along the Atlantic coast from Maine to Florida. The event was declared a UME in April 2017 and includes strandings starting in 2016. Partial or full necropsy examinations have been conducted on approximately half of the 220 known cases as of April 15, 2024. Of the whales examined (approximately 90), about 40 percent had evidence of human interaction, either ship strike or entanglement. While a portion of the whales have shown evidence of pre-mortem vessel strike, this finding is not consistent across all whales examined and more research is needed. NMFS is consulting with researchers that are conducting studies on the humpback whale populations, and these efforts may provide information on changes in whale distribution and habitat use that could provide additional insight into how these vessel interactions occurred. More information is available at: *https://www.fisheries.noaa.gov/national/marine-life-distress/2016–2024-humpback-whale-unusual-mortality-event-along-atlantic-coast.*

Minke Whale

In the Northern Hemisphere, minke whales are usually seen in coastal areas but may also be seen in pelagic waters during their northward migration in spring and summer and southward migration in fall (Stewart and Leatherwood, 1985). Minke whales in the Atlantic have a strong seasonal component to their distribution, with acoustic detections indicating that they migrate south in mid-October to early November and return from wintering grounds starting in March through early April (Hayes *et al.,* 2020). Northward migration appears to track the warmer waters of the Gulf Stream along the continental shelf while southward migration is made farther offshore (Risch *et al.* 2014). Minke whales migrate north of 30° N from March–April and migrate south from Iceland from late September through October (Risch *et al.* 2014; Víkingsson and Heide-Jorgensen 2015).

Víkingsson and Heide-Jorgensen (2015) reported on a satellite-tagged minke whale that traveled through the proposed survey area during late summer 2004. Sightings within the survey area were also recorded during June and July of 2015 (Pike *et al.* 2019a). Waring *et al.* (2008) recorded a minke whale during a summer survey along the Mid-Atlantic Ridge south of the proposed survey area at ~53° N, 40° W, and a sighting was made just north of the proposed survey area during July 2012 (Ryan *et al.* 2013). Although several minke whale sightings have been made in the survey area, most sightings have been reported to the north (Sigurnjónsson *et al.* 1985, 1989, 1991; Vikingsson *et al.* 2002; Gunnlaugsson 1991; Pike *et al.* 2009b, 2010b; NAMMCO 2023). Aerial surveys off western Iceland, north of the proposed survey area, reported minke whale sightings during the summer from 1986 to 2016 (Pike *et al.* 2008a, 2009a, 2019b; Gunnlaugsson *et al.* 2012). There are also whaling records off southwestern Iceland during summer, north of the proposed survey area, from 1979 to 1988 (Sigurnjónsson and Gunnlaugsson 1990). Sightings have also been reported off southeast Greenland from August to September (Hansen *et al.* 2018). In the OBIS database, there are numerous records of minke whales in the waters around Iceland during June–November; one sighting was made during June 2006 at 53.3° N, 40.9° W, but there are no records within the proposed survey area (OBIS 2023).

Since January 2017, a UME has been declared based on elevated minke whale mortalities detected along the U.S. Atlantic coast from Maine through South Carolina, with a total of 166 known strandings as of April 17, 2024. Full or partial necropsy examinations were conducted on more than 60 percent of the whales. Preliminary findings in several of the whales have shown evidence of human interactions or infectious disease, but these findings are not consistent across all of the whales examined, so more research is needed. More information is available

at: *https://www.fisheries.noaa.gov/national/marine-life-distress/2017–2024-minke-whale-unusual-mortality-event-along-atlantic-coast.*

Both the humpback whale and minke whale UME's are of populations of whales found on the Atlantic Coast and may not be the same populations found near the survey area.

Sei Whale

Sei whales are found in all ocean basins (Horwood 2018) but appear to prefer mid-latitude temperate waters (Jefferson *et al.* 2015). Habitat suitability models indicate that sei whale distribution is related to cool water with high chlorophyll levels (Palka *et al.,* 2017; Chavez-Rosales *et al.* 2019). They occur in deeper waters characteristic of the continental shelf edge region (Hain *et al.* 1985) and in other regions of steep bathymetric relief such as seamounts and canyons (Kenney and Winn 1987; Gregr and Trites 2001). Sei whales are listed as endangered under the ESA and designated as depleted under the MMPA.

In the North Atlantic, there are three sei whale populations: Nova Scotia, Iceland-Denmark Strait, and Eastern (Donovan 1991). They undertake seasonal migrations to feed in subpolar latitudes during summer and return to lower latitudes during winter to calve (Gambell 1985; Horwood 2018). A small number of individuals have been sighted in the eastern North Atlantic between October and December, indicating that some animals may remain at higher latitudes during winter (Evans 1992).

Sei whales were the most commonly sighted species during a summer survey along the Mid-Atlantic Ridge from Iceland to north of the Azores, including sightings within the proposed survey area; the greatest number of sightings occurred at the Charlie Gibb Fracture Zone, at ~52° N (Waring *et al.* 2008). Sei whales were also sighted within the survey area at ~60 N during July 2012 (Ryan *et al.* 2013). Numerous sightings have been reported in the waters around Iceland during summer shipboard surveys, but few have been made in the proposed survey area (Sigurnjónsson *et al.* 1985, 1989, 1991; Víkingsson *et al.* 2002, 2009a; Gunlaugsson *et al.* 2004; Pike *et al.* 2019a). Summer aerial surveys documented sightings during 1986–2016 off western Iceland, north of the proposed survey area (Pike *et al.* 2009a, 2019b). There have also been reported catches of sei whale off western Iceland, north of the survey area, during summer (Sigurnjónsson and Gunnlaugsson 1990; Víkingsson *et al.* 2015; OBIS 2023). In the OBIS database, there are numerous whaling records for the waters around Iceland, especially during July; several records are located within the proposed survey area (OBIS 2023).

Sperm Whale

The sperm whale is widely distributed, occurring from the edge of the polar pack ice to the Equator in both hemispheres, with the sexes occupying different distributions (Whitehead 2018). Their distribution and relative abundance can vary in response to prey availability, most notably squid (Jaquet and Gendron 2002). Females generally inhabit waters >1,000 m deep at latitudes <40° where sea surface temperatures are <15° C; adult males move to higher latitudes as they grow older and larger in size, returning to warm-water breeding grounds (Whitehead 2018). Sperm whales are listed as endangered under the ESA and designated as depleted under the MMPA.

Sperm whales were the second most commonly sighted cetacean species during a summer survey along the Mid-Atlantic Ridge during summer 2004, with most sightings occurring north of ~52° N; sightings were made in the proposed survey area (Waring et al. 2008). NAMMCO (2023) has also reported sightings of sperm whales within the survey area. Numerous shipboard surveys during summer have reported sightings of sperm whales in the waters around Iceland, including the proposed survey area (Sigurnjónsson et al. 1985, 1989, 1991; Vikingsson et al. 2002; Gunnlaugsson et al. 2004, 2009; Pike et al. 2019a). Aerial surveys have documented sperm whale sightings during the summer off western Iceland, north of the proposed survey area (Pike et al. 2009a, 2019b). Whaling ships reported sperm whales off southwest Iceland, north of the survey area, during summer (Sigurnjónsson and Gunnlaugsson 1990). There are several thousand records of sperm whales in the OBIS database for the waters around Iceland; most of these are whaling records that occurred between May to December, including several within the proposed survey area (OBIS 2023).

Bearded Seal

Bearded seals are associated with sea ice and have a circumpolar distribution (Burns 1981). There are two currently recognized subspecies of the bearded seal; *E. b. barbatus,* which inhabits the Atlantic and *E. b. nauticus,* which inhabits the Pacific. The Atlantic bearded seals are known to occur along the north coast of Iceland (Reeves et al. 1992) but not the southern coast. During the open-water period, bearded seals occur mainly in relatively shallow areas, because they are predominantly benthic feeders (Burns 1981). Sightings have been recorded off southeastern Greenland (Merkel et al. 2010; Boertmann and Rosing-Asvid 2014), but there are no records for the proposed survey area in the OBIS database (OBIS 2023).

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Not all marine mammal species have equal hearing capabilities (*e.g.,* Richardson *et al.,* 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007, 2019) recommended that marine mammals be divided into hearing groups based on directly measured (behavioral or auditory evoked potential techniques) or estimated hearing ranges (behavioral response data, anatomical modeling, *etc.*). Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 decibel (dB) threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. Marine mammal hearing groups and their associated hearing ranges are provided in table 2.

TABLE 2—MARINE MAMMAL HEARING GROUPS

[NMFS, 2018]

Hearing group	Generalized hearing range *
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz.
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz.
High-frequency (HF) cetaceans (true porpoises, *Kogia,* river dolphins, Cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*).	275 Hz to 160 kHz.
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz.
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz.

* Represents the generalized hearing range for the entire group as a composite (*i.e.,* all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall *et al.* 2007) and PW pinniped (approximation).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2018) for a review of available information.

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

This section provides a discussion of the ways in which components of the specified activity may impact marine mammals and their habitat. The Estimated Take of Marine Mammals section later in this document includes a quantitative analysis of the number of individuals that are expected to be taken by this activity. The Negligible Impact Analysis and Determination section considers the content of this section, the Estimated Take of Marine Mammals section, and the Proposed Mitigation section, to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and whether those impacts are reasonably expected to, or reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

Description of Active Acoustic Sound Sources

This section contains a brief technical background on sound, the characteristics of certain sound types, and on metrics used in this proposal inasmuch as the information is relevant to the specified activity and to a discussion of the potential effects of the specified activity on marine mammals found later in this document.

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in hertz (Hz) or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the ''loudness'' of a sound and is typically described using the relative unit of the dB. A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is 1 micropascal (μPa)) and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of 1 m from the source (referenced to 1 μPa) while the received level is the SPL at the listener's position (referenced to 1 μPa).

Root mean square (RMS) is the quadratic mean sound pressure over the duration of an impulse. Root mean square is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick, 1983). Root mean square accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper, 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

Sound exposure level (SEL; represented as dB re 1 $\mu Pa^2 - s$) represents the total energy contained within a pulse and considers both intensity and duration of exposure. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-p) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source and is represented in the same units as the RMS sound pressure. Another common metric is peak-to-peak sound pressure (pk-pk), which is the algebraic difference between the peak positive and peak negative sound pressures. Peak-to-peak pressure is typically approximately 6 dB higher than peak pressure (Southall *et al.,* 2007).

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources), as is the case for pulses produced by the airgun array considered here. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

Even in the absence of sound from the specified activity, the underwater environment is typically loud due to ambient sound. Ambient sound is defined as environmental background sound levels lacking a single source or point (Richardson *et al.,* 1995), and the sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. These sources may include physical (*e.g.,* wind and waves, earthquakes, ice, atmospheric sound), biological (*e.g.,* sounds produced by marine mammals, fish, and invertebrates), and anthropogenic (*e.g.,* vessels, dredging, construction) sound. A number of sources contribute to ambient sound, including the following (Richardson *et al.,* 1995):

Wind and waves: The complex interactions between wind and water surface, including processes such as breaking waves and wave-induced bubble oscillations and cavitation, are a main source of naturally occurring ambient sound for frequencies between 200 Hz and 50 kHz (Mitson, 1995). In general, ambient sound levels tend to increase with increasing wind speed and wave height. Surf sound becomes

important near shore, with measurements collected at a distance of 8.5 km from shore showing an increase of 10 dB in the 100 to 700 Hz band during heavy surf conditions;

Precipitation: Sound from rain and hail impacting the water surface can become an important component of total sound at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times;

Biological: Marine mammals can contribute significantly to ambient sound levels, as can some fish and snapping shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz; and

Anthropogenic: Sources of anthropogenic sound related to human activity include transportation (surface vessels), dredging and construction, oil and gas drilling and production, seismic surveys, sonar, explosions, and ocean acoustic studies. Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly. Sound from identifiable anthropogenic sources other than the activity of interest (*e.g.,* a passing vessel) is sometimes termed background sound, as opposed to ambient sound.

The sum of the various natural and anthropogenic sound sources at any given location and time—which comprise ''ambient'' or ''background'' sound—depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of this dependence on a large number of varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10–20 dB from day to day (Richardson *et al.,* 1995). The result is that, depending on the source type and its intensity, sound from a given activity may be a negligible addition to the local environment or could form a distinctive signal that may affect marine mammals. Details of source types are described in the following text.

Sounds are often considered to fall into one of two general types: Pulsed and non-pulsed. The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g.,* NMFS, 2018; Ward, 1997 in Southall *et al.,* 2007). Please see Southall *et al.* (2007) for an in-depth discussion of these concepts.

Pulsed sound sources (*e.g.,* airguns, explosions, gunshots, sonic booms, impact pile driving) produce signals that are brief (typically considered to be less than one second), broadband, atonal transients (ANSI, 1986, 2005; Harris, 1998; NIOSH, 1998; ISO, 2003) and occur either as isolated events or repeated in some succession. Pulsed sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features.

Non-pulsed sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous (ANSI, 1995; NIOSH, 1998). Some of these non-pulsed sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.,* rapid rise time). Examples of non-pulsed sounds include those produced by vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems (such as those used by the U.S. Navy). The duration of such sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

Airgun arrays produce pulsed signals with energy in a frequency range from about 10–2,000 Hz, with most energy radiated at frequencies below 200 Hz. The amplitude of the acoustic wave emitted from the source is equal in all directions (*i.e.,* omnidirectional), but airgun arrays do possess some directionality due to different phase delays between guns in different directions. Airgun arrays are typically tuned to maximize functionality for data acquisition purposes, meaning that sound transmitted in horizontal directions and at higher frequencies is minimized to the extent possible.

Acoustic Effects

Here, we discuss the effects of active acoustic sources on marine mammals.

Potential Effects of Underwater Sound [1]—Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The potential effects of underwater sound from active acoustic sources can potentially result in one or more of the following: Temporary or permanent hearing impairment; non-auditory physical or physiological effects; behavioral disturbance; stress; and masking (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007; Götz *et al.,* 2009). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing, if it occurs at all, will occur almost exclusively in cases where a noise is within an animal's hearing frequency range. We first describe specific manifestations of acoustic effects before providing discussion specific to the use of airgun arrays.

Richardson *et al.* (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal, but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological response. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory or other systems. Overlaying these zones to a certain extent is the area within which masking (*i.e.,* when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold) may occur; the masking zone may be highly variable in size.

We describe the more severe effects of certain non-auditory physical or physiological effects only briefly as we do not expect that use of airgun arrays are reasonably likely to result in such effects (see below for further discussion). Potential effects from

[1] Please refer to the information given previously (''Description of Active Acoustic Sound Sources'') regarding sound, characteristics of sound types, and metrics used in this document.

impulsive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al.,* 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.,* change in dive profile as a result of an avoidance reaction) caused by exposure to sound include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007; Zimmer and Tyack, 2007; Tal *et al.,* 2015). The survey activities considered here do not involve the use of devices such as explosives or mid-frequency tactical sonar that are associated with these types of effects.

Threshold Shift—Marine mammals exposed to high-intensity sound, or to lower-intensity sound for prolonged periods, can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Finneran, 2015). Threshold shift can be permanent (PTS), in which case the loss of hearing sensitivity is not fully recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall *et al.,* 2007). Repeated sound exposure that leads to TTS could cause PTS. In severe cases of PTS, there can be total or partial deafness, while in most cases the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985).

When PTS occurs, there is physical damage to the sound receptors in the ear (*i.e.,* tissue damage), whereas TTS represents primarily tissue fatigue and is reversible (Southall *et al.,* 2007). In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.,* Ward, 1997). Therefore, NMFS does not typically consider TTS to constitute auditory injury.

Relationships between TTS and PTS thresholds have not been studied in marine mammals. There is no PTS data for cetaceans, but such relationships are assumed to be similar to those in humans and other terrestrial mammals. PTS typically occurs at exposure levels at least several dBs above (a 40-dB threshold shift approximates PTS onset; *e.g.,* Kryter *et al.,* 1966; Miller, 1974) that inducing mild TTS (a 6-dB threshold shift approximates TTS onset; *e.g.,* Southall *et al.* 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds for impulsive sounds (such as airgun pulses as received close to the source) are at least 6 dB higher than the TTS threshold on a peak-pressure basis and PTS cumulative sound exposure level thresholds are 15 to 20 dB higher than TTS cumulative sound exposure level thresholds (Southall *et al.,* 2007). Given the higher level of sound or longer exposure duration necessary to cause PTS as compared with TTS, it is considerably less likely that PTS could occur.

TTS is the mildest form of hearing impairment that can occur during exposure to sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises, and a sound must be at a higher level in order to be heard. In terrestrial and marine mammals, TTS can last from minutes or hours to days (in cases of strong TTS). In many cases, hearing sensitivity recovers rapidly after exposure to the sound ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals.

Marine mammal hearing plays a critical role in communication with conspecifics, and interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (*i.e.,* recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts.

Finneran *et al.* (2015) measured hearing thresholds in 3 captive bottlenose dolphins before and after exposure to 10 pulses produced by a seismic airgun in order to study TTS induced after exposure to multiple pulses. Exposures began at relatively low levels and gradually increased over a period of several months, with the highest exposures at peak SPLs from 196 to 210 dB and cumulative (unweighted) SELs from 193–195 dB. No substantial TTS was observed. In addition, behavioral reactions were observed that indicated that animals can learn behaviors that effectively mitigate noise exposures (although exposure patterns must be learned, which is less likely in wild animals than for the captive animals considered in this study). The authors note that the failure to induce more significant auditory effects was likely due to the intermittent nature of exposure, the relatively low peak pressure produced by the acoustic source, and the low-frequency energy in airgun pulses as compared with the frequency range of best sensitivity for dolphins and other mid-frequency cetaceans.

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin, beluga whale (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), and Yangtze finless porpoise (*Neophocaena asiaeorientalis*)) exposed to a limited number of sound sources (*i.e.,* mostly tones and octave-band noise) in laboratory settings (Finneran, 2015). In general, harbor porpoises have a lower TTS onset than other measured cetacean species (Finneran, 2015). Additionally, the existing marine mammal TTS data come from a limited number of individuals within these species. There is no direct data available on noise-induced hearing loss for mysticetes.

Critical questions remain regarding the rate of TTS growth and recovery after exposure to intermittent noise and the effects of single and multiple pulses. Data at present are also insufficient to construct generalized models for recovery and determine the time necessary to treat subsequent exposures as independent events. More information is needed on the relationship between auditory evoked potential and behavioral measures of TTS for various stimuli. For summaries of data on TTS in marine mammals or for further discussion of TTS onset thresholds, please see Southall *et al.* (2007, 2019), Finneran and Jenkins (2012), Finneran (2015), and NMFS (2018).

Behavioral Effects—Behavioral disturbance may include a variety of effects, including subtle changes in behavior (*e.g.,* minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. Behavioral responses to sound are highly variable and context-specific, and any reactions depend on numerous intrinsic and extrinsic factors (*e.g.,* species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day), as well as the interplay between factors (*e.g.,* Richardson *et al.,* 1995; Wartzok *et al.,* 2003; Southall *et al.,* 2007, 2019;

Weilgart, 2007; Archer *et al.,* 2010). Behavioral reactions can vary not only among individuals but also within an individual, depending on previous experience with a sound source, context, and numerous other factors (Ellison *et al.,* 2012), and can vary depending on characteristics associated with the sound source (*e.g.,* whether it is moving or stationary, number of sources, distance from the source). Please see appendices B–C of Southall *et al.,* (2007) for a review of studies involving marine mammal behavioral responses to sound.

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al.,* 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. It is important to note that habituation is appropriately considered as a ''progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial,'' rather than as, more generally, moderation in response to human disturbance (Bejder *et al.,* 2009). The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. As noted, behavioral state may affect the type of response. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson *et al.,* 1995; NRC, 2003; Wartzok *et al.,* 2003). Controlled experiments with captive marine mammals have showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway *et al.,* 1997). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic airguns or acoustic harassment devices) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; see also Richardson *et al.,* 1995; Nowacek *et al.,* 2007). However, many delphinids approach acoustic source vessels with no apparent discomfort or obvious behavioral change (*e.g.,* Barkaszi *et al.,* 2012).

Available studies show wide variation in response to underwater sound; therefore, it is difficult to predict specifically how any given sound in a particular instance might affect marine mammals perceiving the signal. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (*e.g.,* Lusseau and Bejder, 2007; Weilgart, 2007; NRC, 2005). However, there are broad categories of potential response, which we describe in greater detail here, that include alteration of dive behavior, alteration of foraging behavior, effects to breathing, interference with or alteration of vocalization, avoidance, and flight.

Changes in dive behavior can vary widely, and may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.,* Frankel and Clark, 2000; Ng and Leung, 2003; Nowacek *et al.,* 2004; Goldbogen *et al.,* 2013a, b). Variations in dive behavior may reflect disruptions in biologically significant activities (*e.g.,* foraging) or they may be of little biological significance. The impact of an alteration to dive behavior resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (*e.g.,* bubble nets or sediment plumes), or changes in dive behavior. As for other types of behavioral response, the frequency, duration, and temporal pattern of signal presentation, as well as differences in species sensitivity, are likely contributing factors to differences in response in any given circumstance (*e.g.,* Croll *et al.,* 2001; Nowacek *et al.;* 2004; Madsen *et al.,* 2006; Yazvenko *et al.,* 2007). A determination of whether foraging disruptions incur fitness consequences would require information on or estimates of the energetic requirements of the affected individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Visual tracking, passive acoustic monitoring (PAM), and movement recording tags were used to quantify sperm whale behavior prior to, during, and following exposure to airgun arrays at received levels in the range 140–160 dB at distances of 7–13 km, following a phase-in of sound intensity and full array exposures at 1–13 km (Madsen *et al.,* 2006; Miller *et al.,* 2009). Sperm whales did not exhibit horizontal avoidance behavior at the surface. However, foraging behavior may have been affected. The sperm whales exhibited 19 percent less vocal, or buzz, rate during full exposure relative to post exposure, and the whale that was approached most closely had an extended resting period and did not resume foraging until the airguns had ceased firing. The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were 6 percent lower during exposure than control periods (Miller *et al.,* 2009). These data raise concerns that seismic surveys may impact foraging behavior in sperm whales, although more data are required to understand whether the differences were due to exposure or natural variation in sperm whale behavior (Miller *et al.,* 2009).

Variations in respiration naturally vary with different behaviors and alterations to breathing rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Various studies have shown that respiration rates may either be unaffected or could increase, depending on the species and signal characteristics, again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure (*e.g.,* Kastelein *et al.,* 2001, 2005, 2006; Gailey *et al.,* 2007, 2016).

Marine mammals vocalize for different purposes and across multiple modes, such as whistling, echolocation click production, calling, and singing. Changes in vocalization behavior in response to anthropogenic noise can occur for any of these modes and may result from a need to compete with an increase in background noise or may reflect increased vigilance or a startle response. For example, in the presence of potentially masking signals, humpback whales and killer whales have been observed to increase the length of their songs or amplitude of calls (Miller *et al.,* 2000; Fristrup *et al.,* 2003; Foote *et al.,* 2004; Holt *et al.,* 2012), while right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al.,* 2007). In some cases, animals may cease sound production during production of aversive signals (Bowles *et al.,* 1994).

Cerchio *et al.* (2014) used PAM to document the presence of singing humpback whales off the coast of northern Angola and to opportunistically test for the effect of seismic survey activity on the number of singing whales. Two recording units were deployed between March and December 2008 in the offshore environment; numbers of singers were counted every hour. Generalized Additive Mixed Models were used to assess the effect of survey day (seasonality), hour (diel variation), moon phase, and received levels of noise (measured from a single pulse during each 10 minutes sampled period) on singer number. The number of singers significantly decreased with increasing received level of noise, suggesting that humpback whale communication was disrupted to some extent by the survey activity.

Castellote *et al.* (2012) reported acoustic and behavioral changes by fin whales in response to shipping and airgun noise. Acoustic features of fin whale song notes recorded in the Mediterranean Sea and northeast Atlantic Ocean were compared for areas with different shipping noise levels and traffic intensities and during a seismic airgun survey. During the first 72 hours of the survey, a steady decrease in song received levels and bearings to singers indicated that whales moved away from the acoustic source and out of the study area. This displacement persisted for a time period well beyond the 10-day duration of seismic airgun activity, providing evidence that fin whales may avoid an area for an extended period in the presence of increased noise. The authors hypothesize that fin whale acoustic communication is modified to compensate for increased background noise and that a sensitization process may play a role in the observed temporary displacement.

Seismic pulses at average received levels of 131 dB re 1 μPa^2-s caused blue whales to increase call production (Di Iorio and Clark, 2010). In contrast, McDonald *et al.* (1995) tracked a blue whale with seafloor seismometers and reported that it stopped vocalizing and changed its travel direction at a range of 10 km from the acoustic source vessel (estimated received level 143 dB pk-pk). Blackwell *et al.* (2013) found that bowhead whale call rates dropped significantly at onset of airgun use at sites with a median distance of 41–45 km from the survey. Blackwell *et al.* (2015) expanded this analysis to show that whales actually increased calling rates as soon as airgun signals were detectable before ultimately decreasing calling rates at higher received levels (*i.e.,* 10-minute cumulative sound exposure level (SEL_{cum}) of ~127 dB). Overall, these results suggest that bowhead whales may adjust their vocal output in an effort to compensate for noise before ceasing vocalization effort and ultimately deflecting from the acoustic source (Blackwell *et al.,* 2013, 2015). These studies demonstrate that even low levels of noise received far from the source can induce changes in vocalization and/or behavior for mysticetes.

Avoidance is the displacement of an individual from an area or migration path as a result of the presence of sound or other stressors, and is one of the most obvious manifestations of disturbance in marine mammals (Richardson *et al.,* 1995). For example, gray whales are known to change direction—deflecting from customary migratory paths—in order to avoid noise from seismic surveys (Malme *et al.,* 1984). Humpback whales show avoidance behavior in the presence of an active seismic array during observational studies and controlled exposure experiments in western Australia (McCauley *et al.,* 2000). Avoidance may be short-term, with animals returning to the area once the noise has ceased (*e.g.,* Bowles *et al.,* 1994; Goold, 1996; Stone *et al.,* 2000; Morton and Symonds, 2002; Gailey *et al.,* 2007). Longer-term displacement is possible, however, which may lead to changes in abundance or distribution patterns of the affected species in the affected region if habituation to the presence of the sound does not occur (*e.g.,* Bejder *et al.,* 2006; Teilmann *et al.,* 2006).

Forney *et al.* (2017) detail the potential effects of noise on marine mammal populations with high site fidelity, including displacement and auditory masking, noting that a lack of observed response does not imply absence of fitness costs and that apparent tolerance of disturbance may have population-level impacts that are less obvious and difficult to document. Avoidance of overlap between disturbing noise and areas and/or times of particular importance for sensitive species may be critical to avoiding population-level impacts because (particularly for animals with high site fidelity) there may be a strong motivation to remain in the area despite negative impacts. Forney *et al.* (2017) state that, for these animals, remaining in a disturbed area may reflect a lack of alternatives rather than a lack of effects.

Forney *et al.* (2017) specifically discuss beaked whales, stating that until recently most knowledge of beaked whales was derived from strandings, as they have been involved in atypical mass stranding events associated with mid-frequency active sonar (MFAS) training operations. Given these observations and recent research, beaked whales appear to be particularly sensitive and vulnerable to certain types of acoustic disturbance relative to most other marine mammal species. Individual beaked whales reacted strongly to experiments using simulated MFAS at low received levels, by moving away from the sound source and stopping foraging for extended periods. These responses, if on a frequent basis, could result in significant fitness costs to individuals (Forney *et al.,* 2017). Additionally, difficulty in detection of beaked whales due to their cryptic surfacing behavior and silence when near the surface pose problems for mitigation measures employed to protect beaked whales. Forney *et al.* (2017) specifically states that failure to consider both displacement of beaked whales from their habitat and noise exposure could lead to more severe biological consequences.

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. The flight response differs from other avoidance responses in the intensity of the response (*e.g.,* directed movement, rate of travel). Relatively little information on flight responses of marine mammals to anthropogenic signals exist, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996). The result of a flight response could range from brief, temporary exertion and displacement from the area where the signal provokes flight to, in extreme cases, marine mammal strandings (Evans and England, 2001). However, it should be noted that response to a perceived predator does not necessarily invoke flight (Ford and Reeves, 2008), and whether individuals are solitary or in groups may influence the response.

Behavioral disturbance can also impact marine mammals in more subtle ways. Increased vigilance may result in costs related to diversion of focus and attention (*i.e.,* when a response consists of increased vigilance, it may come at the cost of decreased attention to other critical behaviors such as foraging or resting). These effects have generally not been demonstrated for marine mammals, but studies involving fish and terrestrial animals have shown that increased vigilance may substantially reduce feeding rates (*e.g.,* Beauchamp and Livoreil, 1997; Fritz *et al.,* 2002; Purser and Radford, 2011). In addition, chronic disturbance can cause

population declines through reduction of fitness (*e.g.,* decline in body condition) and subsequent reduction in reproductive success, survival, or both (*e.g.,* Harrington and Veitch, 1992; Daan *et al.,* 1996; Bradshaw *et al.,* 1998). However, Ridgway *et al.* (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a 5-day period did not cause any sleep deprivation or stress effects.

Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hour cycle). Disruption of such functions resulting from reactions to stressors, such as sound exposure, are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than 1 day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). Note that there is a difference between multi-day substantive behavioral reactions and multi-day anthropogenic activities. For example, just because an activity lasts for multiple days does not necessarily mean that individual animals are either exposed to activity-related stressors for multiple days or, further, exposed in a manner resulting in sustained multi-day substantive behavioral responses.

Stone (2015) reported data from at-sea observations during 1,196 seismic surveys from 1994 to 2010. When arrays of large airguns (considered to be 500 in^3 or more in that study) were firing, lateral displacement, more localized avoidance, or other changes in behavior were evident for most odontocetes. However, significant responses to large arrays were found only for the minke whale and fin whale. Behavioral responses observed included changes in swimming or surfacing behavior, with indications that cetaceans remained near the water surface at these times. Cetaceans were recorded as feeding less often when large arrays were active. Behavioral observations of gray whales during a seismic survey monitored whale movements and respirations pre-, during, and post-seismic survey (Gailey *et al.,* 2016). Behavioral state and water depth were the best ''natural'' predictors of whale movements and respiration and, after considering natural variation, none of the response variables were significantly associated with seismic survey or vessel sounds.

Stress Responses—An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (*e.g.,* Seyle, 1950; Moberg, 2000). In many cases, an animal's first and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

Neuroendocrine stress responses often involve the hypothalamus-pituitary-adrenal system. Virtually all neuroendocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction, altered metabolism, reduced immune competence, and behavioral disturbance (*e.g.,* Moberg, 1987; Blecha, 2000). Increases in the circulation of glucocorticoids are also equated with stress (Romano *et al.,* 2004).

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose serious fitness consequences. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other functions. This state of distress will last until the animal replenishes its energetic reserves sufficiently to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well-studied through controlled experiments and for both laboratory and free-ranging animals (*e.g.,* Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker, 2000; Romano *et al.,* 2002b) and, more rarely, studied in wild populations (*e.g.,* Romano *et al.,* 2002a). For example, Rolland *et al.* (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as ''distress.'' In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003).

Auditory Masking—Sound can disrupt behavior through masking, or interfering with, an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.,* those used for intraspecific communication and social interactions, prey detection, predator avoidance, navigation) (Richardson *et al.,* 1995; Erbe *et al.,* 2016). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.,* snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.,* shipping, sonar, seismic exploration) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.,* signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.,* sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age or TTS hearing loss), and existing ambient noise and propagation conditions.

Under certain circumstances, significant masking could disrupt behavioral patterns, which in turn could affect fitness for survival and reproduction. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without resulting in TS) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

The frequency range of the potentially masking sound is important in predicting any potential behavioral impacts. For example, low-frequency signals may have less effect on high-frequency echolocation sounds produced by odontocetes but are more likely to affect detection of mysticete communication calls and other potentially important natural sounds such as those produced by surf and some prey species. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication

space of animals (*e.g.,* Clark *et al.,* 2009) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.,* Miller *et al.,* 2000; Foote *et al.,* 2004; Parks *et al.,* 2007; Di Iorio and Clark, 2009; Holt *et al.,* 2009). Masking may be less in situations where the signal and noise come from different directions (Richardson *et al.,* 1995), through amplitude modulation of the signal, or through other compensatory behaviors (Houser and Moore, 2014). Masking can be tested directly in captive species (*e.g.,* Erbe, 2008), but in wild populations it must be either modeled or inferred from evidence of masking compensation. There are few studies addressing real-world masking sounds likely to be experienced by marine mammals in the wild (*e.g.,* Branstetter *et al.,* 2013).

Masking affects both senders and receivers of acoustic signals and can potentially have long-term chronic effects on marine mammals at the population level as well as at the individual level. Low-frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand, 2009). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.,* from vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (*e.g.,* Simard *et al.* 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (*e.g.,* Gedamke 2011; Guerra *et al.* 2011, 2016; Klinck *et al.* 2012; Guan *et al.* 2015), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree. Guerra *et al.* (2016) reported that ambient noise levels between seismic pulses were elevated as a result of reverberation at ranges of 50 km from the seismic source. Based on measurements in deep water of the Southern Ocean, Gedamke (2011) estimated that the slight elevation of background noise levels during intervals between seismic pulses reduced blue and fin whale communication space by as much as 36–51 percent when a seismic survey was operating 450–2,800 km away. Based on preliminary modeling, Wittekind *et al.* (2016) reported that airgun sounds could reduce the communication range of blue and fin whales 2,000 km from the seismic source. Nieukirk *et al.* (2012) and Blackwell *et al.* (2013) noted the potential for masking effects from seismic surveys on large whales.

Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the pulses (*e.g.,* Nieukirk *et al.* 2012; Thode *et al.* 2012; Bröker *et al.* 2013; Sciacca *et al.* 2016). Cerchio *et al.* (2014) suggested that the breeding display of humpback whales off Angola could be disrupted by seismic sounds, as singing activity declined with increasing received levels. In addition, some cetaceans are known to change their calling rates, shift their peak frequencies, or otherwise modify their vocal behavior in response to airgun sounds (*e.g.,* Di Iorio and Clark 2010; Castellote *et al.* 2012; Blackwell *et al.* 2013, 2015). The hearing systems of baleen whales are more sensitive to low-frequency sounds than are the ears of the small odontocetes that have been studied directly (*e.g.,* MacGillivray *et al.,* 2014). The sounds important to small odontocetes are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. In general, masking effects of seismic pulses are expected to be minor, given the normally intermittent nature of seismic pulses.

Vessel Noise

Vessel noise from the Langseth could affect marine animals in the proposed survey areas. Houghton *et al.* (2015) proposed that vessel speed is the most important predictor of received noise levels, and Putland *et al.* (2017) also reported reduced sound levels with decreased vessel speed. However, some energy is also produced at higher frequencies (Hermannsen *et al.,* 2014); low levels of high-frequency sound from vessels has been shown to elicit responses in harbor porpoise (Dyndo *et al.,* 2015).

Vessel noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (*e.g.,* Richardson *et al.* 1995; Clark *et al.,* 2009; Jensen *et al.,* 2009; Gervaise *et al.,* 2012; Hatch *et al.,* 2012; Rice *et al.,* 2014; Dunlop 2015; Erbe *et al.,* 2015; Jones *et al.,* 2017; Putland *et al.,* 2017). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (Branstetter *et al.,* 2013, 2016; Finneran and Branstetter 2013; Sills *et al.,* 2017). Branstetter *et al.* (2013) reported that time-domain metrics are also important in describing and predicting masking.

Baleen whales are thought to be more sensitive to sound at these low frequencies than are toothed whales (*e.g.,* MacGillivray *et al.* 2014), possibly causing localized avoidance of the proposed survey area during seismic operations. Many odontocetes show considerable tolerance of vessel traffic, although they sometimes react at long distances if confined by ice or shallow water, if previously harassed by vessels, or have had little or no recent exposure to vessels (Richardson *et al.* 1995). Pirotta *et al.* (2015) noted that the physical presence of vessels, not just ship noise, disturbed the foraging activity of bottlenose dolphins. There is little data on the behavioral reactions of beaked whales to vessel noise, though they seem to avoid approaching vessels (*e.g.,* Würsig *et al.,* 1998) or dive for an extended period when approached by a vessel (*e.g.,* Kasuya 1986).

In summary, project vessel sounds would not be at levels expected to cause anything more than possible localized and temporary behavioral changes in marine mammals, and would not be expected to result in significant negative effects on individuals or at the population level. In addition, in all oceans of the world, large vessel traffic is currently so prevalent that it is commonly considered a usual source of ambient sound (NSF–USGS 2011).

Vessel Strike

Vessel collisions with marine mammals, or vessel strikes, can result in death or serious injury of the animal. Wounds resulting from vessel strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). An animal at the surface may be struck directly by a vessel, a surfacing animal may hit the bottom of a vessel, or an animal just below the surface may be cut by a vessel's propeller. Superficial strikes may not kill or result in the death of the animal. These interactions are typically

associated with large whales (*e.g.,* fin whales), which are occasionally found draped across the bulbous bow of large commercial vessels upon arrival in port. Although smaller cetaceans are more maneuverable in relation to large vessels than are large whales, they may also be susceptible to strike. The severity of injuries typically depends on the size and speed of the vessel, with the probability of death or serious injury increasing as vessel speed increases (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Vanderlaan and Taggart, 2007; Conn and Silber, 2013). Impact forces increase with speed, as does the probability of a strike at a given distance (Silber *et al.,* 2010; Gende *et al.,* 2011).

Pace and Silber (2005) also found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 to 75 percent as vessel speed increased from 10 to 14 knots (kn (26 kilometer per hour (kph)), and exceeded 90 percent at 17 kn (31 kph). Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death through increased likelihood of collision by pulling whales toward the vessel (Clyne, 1999; Knowlton *et al.,* 1995). In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 kn (28 kph). The chances of a lethal injury decline from approximately 80 percent at 15 kn (28 kph) to approximately 20 percent at 8.6 kn (16 kph). At speeds below 11.8 kn (22 kph), the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward one hundred percent above 15 kn (28 kph).

The Langseth will travel at a speed of 5 kn (9 kph) while towing seismic survey gear. At this speed, both the possibility of striking a marine mammal and the possibility of a strike resulting in serious injury or mortality are discountable. At average transit speed, the probability of serious injury or mortality resulting from a strike is less than 50 percent. However, the likelihood of a strike actually happening is again discountable. Vessel strikes, as analyzed in the studies cited above, generally involve commercial shipping, which is much more common in both space and time than is geophysical survey activity. Jensen and Silber (2004) summarized vessel strikes of large whales worldwide from 1975–2003 and found that most collisions occurred in the open ocean and involved large vessels (*e.g.,* commercial shipping). No such incidents were reported for geophysical survey vessels during that time period.

It is possible for vessel strikes to occur while traveling at slow speeds. For example, a hydrographic survey vessel traveling at low speed (5.5 kn (10 kph)) while conducting mapping surveys off the central California coast struck and killed a blue whale in 2009. The State of California determined that the whale had suddenly and unexpectedly surfaced beneath the hull, with the result that the propeller severed the whale's vertebrae, and that this was an unavoidable event. This strike represents the only such incident in approximately 540,000 hours of similar coastal mapping activity ($p = 1.9 \times 10^{-6}$; 95 percent confidence interval = 0–5.5 $\times 10^{-6}$; NMFS, 2013). In addition, a research vessel reported a fatal strike in 2011 of a dolphin in the Atlantic, demonstrating that it is possible for strikes involving smaller cetaceans to occur. In that case, the incident report indicated that an animal apparently was struck by the vessel's propeller as it was intentionally swimming near the vessel. While indicative of the type of unusual events that cannot be ruled out, neither of these instances represents a circumstance that would be considered reasonably foreseeable or that would be considered preventable.

Although the likelihood of the vessel striking a marine mammal is low, we propose a robust vessel strike avoidance protocol (see Proposed Mitigation), which we believe eliminates any foreseeable risk of vessel strike during transit. We anticipate that vessel collisions involving a seismic data acquisition vessel towing gear, while not impossible, represent unlikely, unpredictable events for which there are no preventive measures. Given the proposed mitigation measures, the relatively slow speed of the vessel towing gear, the presence of bridge crew watching for obstacles at all times (including marine mammals), and the presence of marine mammal observers, the possibility of vessel strike is discountable and, further, were a strike of a large whale to occur, it would be unlikely to result in serious injury or mortality. No incidental take resulting from vessel strike is anticipated, and this potential effect of the specified activity will not be discussed further in the following analysis.

Stranding—When a living or dead marine mammal swims or floats onto shore and becomes ''beached'' or incapable of returning to sea, the event is a ''stranding'' (Geraci *et al.,* 1999; Perrin and Geraci, 2002; Geraci and Lounsbury, 2005; NMFS, 2007). The legal definition for a stranding under the MMPA is that a marine mammal is dead and is on a beach or shore of the United States; or in waters under the jurisdiction of the United States (including any navigable waters); or a marine mammal is alive and is on a beach or shore of the United States and is unable to return to the water; on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance.

Marine mammals strand for a variety of reasons, such as infectious agents, biotoxicosis, starvation, fishery interaction, vessel strike, unusual oceanographic or weather events, sound exposure, or combinations of these stressors sustained concurrently or in series. However, the cause or causes of most strandings are unknown (Geraci *et al.,* 1976; Eaton, 1979; Odell *et al.,* 1980; Best, 1982). Numerous studies suggest that the physiology, behavior, habitat relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to another phenomenon. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Chroussos, 2000; Creel, 2005; DeVries *et al.,* 2003; Fair and Becker, 2000; Foley *et al.,* 2001; Moberg, 2000; Relyea, 2005a; 2005b, Romero, 2004; Sih *et al.,* 2004).

There is no conclusive evidence that exposure to airgun noise results in behaviorally-mediated forms of injury. Behaviorally-mediated injury (*i.e.,* mass stranding events) has been primarily associated with beaked whales exposed to mid-frequency active (MFA) naval sonar. MFA sonar and the alerting stimulus used in Nowacek *et al.* (2004) are very different from the noise produced by airguns. One should therefore not expect the same reaction to airgun noise as to these other sources. As explained below, military MFA sonar is very different from airguns, and one should not assume that airguns will cause the same effects as MFA sonar (including strandings).

To understand why military MFA sonar affects beaked whales differently than airguns do, it is important to note the distinction between behavioral sensitivity and susceptibility to auditory injury. To understand the potential for auditory injury in a particular marine mammal species in relation to a given acoustic signal, the frequency range the species is able to hear is critical, as well as the species' auditory sensitivity to frequencies within that range. Current data indicate that not all marine mammal species have equal hearing capabilities across all frequencies and, therefore, species are grouped into hearing groups with generalized hearing ranges assigned on the basis of available data (Southall *et al.,* 2007, 2019). Hearing ranges as well as auditory sensitivity/susceptibility to frequencies within those ranges vary across the different groups. For example, in terms of hearing range, the high-frequency cetaceans (*e.g., Kogia* spp.) have a generalized hearing range of frequencies between 275 Hz and 160 kHz, while mid-frequency cetaceans—such as dolphins and beaked whales—have a generalized hearing range between 150 Hz to 160 kHz. Regarding auditory susceptibility within the hearing range, while mid-frequency cetaceans and high-frequency cetaceans have roughly similar hearing ranges, the high-frequency group is much more susceptible to noise-induced hearing loss during sound exposure, *i.e.,* these species have lower thresholds for these effects than other hearing groups (NMFS, 2018). Referring to a species as behaviorally sensitive to noise simply means that an animal of that species is more likely to respond to lower received levels of sound than an animal of another species that is considered less behaviorally sensitive. So, while dolphin species and beaked whale species—both in the mid-frequency cetacean hearing group—are assumed to generally hear the same sounds equally well and be equally susceptible to noise-induced hearing loss (auditory injury), the best available information indicates that a beaked whale is more likely to behaviorally respond to that sound at a lower received level compared to an animal from other mid-frequency cetacean species that are less behaviorally sensitive. This distinction is important because, while beaked whales are more likely to respond behaviorally to sounds than are many other species (even at lower levels), they cannot hear the predominant, lower frequency sounds from seismic airguns as well as sounds that have more energy at frequencies that beaked whales can hear better (such as military MFA sonar).

Military MFA sonar affects beaked whales differently than airguns do because it produces energy at different frequencies than airguns. Mid-frequency cetacean hearing is generically thought to be best between 8.8 to 110 kHz, *i.e.,* these cutoff values define the range above and below which a species in the group is assumed to have declining auditory sensitivity, until reaching frequencies that cannot be heard (NMFS, 2018). However, beaked whale hearing is likely best within a higher, narrower range (20–80 kHz, with best sensitivity around 40 kHz), based on a few measurements of hearing in stranded beaked whales (Cook *et al.,* 2006; Finneran *et al.,* 2009; Pacini *et al.,* 2011) and several studies of acoustic signals produced by beaked whales (*e.g.,* Frantzis *et al.,* 2002; Johnson *et al.,* 2004, 2006; Zimmer *et al.,* 2005). While precaution requires that the full range of audibility be considered when assessing risks associated with noise exposure (Southall *et al.,* 2007, 2019), animals typically produce sound at frequencies where they hear best. More recently, Southall *et al.* (2019) suggested that certain species in the historical mid-frequency hearing group (beaked whales, sperm whales, and killer whales) are likely more sensitive to lower frequencies within the group's generalized hearing range than are other species within the group, and state that the data for beaked whales suggest sensitivity to approximately 5 kHz. However, this information is consistent with the general conclusion that beaked whales (and other mid-frequency cetaceans) are relatively insensitive to the frequencies where most energy of an airgun signal is found. Military MFA sonar is typically considered to operate in the frequency range of approximately 3–14 kHz (D'Amico *et al.,* 2009), *i.e.,* outside the range of likely best hearing for beaked whales but within or close to the lower bounds, whereas most energy in an airgun signal is radiated at much lower frequencies, below 500 Hz (Dragoset, 1990).

It is important to distinguish between energy (loudness, measured in dB) and frequency (pitch, measured in Hz). In considering the potential impacts of mid-frequency components of airgun noise (1–10 kHz, where beaked whales can be expected to hear) on marine mammal hearing, one needs to account for the energy associated with these higher frequencies and determine what energy is truly ''significant.'' Although there is mid-frequency energy associated with airgun noise (as expected from a broadband source), airgun sound is predominantly below 1 kHz (Breitzke *et al.,* 2008; Tashmukhambetov *et al.,* 2008; Tolstoy *et al.,* 2009). As stated by Richardson *et al.* (1995), ''[. . .] most emitted [seismic airgun] energy is at 10–120 Hz, but the pulses contain some energy up to 500–1,000 Hz.'' Tolstoy *et al.* (2009) conducted empirical measurements, demonstrating that sound energy levels associated with airguns were at least 20 dB lower at 1 kHz (considered ''mid-frequency'') compared to higher energy levels associated with lower frequencies (below 300 Hz) (''all but a small fraction of the total energy being concentrated in the 10–300 Hz range'' [Tolstoy *et al.,* 2009]), and at higher frequencies (*e.g.,* 2.6–4 kHz), power might be less than 10 percent of the peak power at 10 Hz (Yoder, 2002). Energy levels measured by Tolstoy *et al.* (2009) were even lower at frequencies above 1 kHz. In addition, as sound propagates away from the source, it tends to lose higher-frequency components faster than low-frequency components (*i.e.,* low-frequency sounds typically propagate longer distances than high-frequency sounds) (Diebold *et al.,* 2010). Although higher-frequency components of airgun signals have been recorded, it is typically in surface-ducting conditions (*e.g.,* DeRuiter *et al.,* 2006; Madsen *et al.,* 2006) or in shallow water, where there are advantageous propagation conditions for the higher frequency (but low-energy) components of the airgun signal (Hermannsen *et al.,* 2015). This should not be of concern because the likely behavioral reactions of beaked whales that can result in acute physical injury would result from noise exposure at depth (because of the potentially greater consequences of severe behavioral reactions). In summary, the frequency content of airgun signals is such that beaked whales will not be able to hear the signals well (compared to MFA sonar), especially at depth where we expect the consequences of noise exposure could be more severe.

Aside from frequency content, there are other significant differences between MFA sonar signals and the sounds produced by airguns that minimize the risk of severe behavioral reactions that could lead to strandings or deaths at sea, *e.g.,* significantly longer signal duration, horizontal sound direction, typical fast and unpredictable source movement. All of these characteristics of MFA sonar tend towards greater potential to cause severe behavioral or physiological reactions in exposed beaked whales that may contribute to stranding. Although both sources are powerful, MFA sonar contains significantly greater energy in

the mid-frequency range, where beaked whales hear better. Short-duration, high energy pulses—such as those produced by airguns—have greater potential to cause damage to auditory structures (though this is unlikely for mid-frequency cetaceans, as explained later in this document), but it is longer duration signals that have been implicated in the vast majority of beaked whale strandings. Faster, less predictable movements in combination with multiple source vessels are more likely to elicit a severe, potentially anti-predator response. Of additional interest in assessing the divergent characteristics of MFA sonar and airgun signals and their relative potential to cause stranding events or deaths at sea is the similarity between the MFA sonar signals and stereotyped calls of beaked whales' primary predator: the killer whale (Zimmer and Tyack, 2007). Although generic disturbance stimuli—as airgun noise may be considered in this case for beaked whales—may also trigger antipredator responses, stronger responses should generally be expected when perceived risk is greater, as when the stimulus is confused for a known predator (Frid and Dill, 2002). In addition, because the source of the perceived predator (*i.e.,* MFA sonar) will likely be closer to the whales (because attenuation limits the range of detection of mid-frequencies) and moving faster (because it will be on faster-moving vessels), any antipredator response would be more likely to be severe (with greater perceived predation risk, an animal is more likely to disregard the cost of the response; Frid and Dill, 2002). Indeed, when analyzing movements of a beaked whale exposed to playback of killer whale predation calls, Allen *et al.* (2014) found that the whale engaged in a prolonged, directed avoidance response, suggesting a behavioral reaction that could pose a risk factor for stranding. Overall, these significant differences between sound from MFA sonar and the mid-frequency sound component from airguns and the likelihood that MFA sonar signals will be interpreted in error as a predator are critical to understanding the likely risk of behaviorally-mediated injury due to seismic surveys.

The available scientific literature also provides a useful contrast between airgun noise and MFA sonar regarding the likely risk of behaviorally-mediated injury. There is strong evidence for the association of beaked whale stranding events with MFA sonar use, and particularly detailed accounting of several events is available (*e.g.,* a 2000 Bahamas stranding event for which investigators concluded that MFA sonar use was responsible; Evans and England, 2001). D'Amico *et al.,* (2009) reviewed 126 beaked whale mass stranding events over the period from 1950 (*i.e.,* from the development of modern MFA sonar systems) through 2004. Of these, there were two events where detailed information was available on both the timing and location of the stranding and the concurrent nearby naval activity, including verification of active MFA sonar usage, with no evidence for an alternative cause of stranding. An additional 10 events were at minimum spatially and temporally coincident with naval activity likely to have included MFA sonar use and, despite incomplete knowledge of timing and location of the stranding or the naval activity in some cases, there was no evidence for an alternative cause of stranding. The U.S. Navy has publicly stated agreement that five such events since 1996 were associated in time and space with MFA sonar use, either by the U.S. Navy alone or in joint training exercises with the North Atlantic Treaty Organization. The U.S. Navy additionally noted that, as of 2017, a 2014 beaked whale stranding event in Crete coincident with naval exercises was under review and had not yet been determined to be linked to sonar activities (U.S. Navy, 2017). Separately, the International Council for the Exploration of the Sea reported in 2005 that, worldwide, there have been about 50 known strandings, consisting mostly of beaked whales, with a potential causal link to MFA sonar (ICES, 2005). In contrast, very few such associations have been made to seismic surveys, despite widespread use of airguns as a geophysical sound source in numerous locations around the world.

A review of possible stranding associations with seismic surveys (Castellote and Llorens, 2016) states that, ''[s]peculation concerning possible links between seismic survey noise and cetacean strandings is available for a dozen events but without convincing causal evidence.'' The authors' search of available information found 10 events worth further investigation via a ranking system representing a rough metric of the relative level of confidence offered by the data for inferences about the possible role of the seismic survey in a given stranding event. Only three of these events involved beaked whales. Whereas D'Amico *et al.,* (2009) used a 1–5 ranking system, in which ''1'' represented the most robust evidence connecting the event to MFA sonar use, Castellote and Llorens (2016) used a 1–6 ranking system, in which ''6'' represented the most robust evidence connecting the event to the seismic survey. As described above, D'Amico *et al.* (2009) found that two events were ranked ''1'' and 10 events were ranked ''2'' (*i.e.,* 12 beaked whale stranding events were found to be associated with MFA sonar use). In contrast, Castellote and Llorens (2016) found that none of the three beaked whale stranding events achieved their highest ranks of 5 or 6. Of the 10 total events, none achieved the highest rank of 6. Two events were ranked as 5: one stranding in Peru involving dolphins and porpoises and a 2008 stranding in Madagascar. This latter ranking can only be broadly associated with the survey itself, as opposed to use of seismic airguns. An investigation of this stranding event, which did not involve beaked whales, concluded that use of a high-frequency mapping system (12-kHz multibeam echosounder) was the most plausible and likely initial behavioral trigger of the event, which was likely exacerbated by several site- and situation-specific secondary factors. The review panel found that seismic airguns were used after the initial strandings and animals entering a lagoon system, that airgun use clearly had no role as an initial trigger, and that there was no evidence that airgun use dissuaded animals from leaving (Southall *et al.,* 2013).

However, one of these stranding events, involving two Cuvier's beaked whales, was contemporaneous with and reasonably associated spatially with a 2002 seismic survey in the Gulf of California conducted by L–DEO, as was the case for the 2007 Gulf of Cadiz seismic survey discussed by Castellote and Llorens (also involving two Cuvier's beaked whales). Neither event was considered a ''true atypical mass stranding'' (according to Frantzis (1998)) as used in the analysis of Castellote and Llorens (2016). While we agree with the authors that this lack of evidence should not be considered conclusive, it is clear that there is very little evidence that seismic surveys should be considered as posing a significant risk of acute harm to beaked whales or other mid-frequency cetaceans. We have considered the potential for the proposed surveys to result in marine mammal stranding and, based on the best available information, do not expect a stranding to occur.

Entanglement—Entanglements occur when marine mammals become wrapped around cables, lines, nets, or other objects suspended in the water column. During seismic operations, numerous cables, lines, and other objects primarily associated with the

airgun array and hydrophone streamers will be towed behind the Langseth near the water's surface. However, we are not aware of any cases of entanglement of marine mammals in seismic survey equipment. No incidents of entanglement of marine mammals with seismic survey gear have been documented in over 54,000 nautical miles (100,000 km) of previous NSF-funded seismic surveys when observers were aboard (*e.g.,* Smultea and Holst 2003; Haley and Koski 2004; Holst 2004; Smultea *et al.,* 2004; Holst *et al.,* 2005a; Haley and Ireland 2006; SIO and NSF 2006b; Hauser *et al.,* 2008; Holst and Smultea 2008). Although entanglement with the streamer is theoretically possible, it has not been documented during tens of thousands of miles of NSF-sponsored seismic cruises or, to our knowledge, during hundreds of thousands of miles of industrial seismic cruises. There are a relative few deployed devices, and no interaction between marine mammals and any such device has been recorded during prior NSF surveys using the devices. There are no meaningful entanglement risks posed by the proposed survey, and entanglement risks are not discussed further in this document.

Anticipated Effects on Marine Mammal Habitat

Physical Disturbance—Sources of seafloor disturbance related to geophysical surveys that may impact marine mammal habitat include placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor for various activities. Equipment deployed on the seafloor has the potential to cause direct physical damage and could affect bottom-associated fish resources. During this survey, OBSs would be deployed on the seafloor, secured with concrete and/or steel anchors. All OBSs would be recovered by the end of the survey.

Placement of equipment could damage areas of hard bottom where direct contact with the seafloor occurs and could crush epifauna (organisms that live on the seafloor or surface of other organisms). Damage to unknown or unseen hard bottom could occur, but because of the small area covered by most bottom-founded equipment and the patchy distribution of hard bottom habitat, contact with unknown hard bottom is expected to be rare and impacts minor. Seafloor disturbance in areas of soft bottom can cause loss of small patches of epifauna and infauna due to burial or crushing, and bottom-feeding fishes could be temporarily displaced from feeding areas. Overall, any effects of physical damage to habitat are expected to be minor and temporary.

Effects to Prey—Marine mammal prey varies by species, season, and location and, for some, is not well documented. Fish react to sounds which are especially strong and/or intermittent low-frequency sounds, and behavioral responses such as flight or avoidance are the most likely effects. However, the reaction of fish to airguns depends on the physiological state of the fish, past exposures, motivation (*e.g.,* feeding, spawning, migration), and other environmental factors. Several studies have demonstrated that airgun sounds might affect the distribution and behavior of some fishes, potentially impacting foraging opportunities or increasing energetic costs (*e.g.,* Fewtrell and McCauley, 2012; Pearson *et al.,* 1992; Skalski *et al.,* 1992; Santulli *et al.,* 1999; Paxton *et al.,* 2017), though the bulk of studies indicate no or slight reaction to noise (*e.g.,* Miller and Cripps, 2013; Dalen and Knutsen, 1987; Pena *et al.,* 2013; Chapman and Hawkins, 1969; Wardle *et al.,* 2001; Sara *et al.,* 2007; Jorgenson and Gyselman, 2009; Blaxter *et al.,* 1981; Cott *et al.,* 2012; Boeger *et al.,* 2006), and that, most commonly, while there are likely to be impacts to fish as a result of noise from nearby airguns, such effects will be temporary. For example, investigators reported significant, short-term declines in commercial fishing catch rate of gadid fishes during and for up to 5 days after seismic survey operations, but the catch rate subsequently returned to normal (Engas *et al.,* 1996; Engas and Lokkeborg, 2002). Other studies have reported similar findings (Hassel *et al.,* 2004). Skalski *et al.,* (1992) also found a reduction in catch rates—for rockfish (*Sebastes* spp.) in response to controlled airgun exposure—but suggested that the mechanism underlying the decline was not dispersal but rather decreased responsiveness to baited hooks associated with an alarm behavioral response. A companion study showed that alarm and startle responses were not sustained following the removal of the sound source (Pearson *et al.,* 1992). Therefore, Skalski *et al.* (1992) suggested that the effects on fish abundance may be transitory, primarily occurring during the sound exposure itself. In some cases, effects on catch rates are variable within a study, which may be more broadly representative of temporary displacement of fish in response to airgun noise (*i.e.,* catch rates may increase in some locations and decrease in others) than any long-term damage to the fish themselves (Streever *et al.,* 2016).

Sound pressure levels of sufficient strength have been known to cause injury to fish and fish mortality and, in some studies, fish auditory systems have been damaged by airgun noise (McCauley *et al.,* 2003; Popper *et al.,* 2005; Song *et al.,* 2008). However, in most fish species, hair cells in the ear continuously regenerate and loss of auditory function likely is restored when damaged cells are replaced with new cells. Halvorsen *et al.* (2012) showed that a TTS of 4–6 dB was recoverable within 24 hours for one species. Impacts would be most severe when the individual fish is close to the source and when the duration of exposure is long; both of which are conditions unlikely to occur for this survey that is necessarily transient in any given location and likely result in brief, infrequent noise exposure to prey species in any given area. For this survey, the sound source is constantly moving, and most fish would likely avoid the sound source prior to receiving sound of sufficient intensity to cause physiological or anatomical damage. In addition, ramp-up may allow certain fish species the opportunity to move further away from the sound source.

A comprehensive review (Carroll *et al.,* 2017) found that results are mixed as to the effects of airgun noise on the prey of marine mammals. While some studies suggest a change in prey distribution and/or a reduction in prey abundance following the use of seismic airguns, others suggest no effects or even positive effects in prey abundance. As one specific example, Paxton *et al.* (2017), which describes findings related to the effects of a 2014 seismic survey on a reef off of North Carolina, showed a 78 percent decrease in observed nighttime abundance for certain species. It is important to note that the evening hours during which the decline in fish habitat use was recorded (via video recording) occurred on the same day that the seismic survey passed, and no subsequent data is presented to support an inference that the response was long-lasting. Additionally, given that the finding is based on video images, the lack of recorded fish presence does not support a conclusion that the fish actually moved away from the site or suffered any serious impairment. In summary, this particular study corroborates prior studies indicating that a startle response or short-term displacement should be expected.

Available data suggest that cephalopods are capable of sensing the particle motion of sounds and detect low frequencies up to 1–1.5 kHz, depending on the species, and so are

likely to detect airgun noise (Kaifu *et al.,* 2008; Hu *et al.,* 2009; Mooney *et al.,* 2010; Samson *et al.,* 2014). Auditory injuries (lesions occurring on the statocyst sensory hair cells) have been reported upon controlled exposure to low-frequency sounds, suggesting that cephalopods are particularly sensitive to low-frequency sound (Andre *et al.,* 2011; Sole *et al.,* 2013). Behavioral responses, such as inking and jetting, have also been reported upon exposure to low-frequency sound (McCauley *et al.,* 2000b; Samson *et al.,* 2014). Similar to fish, however, the transient nature of the survey leads to an expectation that effects will be largely limited to behavioral reactions and would occur as a result of brief, infrequent exposures.

With regard to potential impacts on zooplankton, McCauley *et al.* (2017) found that exposure to airgun noise resulted in significant depletion for more than half the taxa present and that there were two to three times more dead zooplankton after airgun exposure compared with controls for all taxa, within 1 km of the airguns. However, the authors also stated that in order to have significant impacts on r-selected species (*i.e.,* those with high growth rates and that produce many offspring) such as plankton, the spatial or temporal scale of impact must be large in comparison with the ecosystem concerned, and it is possible that the findings reflect avoidance by zooplankton rather than mortality (McCauley *et al.,* 2017). In addition, the results of this study are inconsistent with a large body of research that generally finds limited spatial and temporal impacts to zooplankton as a result of exposure to airgun noise (*e.g.,* Dalen and Knutsen, 1987; Payne, 2004; Stanley *et al.,* 2011). Most prior research on this topic, which has focused on relatively small spatial scales, has showed minimal effects (*e.g.,* Kostyuchenko, 1973; Booman *et al.,* 1996; Sætre and Ona, 1996; Pearson *et al.,* 1994; Bolle *et al.,* 2012).

A modeling exercise was conducted as a follow-up to the McCauley *et al.* (2017) study (as recommended by McCauley *et al.*), in order to assess the potential for impacts on ocean ecosystem dynamics and zooplankton population dynamics (Richardson *et al.,* 2017). Richardson *et al.* (2017) found that for copepods with a short life cycle in a high-energy environment, a full-scale airgun survey would impact copepod abundance up to 3 days following the end of the survey, suggesting that effects such as those found by McCauley *et al.* (2017) would not be expected to be detectable downstream of the survey areas, either spatially or temporally.

Notably, a more recently described study produced results inconsistent with those of McCauley *et al.* (2017). Researchers conducted a field and laboratory study to assess if exposure to airgun noise affects mortality, predator escape response, or gene expression of the copepod *Calanus finmarchicus* (Fields *et al.,* 2019). Immediate mortality of copepods was significantly higher, relative to controls, at distances of 5 m or less from the airguns. Mortality 1 week after the airgun blast was significantly higher in the copepods placed 10 m from the airgun but was not significantly different from the controls at a distance of 20 m from the airgun. The increase in mortality, relative to controls, did not exceed 30 percent at any distance from the airgun. Moreover, the authors caution that even this higher mortality in the immediate vicinity of the airguns may be more pronounced than what would be observed in free-swimming animals due to increased flow speed of fluid inside bags containing the experimental animals. There were no sublethal effects on the escape performance or the sensory threshold needed to initiate an escape response at any of the distances from the airgun that were tested. Whereas McCauley *et al.* (2017) reported an SEL of 156 dB at a range of 509–658 m, with zooplankton mortality observed at that range, Fields *et al.* (2019) reported an SEL of 186 dB at a range of 25 m, with no reported mortality at that distance. Regardless, if we assume a worst-case likelihood of severe impacts to zooplankton within approximately 1 km of the acoustic source, the brief time to regeneration of the potentially affected zooplankton populations does not lead us to expect any meaningful follow-on effects to the prey base for marine mammals.

A review article concluded that, while laboratory results provide scientific evidence for high-intensity and low-frequency sound-induced physical trauma and other negative effects on some fish and invertebrates, the sound exposure scenarios in some cases are not realistic to those encountered by marine organisms during routine seismic operations (Carroll *et al.,* 2017). The review finds that there has been no evidence of reduced catch or abundance following seismic activities for invertebrates, and that there is conflicting evidence for fish with catch observed to increase, decrease, or remain the same. Further, where there is evidence for decreased catch rates in response to airgun noise, these findings provide no information about the underlying biological cause of catch rate reduction (Carroll *et al.,* 2017).

In summary, impacts of the specified activity on marine mammal prey species will likely generally be limited to behavioral responses, the majority of prey species will be capable of moving out of the area during the survey, a rapid return to normal recruitment, distribution, and behavior for prey species is anticipated, and, overall, impacts to prey species will be minor and temporary. Prey species exposed to sound might move away from the sound source, experience TTS, experience masking of biologically relevant sounds, or show no obvious direct effects. Mortality from decompression injuries is possible in close proximity to a sound, but only limited data on mortality in response to airgun noise exposure are available (Hawkins *et al.,* 2014). The most likely impacts for most prey species in the survey area would be temporary avoidance of the area. The proposed survey would move through an area relatively quickly, limiting exposure to multiple impulsive sounds. In all cases, sound levels would return to ambient once the survey moves out of the area or ends and the noise source is shut down and, when exposure to sound ends, behavioral and/or physiological responses are expected to end relatively quickly (McCauley *et al.,* 2000b). The duration of fish avoidance of a given area after survey effort stops is unknown, but a rapid return to normal recruitment, distribution, and behavior is anticipated. While the potential for disruption of spawning aggregations or schools of important prey species can be meaningful on a local scale, the mobile and temporary nature of this survey and the likelihood of temporary avoidance behavior suggest that impacts would be minor.

Acoustic Habitat—Acoustic habitat is the soundscape—which encompasses all of the sound present in a particular location and time, as a whole—when considered from the perspective of the animals experiencing it. Animals produce sound for, or listen for sounds produced by, conspecifics (communication during feeding, mating, and other social activities), other animals (finding prey or avoiding predators), and the physical environment (finding suitable habitats, navigating). Together, sounds made by animals and the geophysical environment (*e.g.,* produced by earthquakes, lightning, wind, rain, waves) make up the natural contributions to the total acoustics of a place. These acoustic conditions, termed acoustic habitat, are one attribute of an animal's total habitat.

Soundscapes are also defined by, and acoustic habitat influenced by, the total contribution of anthropogenic sound. This may include incidental emissions from sources such as vessel traffic, or may be intentionally introduced to the marine environment for data acquisition purposes (as in the use of airgun arrays). Anthropogenic noise varies widely in its frequency content, duration, and loudness and these characteristics greatly influence the potential habitat-mediated effects to marine mammals (please see also the previous discussion on masking under *Acoustic Effects*), which may range from local effects for brief periods of time to chronic effects over large areas and for long durations. Depending on the extent of effects to habitat, animals may alter their communications signals (thereby potentially expending additional energy) or miss acoustic cues (either conspecific or adventitious). For more detail on these concepts see, *e.g.,* Barber *et al.,* 2010; Pijanowski *et al.,* 2011; Francis and Barber, 2013; Lillis *et al.,* 2014.

Problems arising from a failure to detect cues are more likely to occur when noise stimuli are chronic and overlap with biologically relevant cues used for communication, orientation, and predator/prey detection (Francis and Barber, 2013). Although the signals emitted by seismic airgun arrays are generally low frequency, they would also likely be of short duration and transient in any given area due to the nature of these surveys. As described previously, exploratory surveys such as these cover a large area but would be transient rather than focused in a given location over time and therefore would not be considered chronic in any given location.

Based on the information discussed herein, we conclude that impacts of the specified activity are not likely to have more than short-term adverse effects on any prey habitat or populations of prey species. Further, any impacts to marine mammal habitat are not expected to result in significant or long-term consequences for individual marine mammals, or to contribute to adverse impacts on their populations.

Estimated Take of Marine Mammals

This section provides an estimate of the number of incidental takes proposed for authorization through this IHA, which will inform both NMFS' consideration of ''small numbers,'' and the negligible impact determinations.

Harassment is the only type of take expected to result from these activities. Except with respect to certain activities not pertinent here, section 3(18) of the MMPA defines ''harassment'' as any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

Anticipated takes would primarily be by Level B harassment, as use of the airgun array have the potential to result in disruption of behavioral patterns for individual marine mammals. There is also some potential for auditory injury (Level A harassment) to result for species of certain hearing groups due to the size of the predicted auditory injury zones for those groups. Auditory injury is less likely to occur for mid-frequency species due to their relative lack of sensitivity to the frequencies at which the primary energy of an airgun signal is found as well as such species' general lower sensitivity to auditory injury as compared to high-frequency cetaceans. As discussed in further detail below, we do not expect auditory injury for mid-frequency cetaceans. No mortality is anticipated as a result of these activities. Below we describe how the proposed take numbers are estimated.

For acoustic impacts, generally speaking, we estimate take by considering: (1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed 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 marine mammals within these ensonified areas; and, (4) the number of days of activities. We note that while these factors can contribute to a basic calculation to provide an initial prediction of potential takes, additional information that can qualitatively inform take estimates is also sometimes available (*e.g.,* previous monitoring results or average group size). Below, we describe the factors considered here in more detail and present the proposed take estimates.

Acoustic Thresholds

NMFS recommends the use of acoustic thresholds that identify the received level of underwater sound above which exposed marine mammals would be reasonably expected to be behaviorally harassed (equated to Level B harassment) or to incur PTS of some degree (equated to Level A harassment).

Level B Harassment—Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source or exposure context (*e.g.,* frequency, predictability, duty cycle, duration of the exposure, signal-to-noise ratio, distance to the source), the environment (*e.g.,* bathymetry, other noises in the area, predators in the area), and the receiving animals (hearing, motivation, experience, demography, life stage, depth) and can be difficult to predict (*e.g.,* Southall *et al.,* 2007, 2021, Ellison *et al.,* 2012). Based on what the available science indicates and the practical need to use a threshold based on a metric that is both predictable and measurable for most activities, NMFS typically uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS generally predicts that marine mammals are likely to be behaviorally harassed in a manner considered to be Level B harassment when exposed to underwater anthropogenic noise above root-mean-squared pressure received levels (RMS SPL) of 120 dB (referenced to 1 micropascal (re 1 μPa)) for continuous (*e.g.,* vibratory pile driving, drilling) and above RMS SPL 160 dB re 1 μPa for non-explosive impulsive (*e.g.,* seismic airguns) or intermittent (*e.g.,* scientific sonar) sources. Generally speaking, Level B harassment take estimates based on these behavioral harassment thresholds are expected to include any likely takes by TTS as, in most cases, the likelihood of TTS occurs at distances from the source less than those at which behavioral harassment is likely. TTS of a sufficient degree can manifest as behavioral harassment, as reduced hearing sensitivity and the potential reduced opportunities to detect important signals (conspecific communication, predators, prey) may result in changes in behavior patterns that would not otherwise occur.

L-DEO's proposed survey includes the use of impulsive seismic sources (*i.e.,* airguns), and therefore the 160 dB re 1 μPa is applicable for analysis of Level B harassment.

Level A harassment—NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) (Technical Guidance, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-

impulsive). L-DEO's proposed survey includes the use of impulsive seismic sources (*i.e.,* airguns).

These thresholds are provided in the table below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS' 2018 Technical Guidance, which may be accessed at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance*.

TABLE 3—THRESHOLDS IDENTIFYING THE ONSET OF PERMANENT THRESHOLD SHIFT

Hearing group	PTS Onset acoustic thresholds * (received level)	
	Impulsive	Non-impulsive
Low-Frequency (LF) Cetaceans	*Cell 1:* $L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB	*Cell 2:* $L_{E,LF,24h}$: 199 dB.
Mid-Frequency (MF) Cetaceans	*Cell 3:* $L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	*Cell 4:* $L_{E,MF,24h}$: 198 dB
High-Frequency (HF) Cetaceans	*Cell 5:* $L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB	*Cell 6:* $L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 7:* $L_{pk,flat}$: 218 dB; $L_{E,PW,24h}$: 185 dB	*Cell 8:* $L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	*Cell 9:* $L_{pk,flat}$: 232 dB; $L_{E,OW,24h}$: 203 dB	*Cell 10:* $L_{E,OW,24h}$: 219 dB

* Dual metric acoustic thresholds for impulsive sounds: Use whichever results in the largest isopleth for calculating PTS onset. If a non-impulsive sound has the potential of exceeding the peak sound pressure level thresholds associated with impulsive sounds, these thresholds should also be considered.

Note: Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound exposure level (L_E) has a reference value of 1µPa^{2}s. In this table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI 2013). However, peak sound pressure is defined by ANSI as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, the subscript ''flat'' is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (*i.e.,* varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

Ensonified Area

Here, we describe operational and environmental parameters of the activity that are used in estimating the area ensonified above the acoustic thresholds, including source levels and transmission loss coefficient.

When the Technical Guidance was published (NMFS, 2016), in recognition of the fact that ensonified area/volume could be more technically challenging to predict because of the duration component in the new thresholds, we developed a user spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to help predict takes. We note that because of some of the assumptions included in the methods used for these tools, we anticipate that isopleths produced are typically going to be overestimates of some degree, which may result in some degree of overestimate of Level A harassment take. However, these tools offer the best way to predict appropriate isopleths when more sophisticated 3D modeling methods are not available, and NMFS continues to develop ways to quantitatively refine these tools and will qualitatively address the output where appropriate.

The proposed survey would entail the use of a 36-airgun array with a total discharge volume of 6,600 in^3 at a tow depth of 10 m to 12 m. L-DEO's model results are used to determine the 160 dB_{rms} radius for the airgun source down to a maximum depth of 2,000 m. Received sound levels have been predicted by L-DEO's model (Diebold *et al.* 2010) as a function of distance from the 36-airgun array. This modeling approach uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array at a tow depth of 6 m have been reported in deep water (~1,600 m), intermediate water depth on the slope (~600–1,100 m), and shallow water (~50 m) in the Gulf of Mexico (Tolstoy *et al.* 2009; Diebold *et al.* 2010).

For deep and intermediate water cases, the field measurements cannot be used readily to derive the harassment isopleths, as at those sites the calibration hydrophone was located at a roughly constant depth of 350–550 m, which may not intersect all the SPL isopleths at their widest point from the sea surface down to the assumed maximum relevant water depth (~2000 m) for marine mammals. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data at the deep sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At longer ranges, the comparison with the model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant.

In deep and intermediate water depths at short ranges, sound levels for direct arrivals recorded by the calibration hydrophone and L-DEO model results for the same array tow depth are in good alignment (see figures 12 and 14 in Diebold *et al.* 2010). Consequently, isopleths falling within this domain can be predicted reliably by the L-DEO model, although they may be imperfectly sampled by measurements recorded at a single depth. At greater distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent (see figures 11, 12, and 16 in Diebold *et al.* 2010). Aside from local topography effects, the region around the critical distance is where the observed levels rise closest to the model curve. However, the observed sound levels are found to fall almost entirely below the model curve. Thus, analysis of the Gulf of Mexico calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for conservatively estimating isopleths.

The proposed high-energy survey would acquire data with the 36-airgun array at a tow depth of 10 to 12 m. For deep water (>1,000 m), we use the deep-water radii obtained from L-DEO model results down to a maximum water depth of 2,000 m for the 36-airgun array. The radii for intermediate water depths (100–1,000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near

offsets fall below the corrected mitigation curve (see figure 16 in Diebold *et al.* 2010).

L-DEO's modeling methodology is described in greater detail in L-DEO's application. The estimated distances to the Level B harassment isopleth for the proposed airgun configuration are shown in table 4.

TABLE 4—PREDICTED RADIAL DISTANCES FROM THE R/V LANGSETH SEISMIC SOURCE TO ISOPLETH CORRESPONDING TO LEVEL B HARASSMENT THRESHOLD

Airgun configuration	Tow depth (m) [1]	Water depth (m)	Predicted distances (in m) to the Level B harassment threshold
4 strings, 36 airguns, 6,600 in^3	12	>1,000 100–1,000	[2] 6,733 [3] 10,100

[1] Maximum tow depth was used for conservative distances.
[2] Distance is based on L-DEO model results.
[3] Distance is based on L-DEO model results with a 1.5 × correction factor between deep and intermediate water depths.

TABLE 5—MODELED RADIAL DISTANCE TO ISOPLETHS CORRESPONDING TO LEVEL A HARASSMENT THRESHOLDS

	Low frequency cetaceans	Mid frequency cetaceans	High frequency cetaceans	Phocid pinnipeds
MCS Surveys				
PTS SEL_{cum}	**320.2**	0	1	10.4
PTS Peak	38.9	**13.6**	**268.3**	**43.7**
OBS Surveys				
PTS SEL_{cum}	**103.6**	0	0.3	3.4
PTS Peak	38.9	**13.6**	**268.3**	**43.7**

The largest distance (in bold) of the dual criteria (SEL cum or Peak) was used to estimate threshold distances and potential takes by Level A harassment.

Table 5 presents the modeled PTS isopleths for each cetacean hearing group based on L-DEO modeling incorporated in the companion user spreadsheet, for the high-energy surveys with the shortest shot interval (*i.e.,* greatest potential to cause PTS based on accumulated sound energy) (NMFS 2018).

Predicted distances to Level A harassment isopleths, which vary based on marine mammal hearing groups, were calculated based on modeling performed by L-DEO using the Nucleus software program and the NMFS user spreadsheet, described below. The acoustic thresholds for impulsive sounds contained in the NMFS Technical Guidance were presented as dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure metrics (NMFS 2016). As dual metrics, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the two metrics is exceeded (*i.e.,* metric resulting in the largest isopleth). The SEL_{cum} metric considers both level and duration of exposure, as well as auditory weighting functions by marine mammal hearing group.

The SEL_{cum} for the 36-airgun array is derived from calculating the modified farfield signature. The farfield signature is often used as a theoretical representation of the source level. To compute the farfield signature, the source level is estimated at a large distance (right) below the array (*e.g.,* 9 km), and this level is back projected mathematically to a notional distance of 1 m from the array's geometrical center. However, it has been recognized that the source level from the theoretical farfield signature is never physically achieved at the source when the source is an array of multiple airguns separated in space (Tolstoy *et al.,* 2009). Near the source (at short ranges, distances <1 km), the pulses of sound pressure from each individual airgun in the source array do not stack constructively as they do for the theoretical farfield signature. The pulses from the different airguns spread out in time such that the source levels observed or modeled are the result of the summation of pulses from a few airguns, not the full array (Tolstoy *et al.,* 2009). At larger distances, away from the source array center, sound pressure of all the airguns in the array stack coherently, but not within one time sample, resulting in smaller source levels (a few dB) than the source level derived from the far-field signature. Because the far-field signature does not take into account the large array effect near the source and is calculated as a point source, the far-field signature is not an appropriate measure of the sound source level for large arrays. See L-DEO's application for further detail on acoustic modeling.

Auditory injury is unlikely to occur for mid-frequency cetaceans, given the very small modeled zones of injury for those species (all estimated zones are less than 15 m for mid-frequency cetaceans), in context of distributed source dynamics.

In consideration of the received sound levels in the near-field as described above, we expect the potential for Level A harassment of mid-frequency cetaceans to be de minimis, even before the likely moderating effects of aversion and/or other compensatory behaviors (*e.g.,* Nachtigall *et al.,* 2018) are considered. We do not anticipate that Level A harassment is a likely outcome for any mid-frequency cetacean and do not propose to authorize any take by Level A harassment for these species.

The Level A and Level B harassment estimates are based on a consideration of the number of marine mammals that could be within the area around the operating airgun array where received levels of sound ≥160 dB re 1 µPa rms

are predicted to occur. The estimated numbers are based on the densities (numbers per unit area) of marine mammals expected to occur in the area in the absence of seismic surveys. To the extent that marine mammals tend to move away from seismic sources before the sound level reaches the criterion level and tend not to approach an operating airgun array, these estimates likely overestimate the numbers actually exposed to the specified level of sound.

Marine Mammal Occurrence

In this section, we provide information about the occurrence of marine mammals, including density or other relevant information which will inform the take calculations.

Habitat-based stratified marine mammal densities for the North Atlantic are taken from the US Navy Atlantic Fleet Training and Testing Area Marine Mammal Density (Roberts *et al.,* 2023; Mannocci *et al.,* 2017), which represent the best available information regarding marine mammal densities in the region. This density information incorporates visual line-transect surveys of marine mammals for over 35 years, resulting in various studies that estimated the abundance, density, and distributions of marine mammal populations. The habitat-based density models consisted of 5 km x 5 km grid cells. The AFTT model does not overlap the proposed survey area but provides density data for marine mammals at the same latitudes and water depths as the proposed survey area. The model covers an area of approximately 15–65° N, and from the east coast of the U.S. and Canada to 45° W. More information is available online at *https://seamap.env.duke.edu/models/Duke/AFTT/*. The range of most populations extends past the coverage of the model.

For most species, only annual densities were available. For some baleen whale species, seasonal densities were available; thus, densities that overlapped the timing of the proposed survey (*i.e.,* summer) were used.

Take Estimation

Here, we describe how the information provided above is synthesized to produce a quantitative estimate of the take that is reasonably likely to occur and proposed for authorization. In order to estimate the number of marine mammals predicted to be exposed to sound levels that would result in Level A or Level B harassment, radial distances from the airgun array to the predicted isopleth corresponding to the Level A harassment and Level B harassment thresholds are calculated, as described above. Those radial distances were then used to calculate the area(s) around the airgun array predicted to be ensonified to sound levels that exceed the harassment thresholds. The distance for the 160-dB Level B harassment threshold and PTS (Level A harassment) thresholds (based on L–DEO model results) was used to draw a buffer around the area expected to be ensonified (*i.e.,* the survey area). The ensonified areas were then increased by 25 percent to account for potential delays, which is equivalent to adding 25 percent to the proposed line km to be surveyed. The density for each species was then multiplied by the daily ensonified areas (increased as described above) and then multiplied by the number of survey days (14) to estimate potential takes (see appendix B of L–DEO's application for more information).

L–DEO assumed that their estimates of marine mammal exposures above harassment thresholds equate to take and requested authorization of those takes. Those estimates in turn form the basis for our proposed take authorization numbers. For the species for which NMFS does not expect there to be a reasonable potential for take by Level A harassment to occur (*i.e.,* mid-frequency cetaceans and phocid seals), we have added L–DEO's estimated exposures above Level A harassment thresholds to their estimated exposures above the Level B harassment threshold to produce a total number of incidents of take by Level B harassment that is proposed for authorization. Estimated exposures and proposed take numbers for authorization are shown in table 6.

TABLE 6—ESTIMATED TAKE PROPOSED FOR AUTHORIZATION

Species	Estimated take		Proposed authorized take		Modeled abundance [1]	Percent of modeled abundance [2]
	Level B	Level A	Level B	Level A		
Humpback whale [3]	80	3	80	3	4,990	1.66
Minke whale	84	3	84	3	13,784	0.63
Fin whale	82	3	82	3	11,672	0.73
Sei whale	113	4	113	4	19,530	0.60
Blue whale	1	0	1	0	191	0.53
Sperm whale	214	0	214	0	64,015	0.33
Northern bottlenose whale	2	0	2	0	1,056	0.23
Beaked whales [4]	255	0	255	0	65,069	0.39
Risso's dolphin	914	2	916	0	78,205	1.17
Atlantic white-sided dolphin	4,052	8	4,060	0	175,299	2.23
Bottlenose dolphin	974	2	976	0	418,151	0.23
Striped dolphin	148	0	148	0	412,729	0.04
White-beaked dolphin	46	0	46	0	2,627	1.76
Common dolphin	13,443	25	13,468	0	418,151	2.85
Long-finned pilot whale [5]	1,020	2	1,022	0	264,907	0.39
Killer whale	24	0	24	0	972	2.48
Harbor porpoise	1,181	45	1,181	45	94,583	1.30
Phocid Seals [6]	5,844	35	5,879	0	150,075	3.92

[1] Modeled abundance (Roberts *et al.* 2023) or North Atlantic abundance (NAMMCO 2023), where applicable.

[2] Requested take authorization is expressed as percent of population for the AFTT Area (Roberts *et al.* 2023).

[3] Based on the best population estimates of 10,752 individuals for the West Indies breeding population (Stevick *et al.* 2003), and 260 individuals for the Cape Verde breeding population (Ryan *et al.* 2014); the ratio for these 2 populations was applied to estimate 2 takes for the Cape Verde/Northwest Africa DPS and 81 takes for the West Indies DPS.

[4] Beaked whale guild. Includes Cuvier's beaked whale, Blainville's beaked whale, and Sowerby's beaked whale. Most takes are assumed to be for Cuvier's beaked whale, as they are most likely to be encountered in the survey area.

[5] Takes based on density for *Globicephala sp.* All takes are assumed to be for long-finned pilot whales as short-finned pilot whales are only found in tropical, subtropical, and warm temperate waters (Olson 2018) and are not expected to be found at this latitude.

[6] Seal guild. Includes hooded seal, harp seal, bearded seal, gray seal and harbor seal. Most takes are assumed to be for hooded seal and harp seal, as they are the most likely to be encountered in the survey area.

Proposed Mitigation

In order to issue an IHA under section 101(a)(5)(D) of the MMPA, NMFS must set forth the 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 this action). NMFS 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 CFR 216.104(a)(11)).

In evaluating how mitigation may or may not be appropriate to ensure the least practicable adverse impact on species or stocks and their habitat, as well as subsistence uses where applicable, NMFS considers two primary factors:

(1) 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. 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;

(2) The practicability of the measures for applicant implementation, which may consider such things as cost and impact on operations.

Vessel-Based Visual Mitigation Monitoring

Visual monitoring requires the use of trained observers (herein referred to as visual protected species observers (PSOs)) to scan the ocean surface for the presence of marine mammals. The area to be scanned visually includes primarily the shutdown zone (SZ), within which observation of certain marine mammals requires shutdown of the acoustic source, a buffer zone, and to the extent possible depending on conditions, the surrounding waters. The buffer zone means an area beyond the SZ to be monitored for the presence of marine mammals that may enter the SZ. During pre-start clearance monitoring (*i.e.,* before ramp-up begins), the buffer zone also acts as an extension of the SZ in that observations of marine mammals within the buffer zone would also prevent airgun operations from beginning (*i.e.,* ramp-up). The buffer zone encompasses the area at and below the sea surface from the edge of the 0–500 m SZ, out to a radius of 1,000 m from the edges of the airgun array (500–1,000 m). This 1,000-m zone (SZ plus buffer) represents the pre-start clearance zone. Visual monitoring of the SZ and adjacent waters(buffer plus surrounding waters) is intended to establish and, when visual conditions allow, maintain zones around the sound source that are clear of marine mammals, thereby reducing or eliminating the potential for injury and minimizing the potential for more severe behavioral reactions for animals occurring closer to the vessel. Visual monitoring of the buffer zone is intended to (1) provide additional protection to marine mammals that may be in the vicinity of the vessel during pre-start clearance, and (2) during airgun use, aid in establishing and maintaining the SZ by alerting the visual observer and crew of marine mammals that are outside of, but may approach and enter, the SZ.

L-DEO must use dedicated, trained, and 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. PSO resumes shall be provided to NMFS for approval.

At least one of the visual and two of the acoustic PSOs (discussed below) aboard the vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, 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 protected species observation team. The lead PSO shall serve as primary point of contact for the vessel operator and ensure all PSO requirements per the IHA are met. To the maximum extent practicable, the experienced PSOs should be scheduled to be on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

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). Visual monitoring of the pre-start clearance zone must begin no less than 30 minutes prior to ramp-up and monitoring 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° 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.

PSOs shall establish and monitor the SZ and buffer zone. These zones shall be based upon the radial distance from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the airgun array (*i.e.,* anytime airguns are active, including ramp-up), detections of marine mammals within the buffer zone (but outside the SZ) shall be communicated to the operator to prepare for the potential shutdown of the airgun array. Visual PSOs will immediately communicate all observations to the on duty acoustic PSO(s), including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination. Any observations of marine mammals by crew members shall be relayed to the PSO team. During good conditions (*e.g.,* daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall 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 same time) may not exceed 12 hours per 24-hour period for any individual PSO.

Passive Acoustic Monitoring

Passive acoustic monitoring means the use of trained personnel (sometimes referred to as PAM operators, herein referred to as acoustic PSOs) to operate PAM equipment to acoustically detect the presence of marine mammals. Acoustic monitoring involves acoustically detecting marine mammals regardless of distance from the source, as localization of animals may not always be possible. Acoustic monitoring is intended to further support visual monitoring (during daylight hours) in maintaining a SZ around the sound source that is clear of marine mammals. In cases where visual monitoring is not effective (*e.g.,* due to weather, nighttime), acoustic monitoring may be used to allow certain activities to occur, as further detailed below.

PAM would take place in addition to the visual monitoring program. Visual monitoring typically is not effective during periods of poor visibility or at night and even with good visibility, is unable to detect marine mammals when they are below the surface or beyond visual range. Acoustic monitoring can be used in addition to visual observations to improve detection, identification, and localization of cetaceans. The acoustic monitoring would serve to alert visual PSOs (if on duty) when vocalizing cetaceans are detected. It is only useful when marine mammals vocalize, but it can be effective either by day or by night and does not depend on good visibility. It would be monitored in real time so that the visual observers can be advised when cetaceans are detected.

The R/V Langseth will use a towed PAM system, 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. Acoustic PSOs may be on watch for a maximum of 4 consecutive hours followed by a break of at least 1 hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (acoustic and visual but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO.

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

- Sea state is less than or equal to BSS 4;
- No marine mammals (excluding delphinids) detected solely by PAM in the SZ in the previous 2 hours;
- NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and
- Operations with an active airgun array, but without an operating PAM system, do not exceed a cumulative total of 10 hours in any 24-hour period.

Establishment of Shutdown and Pre-Start Clearance Zones

A SZ is a defined area within which occurrence of a marine mammal triggers mitigation action intended to reduce the potential for certain outcomes (*e.g.,* auditory injury, disruption of critical behaviors). The PSOs would establish a minimum SZ with a 500-m radius. The 500-m SZ would be based on radial distance from the edge of the airgun array (rather than being based on the center of the array or around the vessel itself). With certain exceptions (described below), if a marine mammal appears within or enters this zone, the airgun array would be shut down.

The pre-start clearance zone is defined as the area that must be clear of marine mammals prior to beginning ramp-up of the airgun array and includes the SZ plus the buffer zone. Detections of marine mammals within the pre-start clearance zone would prevent airgun operations from beginning (*i.e.,* ramp-up).

The 500-m SZ is intended to be precautionary in the sense that it would be expected to contain sound exceeding the injury criteria for all cetacean hearing groups, (based on the dual criteria of SEL_{cum} and peak SPL), while also providing a consistent, reasonably observable zone within which PSOs would typically be able to conduct effective observational effort. Additionally, a 500-m SZ 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, we expect that 500 m is likely regularly attainable for PSOs using the naked eye during typical conditions. The pre-start clearance zone simply represents the addition of a buffer to the SZ, doubling the SZ size during pre-clearance.

An extended SZ of 1,500 m must be enforced for all beaked whales, a large whale with a calf, and groups of six or more large whales. No buffer of this extended SZ is required, as NMFS concludes that this extended SZ is sufficiently protective to mitigate harassment to these groups.

Pre-Start Clearance and Ramp-Up

Ramp-up (sometimes referred to as ''soft start'') means the gradual and systematic increase of emitted sound levels from an 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 an array's airguns are active. Each stage should be approximately the same duration, and the total duration should not be less than approximately 20 minutes. The intent of pre-start clearance observation (30 minutes) is to ensure no marine mammals are observed within the pre-start clearance zone (or extended SZ, for beaked whales, a large whale with a calf, and groups of six or more large whales) prior to the beginning of ramp-up. During the pre-start clearance period is the only time observations of marine mammals in the buffer zone would prevent operations (*i.e.,* the beginning of ramp-up). The intent of ramp-up is to warn marine mammals of pending seismic survey operations and to allow sufficient time for those animals to leave the immediate vicinity prior to the sound source reaching full intensity. A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total 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. All operators must adhere to the following pre-start clearance and ramp-up requirements:

- The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up in order to allow the PSOs time to monitor the pre-start clearance zone (and extended SZ) for 30 minutes prior to the initiation of ramp-up (pre-start clearance);
- Ramp-ups shall be scheduled so as to minimize the time spent with the source activated prior to reaching the designated run-in;
- One of the PSOs conducting pre-start clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed;
- Ramp-up may not be initiated if any marine mammal is within the applicable shutdown or buffer zone. If a marine mammal is observed within the pre-start

clearance zone (or extended SZ, for beaked whales, a large whale with a calf, and groups of six or more large whales) during the 30 minute pre-start clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zones or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and pinnipeds, and 30 minutes for all mysticetes and all other odontocetes, including sperm whales, beaked whales, and large delphinids, such as pilot whales);

- Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Duration shall not be less than 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed;
- PSOs must monitor the pre-start clearance zone and extended SZ during ramp-up, and ramp-up must cease and the source must be shut down upon detection of a marine mammal within the applicable zone. Once ramp-up has begun, detections of marine mammals within the buffer zone do not require shutdown, but such observation shall be communicated to the operator to prepare for the potential shutdown;
- Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Airgun array activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances;
- If the airgun array is shut down for brief periods (*i.e.,* less than 30 minutes) for reasons other than implementation of prescribed mitigation (*e.g.,* mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual or acoustic detections of marine mammals have occurred within the pre-start clearance zone (or extended SZ, where applicable). For any longer shutdown, pre-start clearance observation and ramp-up are required; and
- Testing of the airgun array involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-start clearance of 30 minutes.

Shutdown

The shutdown of an airgun array requires the immediate de-activation of all individual airgun elements of the array. Any PSO on duty will have the authority to call for shutdown of the airgun array if a marine mammal is detected within the applicable SZ. 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 both visual and acoustic PSOs are on duty, all detections will 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. When the airgun array is active (*i.e.,* anytime one or more airguns is active, including during ramp-up) and (1) a marine mammal appears within or enters the applicable SZ and/or (2) a marine mammal (other than delphinids, see below) is detected acoustically and localized within the applicable SZ, the airgun array will be shut down. When shutdown is called for by a PSO, the airgun array will be immediately deactivated and any dispute resolved only following deactivation. Additionally, shutdown will occur whenever PAM alone (without visual sighting), confirms presence of marine mammal(s) in the SZ. If the acoustic PSO cannot confirm presence within the SZ, visual PSOs will be notified but shutdown is not required.

Following a shutdown, airgun activity would not resume until the marine mammal has cleared the SZ. The animal would be considered to have cleared the SZ if it is visually observed to have departed the SZ (*i.e.,* animal is not required to fully exit the buffer zone where applicable), or it has not been seen within the SZ for 15 minutes for small odontocetes or 30 minutes for all mysticetes and all other odontocetes, including sperm whales, beaked whales, and large delphinids, such as pilot whales.

The shutdown requirement is waived for pinnipeds and specific genera of small dolphins if an individual is detected within the SZ. The small dolphin group is intended to encompass those members of the Family Delphinidae most likely to voluntarily approach the source vessel for purposes of interacting with the vessel and/or airgun array (*e.g.,* bow riding). This exception to the shutdown requirement applies solely to pinnipeds and the specific genera of small dolphins (*Delphinus, Lagenodelphis, Stenella,* and *Tursiops*).

We include this pinniped and small dolphin exception because shutdown requirements for these species under all circumstances represent practicability concerns without likely commensurate benefits for the animals in question. Small dolphins are generally the most commonly observed marine mammals in the specific geographic region and would typically be the only marine mammals likely to intentionally approach the vessel. As described above, auditory injury is extremely unlikely to occur for mid-frequency cetaceans (*e.g.,* phocid seals and delphinids), as this group is relatively insensitive to sound produced at the predominant frequencies in an airgun pulse while also having a relatively high threshold for the onset of auditory injury (*i.e.,* permanent threshold shift).

A large body of anecdotal evidence indicates that small dolphins commonly approach vessels and/or towed arrays during active sound production for purposes of bow riding with no apparent effect observed (*e.g.,* Barkaszi *et al.,* 2012, Barkaszi and Kelly, 2018). The potential for increased shutdowns resulting from such a measure would require the Langseth to revisit the missed track line to reacquire data, resulting in an overall increase in the total sound energy input to the marine environment and an increase in the total duration over which the survey is active in a given area. Although other mid-frequency hearing specialists (*e.g.,* large delphinids) are no more likely to incur auditory injury than are small dolphins, they are much less likely to approach vessels. Therefore, retaining a shutdown requirement for large delphinids would not have similar impacts in terms of either practicability for the applicant or corollary increase in sound energy output and time on the water. We do anticipate some benefit for a shutdown requirement for large delphinids in that it simplifies somewhat the total range of decision-making for PSOs and may preclude any potential for physiological effects other than to the auditory system as well as some more severe behavioral reactions for any such animals in close proximity to the Langseth.

Visual PSOs shall use best professional judgment 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 SZ).

L–DEO must implement shutdown if a marine mammal species for which take was not authorized or a species for which authorization was granted but the

authorized takes have been met approaches the Level A or Level B harassment zones. L–DEO must also implement shutdown if any large whale (defined as a sperm whale or any mysticete species) with a calf (defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult) and/or an aggregation of six or more large whales are observed at any distance.

Vessel Strike Avoidance Mitigation Measures

Vessel personnel should use an appropriate reference guide that includes identifying information on all marine mammals that may be encountered. Vessel operators must comply with the below measures except under extraordinary circumstances when the safety of the vessel or crew is in doubt or the safety of life at sea is in question. These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply.

Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A single marine mammal at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should always be exercised. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (separation distances stated below). Visual observers monitoring the vessel strike avoidance zone may be third-party observers (*i.e.,* PSOs) or crew members, but crew members responsible for these duties must be provided sufficient training to (1) distinguish marine mammals from other phenomena and (2) broadly to identify a marine mammal as a right whale, other whale (defined in this context as sperm whales or baleen whales other than right whales), or other marine mammals.

Vessel speeds must be reduced to 10 kn (18.5 kph) or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel. All vessels must maintain a minimum separation distance of 100 m from sperm whales and all other baleen whales. All vessels must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an 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 shall take action as necessary to avoid violating the relevant separation distance (*e.g.,* attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impact on the affected species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an IHA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must set forth requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for authorizations 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 while conducting the activities. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS should contribute to 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 (*e.g.,* life history, dive patterns); (3) co-occurrence of marine mammal species with the activity; 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); and,
- Mitigation and monitoring effectiveness.

Vessel-Based Visual Monitoring

As described above, PSO observations would take place during daytime airgun operations. During seismic survey operations, at least five visual PSOs would be based aboard the Langseth. Two visual PSOs would be on duty at all times during daytime hours. Monitoring shall be conducted in accordance with the following requirements:

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

PSOs must have the following requirements and qualifications:

- PSOs shall be independent, dedicated, trained visual and acoustic PSOs and must be employed by a third-party observer provider;
- PSOs shall have no tasks other than to conduct observational effort (visual or acoustic), collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards);
- PSOs shall have successfully completed an approved 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;

- PSOs can act as acoustic or visual observers (but not at the same time) as long as they demonstrate that their training and experience are sufficient to perform the task at hand;
- NMFS must review and approve PSO resumes accompanied by a relevant training course information packet that includes the name and qualifications (*i.e.,* experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material as well as a document stating successful completion of the course;
- 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;
- 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; and
- The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Requests shall be granted or denied (with justification) by NMFS within 1 week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.
- For data collection purposes, PSOs shall use standardized electronic data collection forms. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the airgun array and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the airgun array. If required mitigation was not implemented, PSOs should record a description of the circumstances. At a minimum, the following information must be recorded:
  - Vessel name, vessel size and type, maximum speed capability of vessel;
  - Dates (MM/DD/YYYY) of departures and returns to port with port name;
  - PSO names and affiliations, PSO ID (initials or other identifier);
  - Date (MM/DD/YYYY) and participants of PSO briefings;
  - Visual monitoring equipment used (description);
  - PSO location on vessel and height (meters) of observation location above water surface;
  - Watch status (description);
  - Dates (MM/DD/YYYY) and times (Greenwich Mean Time/UTC) of survey on/off effort and times (GMC/UTC) corresponding with PSO on/off effort;
  - Vessel location (decimal degrees) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
  - Vessel location (decimal degrees) at 30-second intervals if obtainable from data collection software, otherwise at practical regular interval;
  - Vessel heading (compass heading) and speed (knots) at beginning and end of visual PSO duty shifts and upon any change;
  - Water depth (meters) (if obtainable from data collection software);
  - 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;
  - Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (description) (*e.g.,* vessel traffic, equipment malfunctions); and
  - Vessel/Survey activity information (and changes thereof) (description), such as airgun power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.,* pre-start clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, *etc.*).
- Upon visual observation of any marine mammals, the following information must be recorded:
  - Sighting ID (numeric);
  - Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
  - Location of PSO/observer (description);
  - Vessel activity at the time of the sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other);
  - PSO who sighted the animal/ID;
  - Time/date of sighting (GMT/UTC, MM/DD/YYYY);
  - Initial detection method (description);
  - Sighting cue (description);
  - Vessel location at time of sighting (decimal degrees);
  - Water depth (meters);
  - Direction of vessel's travel (compass direction);
  - Speed (knots) of the vessel from which the observation was made;
  - Direction of animal's travel relative to the vessel (description, compass heading);
  - Bearing to sighting (degrees);
  - 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;
  - Species reliability (an indicator of confidence in identification) (1 = unsure/possible, 2 = probable, 3 = definite/sure, 9 = unknown/not recorded);
  - Estimated distance to the animal (meters) and method of estimating distance;
  - Estimated number of animals (high/low/best) (numeric);
  - 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 (meters) and/or closest distance from any element of the airgun array;
  - Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up) and time and location of the action.
  - Photos (Yes/No);
  - Photo Frame Numbers (List of numbers); and
  - Conditions at time of sighting (Visibility; Beaufort Sea State).

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

- 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); and

• 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.

Reporting

The Holder shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). The draft report shall also include geo-referenced time-stamped vessel tracklines for all time periods during which airgun arrays were operating. Tracklines should include points recording any change in airgun array status (*e.g.,* when the sources began operating, when they were turned off, or when they changed operational status such as from full array to single gun or vice versa). Geographic Information System files shall be provided in Environmental Systems Research Institute shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available. The report must summarize data collected as described above in Proposed Monitoring and Reporting. A final report must be submitted within 30 days following resolution of any comments on the draft report.

The report must include a validation document concerning the use of PAM, which should include necessary noise validation diagrams and demonstrate whether background noise levels on the PAM deployment limited achievement of the planned detection goals. Copies of any vessel self-noise assessment reports must be included with the report.

Reporting Injured or Dead Marine Mammals

Discovery of injured or dead marine mammals—In the event that personnel involved in the survey activities discover an injured or dead marine mammal, the L–DEO shall report the incident to the Office of Protected Resources (OPR) and NMFS as soon as feasible. The report must include the following information:

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

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

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

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

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

• General circumstances under which the animal was discovered.

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

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

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

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

• Status of all sound sources in use;

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

• Environmental conditions (*e.g.,* wind speed and direction, BSS, cloud cover, visibility) immediately preceding the strike;

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

• Estimated size and length of the animal that was struck;

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

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

• 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

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

Negligible Impact Analysis and Determination

NMFS has defined negligible impact as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival (50 CFR 216.103). A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.,* population-level effects). An estimate of the number of takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be ''taken'' through harassment, NMFS considers other factors, such as the likely nature of any impacts or responses (*e.g.,* intensity, duration), the context of any impacts or responses (*e.g.,* critical reproductive time or location, foraging impacts affecting energetics), as well as effects on habitat, and the likely effectiveness of the mitigation. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population status. Consistent with the 1989 preamble for NMFS' implementing regulations (54 FR 40338, September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the baseline (*e.g.,* as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

To avoid repetition, the discussion of our analysis applies to all the species listed in table 1, given that the anticipated effects of this activity on these different marine mammal stocks are expected to be similar. Where there are meaningful differences between species or stocks they are included as separate subsections below. NMFS does not anticipate that serious injury or mortality would occur as a result of L–DEO's planned survey, even in the absence of mitigation, and no serious injury or mortality is proposed to be authorized. As discussed in the Potential Effects of Specified Activities on Marine Mammals and Their Habitat section above, non-auditory physical effects and vessel strike are not expected to occur. NMFS expects that the majority of potential takes would be in the form of short-term Level B behavioral harassment, resulting from temporary avoidance of the area or decreased foraging (if such activity was

occurring), reactions that are considered to be of low severity and with no lasting biological consequences (*e.g.,* Southall *et al.,* 2007).

We are proposing to authorize a limited number of Level A harassment events of five species in the form of PTS (humpback whale, minke whale, fin whale, sei whale, and harbor porpoise) and Level B harassment only of the remaining marine mammal species. If any PTS is incurred in marine mammals as a result of the specified activity, we expect only a small degree of PTS that would not result in severe hearing impairment because of the constant movement of both the Langseth and of the marine mammals in the project areas, as well as the fact that the vessel is not expected to remain in any one area in which individual marine mammals would be expected to concentrate for an extended period of time. Additionally, L–DEO would shut down the airgun array if marine mammals approach within 500 m (with the exception of specific genera of dolphins, see Proposed Mitigation), further reducing the expected duration and intensity of sound and therefore, the likelihood of marine mammals incurring PTS. Since the duration of exposure to loud sounds will be relatively short, it would be unlikely to affect the fitness of any individuals. Also, as described above, we expect that marine mammals would likely move away from a sound source that represents an aversive stimulus, especially at levels that would be expected to result in PTS, given sufficient notice of the Langseth's approach due to the vessel's relatively low speed when conducting seismic surveys.

In addition, the maximum expected Level B harassment zone around the survey vessel is 6,733 m for water depths greater than 1,000 m (and up to 10,100 m in water depths of 100 to 1,000 m), with 78% of the survey occurring in depths greater than 1,000 m. Therefore, the ensonified area surrounding the vessel is relatively small compared to the overall distribution of animals in the area and their use of the habitat. Feeding behavior is not likely to be significantly impacted as prey species are mobile and are broadly distributed throughout the survey area; therefore, marine mammals that may be temporarily displaced during survey activities are expected to be able to resume foraging once they have moved away from areas with disturbing levels of underwater noise. Because of the short duration (14 survey days) and temporary nature of the disturbance and the availability of similar habitat and resources in the surrounding area, the impacts to marine mammals and marine mammal prey species are not expected to cause significant or long-term fitness consequences for individual marine mammals or their populations.

Additionally, the acoustic ''footprint'' of the proposed survey would be very small relative to the ranges of all marine mammals that would potentially be affected. Sound levels would increase in the marine environment in a relatively small area surrounding the vessel compared to the range of the marine mammals within the proposed survey area. The seismic array would be active 24 hours per day throughout the duration of the proposed survey. However, the very brief overall duration of the proposed survey (14 survey days) would further limit potential impacts that may occur as a result of the proposed activity.

Of the marine mammal species that are likely to occur in the project area, the following species are listed as endangered under the ESA: humpback whales (Cape Verde/Northwest Africa DPS), blue whales, fin whales, sei whales, and sperm whales. The take numbers proposed for authorization for these species (table 6) are minimal relative to their modeled population sizes; therefore, we do not expect population-level impacts to any of these species. Moreover, the actual range of the populations extends past the area covered by the model, so modeled population sizes are likely smaller than their actual population size. The other marine mammal species that may be taken by harassment during NSF's seismic survey are not listed as threatened or endangered under the ESA. There is no designated critical habitat for any ESA-listed marine mammals within the project area.

There are no rookeries, mating, or calving grounds known to be biologically important to marine mammals within the survey area, and there are no feeding areas known to be biologically important to marine mammals within the survey area.

Marine Mammal Species With Active UMEs

As discussed above, there are several active UMEs for marine mammal populations that occur in the survey area. Elevated humpback whale mortalities have occurred along the Atlantic coast from Maine through Florida since January 2016. Of the cases examined, approximately half had evidence of human interaction (ship strike or entanglement). The UME does not yet provide cause for concern regarding population-level impacts. Only the West Indies DPS is potentially impacted by this UME, and their current population remains stable at approximately 12,000 individuals.

The proposed mitigation measures are expected to reduce, to the extent practicable, the intensity and/or duration of takes for all species listed in table 1. In particular, they would provide animals the opportunity to move away from the sound source throughout the survey area before seismic survey equipment reaches full energy, thus, preventing them from being exposed to sound levels that have the potential to cause injury (Level A harassment) or more severe Level B harassment.

In summary and as described above, the following factors primarily support our preliminary determination that the impacts resulting from this activity are not expected to adversely affect any of the species or populations through effects on annual rates of recruitment or survival:

- No serious injury or mortality is anticipated or proposed to be authorized;
- We are proposing to authorize a limited number of Level A harassment events of five species in the form of PTS; if any PTS is incurred as a result of the specified activity, we expect only a small degree of PTS that would not result in severe hearing impairment because of the constant movement of both the vessel and of the marine mammals in the project areas, as well as the fact that the vessel is not expected to remain in any one area in which individual marine mammals would be expected to concentrate for an extended period of time.
- The proposed activity is temporary and of relatively short duration (38 days total with 14 days of planned survey activity);
- The vast majority of anticipated impacts of the proposed activity on marine mammals would be temporary behavioral changes due to avoidance of the ensonified area, which is relatively small (*see* table 4);
- The availability of alternative areas of similar habitat value for marine mammals to temporarily vacate the survey area during the proposed survey to avoid exposure to sounds from the activity is readily abundant;
- The potential adverse effects on fish or invertebrate species that serve as prey species for marine mammals from the proposed survey would be temporary and spatially limited and impacts to marine mammal foraging would be minimal;

• The proposed mitigation measures are expected to reduce the number and severity of takes, to the extent practicable, by visually and/or acoustically detecting marine mammals within the established zones and implementing corresponding mitigation measures (*e.g.,* delay; shutdown).

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily finds that the marine mammal take from the proposed activity will have a negligible impact on all affected marine mammal species or populations.

Small Numbers

As noted previously, only take of small numbers of marine mammals may be authorized under sections 101(a)(5)(A) and (D) of the MMPA for specified activities other than military readiness activities. The MMPA does not define small numbers and so, in practice, where estimated numbers are available, NMFS compares the number of individuals taken to the most appropriate estimation of abundance of the relevant species or population in our determination of whether an authorization is limited to small numbers of marine mammals. When the predicted number of individuals to be taken is fewer than one-third of the species or population abundance, the take is considered to be of small numbers. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities.

The number of takes NMFS proposes to authorize is below one-third of the modeled abundance for all relevant populations (specifically, take of individuals is less than four percent of the modeled abundance of each affected population, see table 6). This is conservative because the modeled abundance represents a population of the species and we assume all takes are of different individual animals, which is likely not the case. Some individuals may be encountered multiple times in a day, but PSOs would count them as separate individuals if they cannot be identified.

Based on the analysis contained herein of the proposed activity, including the proposed mitigation and monitoring measures, and the proposed authorized take of marine mammals, NMFS preliminarily finds that small numbers of marine mammals would be taken relative to the size of the affected species or populations.

Unmitigable Adverse Impact Analysis and Determination

There are no relevant subsistence uses of the affected marine mammal stocks or species implicated by this action. Therefore, NMFS has determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Endangered Species Act

Section 7(a)(2) of the Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 *et seq.*) requires that each Federal agency insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. To ensure ESA compliance for the issuance of IHAs, NMFS consults internally whenever we propose to authorize take for endangered or threatened species.

NMFS is proposing to authorize take of humpback whales (Cape Verde/Northwest Africa DPS), blue whales, fin whales, sei whales, and sperm whales, which are listed under the ESA. The NMFS Office of Protected Resources (OPR) Permits and Conservation Division has requested initiation of section 7 consultation with the OPR ESA Interagency Cooperation Division for the issuance of this IHA. NMFS will conclude the ESA consultation prior to reaching a determination regarding the proposed issuance of the authorization.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to L–DEO for conducting a marine geophysical survey at the Reykjanes Ridge in the North Atlantic Ocean during summer 2024, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. A draft of the proposed IHA can be found at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities.*

Request for Public Comments

We request comment on our analyses, the proposed authorization, and any other aspect of this notice of proposed IHA for the proposed marine geophysical survey. We also request comment on the potential renewal of this proposed IHA as described in the paragraph below. Please include with your comments any supporting data or literature citations to help inform decisions on the request for this IHA or a subsequent renewal IHA.

On a case-by-case basis, NMFS may issue a one-time, 1 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 as described in the Description of Proposed Activity section of this notice is planned or (2) the activities as described in the Description of Proposed Activity section of this notice would not be completed by the time the IHA expires and a renewal would allow for completion of the activities beyond that described in the *Dates and Duration* section of this notice, 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 one year from expiration of the initial IHA).

• The request for renewal must include the following:

(1) An explanation that the activities to be conducted under the requested 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).

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

Upon review of the request for renewal, the status of the affected species or stocks, and any other pertinent information, NMFS 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.

Dated: May 7, 2024.

Kimberly Damon-Randall,

Director, Office of Protected Resources, National Marine Fisheries Service.

[FR Doc. 2024–10304 Filed 5–10–24; 8:45 am]

BILLING CODE 3510–22–P