DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XF986

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Low-Energy Geophysical Survey in the Northwest Atlantic Ocean

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

ACTION: Notice; proposed incidental harassment authorization; request for comments.

SUMMARY: NMFS has received a request from the Scripps Institution of Oceanography (SIO) for authorization to take marine mammals incidental to a low-energy marine geophysical survey in the Northwest 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 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 May 29, 2018.

ADDRESSES: Comments should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service. Physical comments should be sent to 1315 East-West Highway, Silver Spring, MD 20910 and electronic comments should be sent to *ITP.Carduner@noaa.gov.*

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 received electronically, including all attachments, must not exceed a 25-megabyte file size. Attachments to electronic comments will be accepted in Microsoft Word or Excel or Adobe PDF file formats only. All comments received are a part of the public record and will generally be posted online at *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: Jordan Carduner, Office of Protected Resources, NMFS, (301) 427–8401. 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: *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 above.

SUPPLEMENTARY INFORMATION:

Background

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 issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review.

An authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth.

NMFS has defined ''negligible impact'' in 50 CFR 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

The MMPA states that the term ''take'' means to harass, hunt, capture, kill or attempt to harass, hunt, capture, or kill any marine mammal.

Except with respect to certain activities not pertinent here, 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).

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 incidental harassment authorization) with respect to potential impacts on the human environment. This action is consistent with categories of activities identified in Categorical Exclusion B4 (incidental harassment authorizations with no anticipated serious injury or mortality) of the Companion Manual for NOAA Administrative Order 216–6A, which do not individually or cumulatively have the potential for significant impacts on the quality of the human environment and for which we have not identified any extraordinary circumstances that would preclude this categorical exclusion. Accordingly, NMFS has preliminarily determined that the issuance of the proposed IHA qualifies to be categorically excluded from further NEPA review.

Summary of Request

On November 20, 2017, NMFS received a request from SIO for an IHA to take marine mammals incidental to conducting a low-energy marine geophysical survey in the Northwest Atlantic Ocean. On February 8, 2018, we deemed SIO's application for authorization to be adequate and complete. SIO's request is for take of a small number of 35 species of marine mammals by Level B harassment and Level A harassment. Neither SIO nor NMFS expects mortality to result from this activity, and, therefore, an IHA is appropriate. The planned activity is not expected to exceed one year, hence, we do not expect subsequent MMPA incidental harassment authorizations would be issued for this particular activity.

Description of Proposed Activity

Overview

SIO proposes to conduct low-energy marine seismic surveys in the Northwest Atlantic Ocean during June–July 2018. The surveys would take place in International Waters in water deeper than 1,000 meters (m) (See Figure 1 in the IHA application). The proposed surveys would involve one source vessel, the R/V *Atlantis.* The *Atlantis* would tow a pair of 45 cubic inch (in^3) GI airguns at a depth of 2–4 m with a total discharge volume of approximately

90 in^3 as an energy source along predetermined lines.

Dates and Duration

The seismic survey would be carried out for approximately 25 days. The *Atlantis* would likely depart from St. George's, Bermuda, on or about June 14, 2018 and would return to Woods Hole, Massachusetts, on or about July 17, 2018. Some deviation in timing could result from unforeseen events such as weather, logistical issues, or mechanical issues with the research vessel and/or equipment. Seismic activities would occur 24 hours per day during the proposed survey.

Specific Geographic Region

The proposed surveys would take place in International Waters of the Northwest Atlantic Ocean, between ~33.5° and 53.5° N, and 37° and 49° W. Representative survey track lines for the survey area is shown in Figure 1 of the IHA application. The *Atlantis* would depart from St. George's, Bermuda, and would return to Woods Hole, Massachusetts.

Detailed Description of Specific Activity

SIO proposes to conduct low-energy seismic surveys low-energy seismic surveys in the Northwest Atlantic Ocean in International Waters between ~33.5° and 53.5° N, and 37° and 49° W, in water deeper than 1,000 m. The survey area and representative survey tracklines are shown in Figure 1 in the IHA application. As described above, some deviation in actual tracklines and timing could be necessary. The proposed surveys would be in support of a potential future International Ocean Discovery Program (IODP) project and would examine regional seismic stratigraphy and provide seismic images of changing sediment distributions from deepwater production changes. The proposed surveys would thus take place in an area that is of interest to the IODP and that has older Deep Sea Drilling Project (DSDP) sites. To achieve the program's goals, the Principal Investigators propose to collect low-energy, high-resolution multi-channel seismic (MCS) profiles.

The procedures to be used for the seismic surveys would be similar to those used during previous seismic surveys by SIO and would use conventional seismic methodology. The surveys would involve one source vessel, R/V *Atlantis,* which is operated by Woods Hole Oceanographic Institution (WHOI). R/V *Atlantis* would deploy a pair of 45-in^3 GI airguns as an energy source with a total volume of 90 in^3. The receiving system would consist of one hydrophone streamer, either 200 or 600 m in length, as described below. As the airguns are towed along the survey lines, the hydrophone streamer would receive the returning acoustic signals and transfer the data to the on-board processing system.

The proposed surveys would consist of: (1) Digital bathymetric, echosounding and MCS surveys at six locations to enable the selection and analysis of potential future IODP drill sites (see Survey Areas 1–6 in Figure 1 in the IHA application); and (2) digital bathymetric, echo-sounding and MCS reflection profiles that tie the proposed drill sites to existing DSDP drill sites and replace poor-quality analog seismic data. Each of the six site surveys would consist of grids of ship tracks that would be acquired using two different types of airgun array configurations. The first would be a reconnaissance grid designed to identify the optimum orientation and length of seismic lines needed for a second, higher-data quality survey designed to locate exactly the most suitable potential future drill site suggested by results of the reconnaissance survey. This two-step effort is needed for two reasons. First, most of the proposed survey sites have been crossed by low-resolution, single-channel, analog seismic data collected 30–40 years ago, and as such are only marginally suitable for proper drill site selection. Second, basement ridges are typically spaced closer than the 10–20 kilometer (km) resolution of satellite bathymetry that currently provides constraints on seafloor features in this region, making it necessary to conduct ship-borne bathymetric surveys as a first indicator of potential future drill locations.

Each reconnaissance grid would be collected using a pair of 45-in^3 airguns, with airguns spaced 8 m apart at a water depth of 2–4 m, with a 200 m hydrophone streamer and with the vessel traveling at 8 knots (kt). Each high-quality site-selection grid, embedded entirely within the boundaries of the reconnaissance grid, would be collected using a pair of 45-in^3 airguns, with airguns spaced 2 m apart at a depth of 2–4 m, with a 600 m hydrophone streamer and with the vessel traveling at to 5 kt to achieve especially high-quality seismic reflection data.

A reconnaissance grid and an embedded high-quality survey grid would be centered at each of the six Survey Areas, as shown in Figure 1 of the IHA application. Figure 1 of the IHA application also shows representative tracklines for a potential reconnaissance grid consisting of four 30 nautical mile (nm) long main lines, three 20 nm cross lines, and ~60 nm of turns, for a total of ~240 nm data per reconnaissance grid. All data, including turns, would be collected inside the boundaries of a 40 x 40 nm box. The location, orientation, and size of the embedded high-quality survey grid would depend on the information obtained during the reconnaissance survey. A potential high-quality grid could have 10 intersecting tracklines. A site appropriate for potential future drilling by the IODP would be identified with each of these high-quality digital data grids. These latter grids would comprise at least 120 nm of data. In addition to the six site surveys, MCS profiles would be acquired at a speed of 8 kt, with a pair of 45-in^3 airguns towed 8 m apart at a water depth of 2–4 m, using a 200-m streamer.

The six proposed site surveys would collect up to 4,334 km of data; survey lines connecting several grids and existing DSDP drill sites, as shown in Figure 1, comprise another 3,577 km, for a total of 7,911 km of seismic acquisition. All data would be collected in water depths of more than 1,000 m. There could be additional seismic operations in the project area associated with equipment testing, re-acquisition due to equipment malfunction, data degradation during poor weather, or interruption due to shutdown or track deviation in compliance with IHA requirements. To account for these additional seismic operations, 25 percent has been added in the form of operational days, which is equivalent to adding 25 percent to the proposed line km to be surveyed.

In addition to the operations of the airgun array, a multibeam echosounder (MBES) and a sub-bottom profiler (SBP) would also be operated continuously throughout the survey, but not during transits to and from the project area. All planned geophysical data acquisition activities would be conducted by SIO with on-board assistance by the scientists who have proposed the study. The vessel would be self-contained, and the crew would live aboard the vessel for the entire cruise.

The *Atlantis* has a length of 84 m, a beam of 16 m, and a maximum draft of 5.8 m. The ship is powered by diesel electric motors and 1,180 SHP azimuthing stern thrusters. An operation speed of approximately 5–8 kt (9–15 km/hr) would be used during seismic acquisition. When not towing seismic survey gear, the *Atlantis* cruises at approximately 11 kt (20 km/hr). It has a normal operating range of approximately 32,000 km. The *Atlantis* would also serve as the platform from which vessel-based protected species visual observers (PSO) would watch for marine mammals during airgun operations.

During the survey, the *Atlantis* would tow a pair of 45-in³ GI airguns and a 200- or 600-m long streamer containing hydrophones along predetermined lines. The generator chamber of each GI airgun, the one responsible for introducing the sound pulse into the ocean, is 45 in³. The larger (105 in³) injector chamber injects air into the previously generated bubble to maintain its shape, and does not introduce more sound into the water. The two 45-in³ GI airguns would be towed 21 m behind R/V *Atlantis,* 2 m (during 5-kt grid surveys) or 8 m (8-kt reconnaissance and seismic transect surveys) apart side by side, at a depth of 2–4 m. Surveys with the 2-m airgun separation configuration would use a 600-m hydrophone streamer, whereas surveys with the 8-m airgun separation configuration would use a 200-m hydrophone streamer. Seismic pulses would be emitted at intervals of 25 m for the 5 kt surveys using the 2-m GI airgun separation and at intervals of 50 m for the 8 kt surveys using the 8-m airgun separation.

TABLE 1—SPECIFICATIONS OF THE R/V ATLANTIS AIRGUN ARRAY

Number of airguns	2.
Gun positions used	Two inline airguns 2- or 8-m apart.
Tow depth of energy source.	2–4 m.
Dominant frequency components.	0–188 Hz.
Air discharge volume	Approximately 90 in³.
Shot interval	7.8 seconds.

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

Description of Marine Mammals in the Area of Specified Activities

Section 4 of the application summarizes available information regarding status and trends, distribution and habitat preferences, and behavior and life history, of the potentially affected species. Additional information about these species (*e.g.,* physical and behavioral descriptions) may be found on NMFS' website (*www.fisheries.noaa.gov/find-species*).

The populations of marine mammals considered in this document do not occur within the U.S. EEZ and are therefore not assigned to stocks and are not assessed in NMFS' Stock Assessment Reports (SAR). As such, information on potential biological removal (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 on 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 abundance estimates presented here are based on the U.S. Atlantic SARs (Hayes *et al.,* 2017), as this is considered the best available information on potential abundance of marine mammals in the area. However, as described above, the marine mammals encountered by the proposed survey are not assigned to stocks. All abundance estimate values presented in Table 2 are the most recent available at the time of publication and are available in the 2017 U.S. Atlantic draft SARs (*e.g.,* Hayes *et al.* 2017) available online at: *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments,* except where noted otherwise.

Table 2 lists all species with expected potential for occurrence in the survey area and with the potential to be taken as a result of the proposed survey, and summarizes information related to the population, including regulatory status under the MMPA and ESA. For taxonomy, we follow Committee on Taxonomy (2016).

TABLE 2—MARINE MAMMAL SPECIES POTENTIALLY PRESENT IN THE PROJECT AREA EXPECTED TO BE AFFECTED BY THE SPECIFIED ACTIVITIES

Species	Stock	ESA/MMPA status; Strategic (Y/N) [1]	Abundance [2]	Relative occurrence in project area
Order Cetartiodactyla—Cetacea—Superfamily Mysticeti (baleen whales)				
Family: Balaenopteridae:				
Humpback whale [3] (*Megaptera novaeangliae*)	n/a	-/-; N	12,312	Uncommon.
Minke whale [4] (*Balaenoptera acutorostrata*)	n/a	-/-; N	20,741	Uncommon.
Bryde's whale (*Balaenoptera brydei*)	n/a	-/-; N	unknown	Uncommon.
Sei whale (*Balaenoptera borealis*)	n/a	E/D; Y	357	Uncommon.
Fin whale [4] (*Balaenoptera physalus*)	n/a	E/D; Y	3,522	Uncommon.
Blue whale (*Balaenoptera musculus*)	n/a	E/D; Y	440	Uncommon.
Order Cetartiodactyla—Cetacea—Superfamily Odontoceti (toothed whales, dolphins, and porpoises)				
Family: Physeteridae:				
Sperm whale (*Physeter macrocephalus*)	n/a	E/D; Y	2,288	Uncommon.
Order Cetartiodactyla—Cetacea—Superfamily Odontoceti (toothed whales, dolphins, and porpoises)				
Family: Kogiidae:				
Pygmy sperm whale [5] (*Kogia breviceps*)	n/a	-/-; N	3,785	Rare.
Dwarf sperm whale [5] (*Kogia sima*)	n/a	-/-; N	3,785	Rare.

TABLE 2—MARINE MAMMAL SPECIES POTENTIALLY PRESENT IN THE PROJECT AREA EXPECTED TO BE AFFECTED BY THE SPECIFIED ACTIVITIES—Continued

Species	Stock	ESA/MMPA status; Strategic (Y/N) [1]	Abundance [2]	Relative occurrence in project area
Order Cetartiodactyla—Cetacea—Superfamily Odontoceti (toothed whales, dolphins, and porpoises)				
Family: Delphinidae:				
Killer whale (*Orcinus orca*)	n/a	-/-; N	unknown	Uncommon.
False killer whale (*Pseudorca crassidens*)	n/a	-/-; N	442	Uncommon.
Pygmy killer whale (*Feresa attenuata*)	n/a	-/-; N	unknown	Rare.
Short-finned pilot whale (*Globicephala macrorhynchus*)	n/a	-/-; N	21,515	Uncommon.
Long-finned pilot whale (*Globicephala melas*)	n/a	-/-; N	5,636	Uncommon.
Harbor porpoise (*Phocoena phocoena*)	n/a	-/-; N	79,833	Uncommon.
Bottlenose dolphin (*Tursiops truncatus*)	n/a	-/-; N	77,532	Uncommon.
Striped dolphin (*Stenella coeruleoala*)	n/a	-/-; N	54,807	Uncommon.
Risso's dolphin (*Grampus griseus*)	n/a	-/-; N	18,250	Uncommon.
Common dolphin [4] (*Delphinus delphis*)	n/a	-; N	173,486	Uncommon.
Atlantic white-sided dolphin (*Lagenorhynchus obliquidens*)	n/a	-; N	48,819	Uncommon.
Atlantic spotted dolphin (*Stenella frontalis*)	n/a	-; N	44,715	Uncommon.
Pantropical spotted dolphin (*Stenella attenuate*)	n/a	-; N	3,333	Uncommon.
White beaked dolphin (*Lagenorhynchus albirostris*)	n/a	-; N	2,003	Uncommon.
Rough-toothed dolphin (*Steno bredanensis*)	n/a	-; N	271	Rare.
Order Cetartiodactyla—Cetacea—Superfamily Odontoceti (toothed whales, dolphins, and porpoises)				
Family: Ziphiidae:				
Cuvier's beaked whale (*Ziphius cavirostris*)	n/a	-/-; N	6,532	Uncommon.
Blainville's beaked whale [6] (*Mesoplodon densirostris*)	n/a	-; N	7,092	Uncommon.
True's beaked whale [6] (*Mesoplodon mirus*)	n/a	-/-; N	7,092	Rare.
Gervais beaked whale [6] (*Mesoplodon europaeus*)	n/a	-; N	7,092	Uncommon.
Sowerby's beaked whale [6] (*Mesoplodon bidens*)	n/a	-; N	7,092	Uncommon.
Northern bottlenose whale (*Hyperoodon ampullatus*)	n/a	-; N	unknown	Uncommon.
Order Carnivora—Superfamily Pinnipedia				
Family: Phocidae (earless seals):				
Hooded seal (*Cystophora cristata*)	n/a	-; N	592,100	Rare.
Harp seal (*Pagophilus groenlandicus*)	n/a	-; N	7,100,000	Rare.
Ringed seal (*Pusa hispida*) [7]	n/a	-; N	unknown	Rare.

[1] Endangered Species Act (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] Abundance estimates are from the NMFS 2017 draft Atlantic SAR (Hayes *et al.,* 2017) unless otherwise noted. We note that marine mammals in the survey area would not belong to NMFS stocks, as the survey area is outside the geographic boundaries for stock assessments, thus stock abundance estimates are provided for comparison purposes only.

[3] NMFS defines a stock of humpback whales only on the basis of the Gulf of Maine feeding population; however, multiple feeding populations originate from the Distinct Population Segment (DPS) that is expected to occur in the proposed survey area (the West Indies DPS). As West Indies DPS whales from multiple feeding populations may be encountered in the proposed survey area, the total abundance of the West Indies DPS best reflects the abundance of the population that may encountered by the proposed survey. The West Indies DPS abundance estimate shown here reflects the latest estimate as described in the NMFS Status Review of the Humpback Whale under the Endangered Species Act (Bettridge *et al.,* 2015).

[4] Abundance for these species is from the 2007 Canadian Trans-North Atlantic Sighting Survey (TNASS), which provided full coverage of the Atlantic Canadian coast (Lawson and Gosselin, 2009). Abundance estimates from TNASS were corrected for perception and availability bias, when possible. In general, where the TNASS survey effort provided superior coverage of a stock's range (as compared with NOAA shipboard survey effort), we elect to use the resulting abundance estimate over the current NMFS abundance estimate (derived from survey effort with inferior coverage of the stock range).

[5] Abundance estimate represents pygmy and dwarf sperm whales combined.

[6] Abundance estimate represents all species of *Mesoplodon* in the Atlantic.

[7] NMFS does not have a defined stock of ringed seals in the Atlantic Ocean.

Four marine mammal species that are listed under the Endangered Species Act (ESA) may be present in the survey area and are included in the take request: The fin whale, sei whale, blue whale and sperm whale.

Below is a description of the species that are both common in the survey area and that have the highest likelihood of occurring in the survey area and thus are expected to have the potential to be taken by the proposed activities. Though other marine mammal species are known to occur in the North Atlantic Ocean, the temporal and/or spatial occurrence of several of these species is such that take of these species is not expected to occur, and they are therefore not discussed further beyond the explanation provided here. Four cetacean species, although present in the wider North Atlantic Ocean, likely would not be found near the proposed project area because their ranges generally do not extend as far north: Clymene dolphin, Fraser's dolphin, spinner dolphin, and melon-headed whale. Another cetacean species, the North Atlantic right whale, occurs in nearshore waters off the U.S. coast, and its range does not extend as far offshore as the proposed project area. Another three cetacean species occur in arctic waters, and their ranges generally do not extend as far south as the proposed project area: The bowhead whale, narwhal, and beluga. Two additional cetacean species, the Atlantic humpback dolphin (which occurs in coastal waters of western Africa) and the long-beaked common dolphin (which occurs in coastal waters of South America and western Africa) do not occur in deep offshore waters. Several pinniped species also are known to occur in North Atlantic waters, but are not expected to occur in deep offshore waters of the proposed project area, including the gray seal, harbor seal, and bearded seal.

We have reviewed SIO's species descriptions, including life history information, distribution, regional distribution, diving behavior, and acoustics and hearing, for accuracy and completeness. We refer the reader to Section 4 of SIO's IHA application, rather than reprinting the information here.

Humpback Whale

Humpback whales are found worldwide in all ocean basins. In winter, most humpback whales occur in the subtropical and tropical waters of the Northern and Southern Hemispheres (Muto *et al.,* 2015). These wintering grounds are used for mating, giving birth, and nursing new calves. Humpback whales were listed as endangered under the Endangered Species Conservation Act (ESCA) in June 1970. In 1973, the ESA replaced the ESCA, and humpbacks continued to be listed as endangered. NMFS recently evaluated the status of the species, and on September 8, 2016, NMFS divided the species into 14 distinct population segments (DPS), removed the current species-level listing, and in its place listed four DPSs as endangered and one DPS as threatened (81 FR 62259; September 8, 2016). The remaining nine DPSs were not listed. The West Indies DPS, which is not listed under the ESA, is the only DPS of humpback whale that is expected to occur in the survey area.

Based on density modeling by Mannocci *et al.* (2017) for the western North Atlantic, higher densities are expected to occur north of 40° N during the summer; very low densities are expected south of 40° N. Several sightings have been made in water >2,000 m deep during the summer to the west of SIO's proposed Survey Areas 4, 5, and 6, and northwest of Survey Area 6 (Figure 1 in the IHA application) (DFO Sightings Database 2017; OBIS, 2017). Two humpback whales outfitted with satellite transmitters near the Dominican Republic during winter and spring of 2008 to 2012 were later reported off the east coast of Canada, as well as near the proposed project area between Survey Sites 4 and 5 (Kennedy *et al.* 2014). Humpback whales were sighted during a summer survey along the Mid-Atlantic Ridge from Iceland to north of the Azores, including east of the survey area (Waring *et al.* 2008) and they have also been sighted near the Mid-Atlantic Ridge near the Azores (Silva *et al.* 2014; OBIS, 2017). Humpback whales could be encountered in the proposed project area during June–July, especially north of 40° N.

Minke Whale

The minke whale has a cosmopolitan distribution ranging from the tropics and subtropics to the ice edge in both hemispheres (Jefferson *et al.* 2008). Some populations migrate from high latitude summering grounds to lower latitude wintering grounds (Jefferson *et al.* 2015). In the Northern Hemisphere, the minke whale is usually seen in coastal areas, but can also occur in pelagic waters during northward migrations in spring and summer, and southward migration in autumn (Stewart and Leatherwood, 1985; Perrin and Brownell, 2009). Based on density modeling by Mannocci et al. (2017) for the western North Atlantic, higher densities are expected to occur north of 40° N; very low densities are expected south of 40° N. One minke whale was sighted during a summer survey along the Mid-Atlantic Ridge from Iceland to north of the Azores, east of SIO's proposed Survey Area 5 (Figure 1 in the IHA application) (Waring et al., 2008), and one sighting was made during June 2006 to the east of SIO's proposed Survey Area 6 at 53.3° N, 40.9° W (OBIS 2017). Other minke whale sightings have also been reported between the proposed project area and the Mid-Atlantic Ridge (OBIS 2017), and sightings have been made to the west of SIO's proposed Survey Areas 2 to 6 during summer and other seasons (DFO Sightings Database 2017; OBIS 2017).

Bryde's Whale

Bryde's whales are distributed worldwide in tropical and sub-tropical waters, but the taxonomy and number of species and/or subspecies of Bryde's whales in the world is currently a topic of debate (Kato and Perrin 2009; Rosel and Wilcox 2014). In the western Atlantic Ocean, Bryde's whales are reported from the southeastern United States including the Gulf of Mexico and the southern West Indies to Cabo Frio, Brazil (Leatherwood and Reeves, 1983). Bryde's whales have been observed feeding in the Azores during their northward spring migration (Villa *et al.* 2011), but the distribution of Bryde's whale elsewhere in the North Atlantic is not well known, though there are records from Virginia south to Brazil in the west, and from Morocco south to Cape of Good Hope in the east (Kato and Perrin, 2009). There was one Bryde's whale sighting reported at ~40° N during a survey along the Mid-Atlantic Ridge north of the Azores (Waring *et al.* 2008). Bryde's whales could be encountered in the proposed project area during June–July.

Sei Whale

The sei whale occurs in all ocean basins (Horwood 2009) but appears to prefer mid-latitude temperate waters (Jefferson *et al.* 2008). It undertakes seasonal migrations to feed in subpolar latitudes during summer and returns to lower latitudes during winter to calve (Horwood 2009). The sei whale is pelagic and generally not found in coastal waters (Harwood and Wilson 2001). It occurs 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).

Based on density modeling by Mannocci et al. (2017) for the western North Atlantic, higher densities are expected to occur north of 40° N during the summer; very low densities are expected south of 40° N. Sei whales are regularly sighted near the Azores during spring (Víkingsson et al. 2010; Ryan et al. 2013; Silva et al. 2014), and numerous sightings have also been made there during summer (Silva et al. 2014; OBIS 2017). One sei whale that was tagged in the Azores during 2005 (Olsen *et al.* 2009) and seven individuals that were tagged in the Azores during May–June 2008 and 2009 travelled to the Labrador Sea, where they spent extended periods of time on the northern shelf, presumably to feed (Prieto *et al.* 2010, 2014), then travelled northbound from the Azores just to the east of SIO's proposed Survey Areas 3 and 4, and between Survey Areas 5 and 6, during May and June, en route to the Labrador Sea (Olsen et al. 2009; Prieto et al. 2010, 2014). Sei whales could be encountered in the proposed project area during June–July, especially north of 40° N.

Fin Whale

Fin whales are found throughout all oceans from tropical to polar latitudes. The species occurs most commonly offshore but can also be found in coastal areas (Aguilar, 2009). Most populations migrate seasonally between temperate waters where mating and calving occur in winter, and polar waters where feeding occurs in summer (Aguilar, 2009). However, recent evidence suggests that some animals may remain at high latitudes in winter or low latitudes in summer (Edwards *et al.* 2015).

Based on density modeling by Mannocci *et al.* (2017) for the western North Atlantic, higher densities are expected to occur north of 40° N; very low densities are expected south of 40° N. Fin whales are commonly sighted off Newfoundland and Labrador, with most records for June through November (DFO Sightings Database 2017). Several fin whale sightings have been made to the west of SIO's proposed Survey Areas 3 to 6 (see Figure 1 in IHA application) (DFO Sightings Database 2017; OBIS 2017). One sighting was made near SIO's proposed Survey Area 5 at 53° N, 40° W (OBIS 2017). Fin whales were sighted during a summer survey along the Mid-Atlantic Ridge from Iceland to north of the Azores, including east of SIO's proposed Survey Area 5 and between 40 and 45° N (Waring et al. 2008). Several sightings have also been made between the proposed project area and the Mid-Atlantic Ridge (OBIS 2017) and fin whales were seen near the Mid-Atlantic Ridge at ~60° N in July 2012 (Ryan et al. 2013). Fin whales could be encountered in the proposed project area during June–July, especially north of 40° N.

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.* 2008). Blue whale migration is less well defined than for some other rorquals, and their movements tend to be more closely linked to areas of high primary productivity, and hence prey, to meet their high energetic demands (Branch *et al.* 2007). Generally, blue whales are seasonal migrants between high latitudes in the summer, where they feed, and low latitudes in the winter, where they mate and give birth (Lockyer and Brown 1981). Some individuals may stay in low or high latitudes throughout the year (Reilly and Thayer 1990; Watkins *et al.* 2000).

Blue whales are uncommon in the waters of Newfoundland, but are seen from spring through fall, with most sightings reported for July and August (DFO Sightings Database 2017). Blue whales have also been observed off Newfoundland to the west of SIO's proposed Survey Areas 2 and 3 (DFO Sightings Database 2017; OBIS 2017), as well as northwest of SIO's proposed Survey Area 6 (OBIS 2017). Blue whales were seen during a summer survey along the Mid-Atlantic Ridge from Iceland to north of the Azores, between 40 and 45° N (Waring *et al.* 2008). Additionally, blue whales outfitted with satellite tags were tracked from the Azores northward along the Mid-Atlantic Ridge during spring 2009 and 2011 (Silva et al. 2013). They have also been sighted in the Azores during late spring and summer (Ryan et al. 2013; OBIS 2017). Blue whales could be encountered within the proposed project area during June–July, but are considered to be uncommon in the area.

Sperm Whale

Sperm whales are found throughout the world's oceans in deep waters between about 60° N and 60° S latitudes. Their distribution is dependent on their food source and suitable conditions for breeding, and varies with the sex and age composition of the group. They are generally distributed over large areas that have high secondary productivity and steep underwater topography, in waters at least 1,000 m deep (Jaquet and Whitehead 1996; Whitehead 2009). Based on density modeling by Mannocci et al. (2017), sperm whale are expected to occur throughout the deeper offshore waters of the western North Atlantic. Sightings of sperm whales were also made on and east of the Flemish Cap, along the Mid-Atlantic Ridge from at least 32 to 57° N, and near SIO's proposed Survey Areas 1–4 and the seismic transects south of 45.5° N (OBIS 2017). Sperm whales were the second most commonly sighted cetacean species (n = 48) during a summer survey along the Mid-Atlantic Ridge from Iceland to north of the Azores; sightings were more abundant at and north of ~52° N, including to the east of SIO's proposed Survey Site 5 (Waring et al. 2008). Sperm whales were also sighted ~500 km north of Survey Area 1 during the summer 2004 seismic survey by L–DEO (Haley and Koski, 2004). There are also numerous sightings of sperm whales in the Azores (Morato et al. 2008; Ryan et al. 2013; Silva et al. 2014; OBIS 2017). Sperm whales could be encountered in the proposed project area during June–July.

Pygmy and Dwarf Sperm Whale

Pygmy sperm whales are found in tropical and warm-temperate waters throughout the world (Ross and Leatherwood 1994) and prefer deeper waters with observations of this species in greater than 4,000 m depth (Baird *et al.,* 2013). Both *Kogia* species are sighted primarily along the continental shelf edge and slope and over deeper waters off the shelf (Hansen et al. 1994; Davis et al. 1998). Several studies have suggested that pygmy sperm whales live mostly beyond the continental shelf edge, whereas dwarf sperm whales tend to occur closer to shore, often over the continental shelf (Rice 1998; Wang et al. 2002; MacLeod et al. 2004). Based on density modeling by Mannocci et al. (2017) for the western North Atlantic, slightly higher densities are expected to occur south of 40° N compared to northern regions. Pygmy and dwarf sperm whales likely would be rare in the proposed project area.

Cuvier's Beaked Whale

Cuvier's beaked whale is the most widespread of the beaked whales occurring in almost all temperate, subtropical, and tropical waters and even some sub-polar and polar waters (MacLeod *et al.* 2006). It is found in deep water over and near the continental slope (Jefferson *et al.* 2008). There is one record of a Cuvier's beaked whale from June 2006 between the proposed seismic transects at 51.4° N, 43.1° W, as well as numerous sightings from the Azores (Silva *et al.* 2014; OBIS 2017). Cuvier's beaked whales could be encountered in the proposed project area.

Mesoplodont Beaked Whales (Including True's, Gervais', Sowerby's, and Blainville's Beaked Whale)

Mesoplodont beaked whales are distributed throughout deep waters and along the continental slopes of the North Atlantic Ocean. True's beaked whale is mainly oceanic and occurs in warm temperate waters of the North Atlantic and southern Indian oceans (Pitman 2009). Gervais' beaked whale is mainly oceanic and occurs in tropical and warmer temperate waters of the Atlantic Ocean (Jefferson et al. 2015). Sowerby's beaked whale occurs in cold temperate waters of the Atlantic from the Labrador Sea to the Norwegian Sea, and south to New England, the Azores, and Madeira (Mead 1989). Blainville's beaked whale is found in tropical and warm temperate waters of all oceans; it has the widest distribution throughout the world of all mesoplodont species and appears to be relatively common

(Pitman 2009). Relatively few records exist of Mesoplodont beaked whale observations in the proposed survey area. There are 16 records of Sowerby's beaked whale near the Azores (OBIS 2017) and 10 records of stranded Sowerby's beaked whales were recorded in the central group of islands in the Azores from 2002 through 2009 (Pereira et al. 2011). Mesoplodont beaked whales, including True's, Gervais', Sowerby's, and Blainville's beaked whale, may be encountered in the proposed project area.

Northern Bottlenose Whale

Northern bottlenose whales are distributed in the North Atlantic from Nova Scotia to about 70° N in the Davis Strait, along the east coast of Greenland to 77° N and from England, Norway, Iceland and the Faroe Islands to the south coast of Svalbard. It is largely a deep-water species and is very seldom found in waters less than 2,000 m deep (Mead, 1989; Whitehead and Hooker, 2012). There are two records just west of SIO's proposed Survey Area 4, four records for the Mid-Atlantic Ridge between 52.8 and 54.3° N, and one record northeast of the beginning of the southwestern-most seismic transect (OBIS 2017). Northern bottlenose whales were also sighted ~520 km north of Survey Area 1 during the summer 2004 seismic survey by L–DEO (Haley and Koski 2004). Sightings have also been made in the Azores, including during summer (Silva et al. 2014; OBIS 2017). Northern bottlenose whales could be encountered in the proposed project area.

Killer Whale

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Killer whale distribution in the Western Atlantic extends from the Arctic ice edge to the West Indies. Although reported from tropical and offshore waters (Heyning and Dahlheim 1988), killer whales prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). Killer whales have been sighted in shelf and offshore waters of Newfoundland and Labrador during June to September (DFO Sightings Database 2017; OBIS 2017). There is one record near SIO's proposed Survey Area 6, one near the end of the proposed seismic transect heading southwest of Survey Area 6, east of the Flemish Cap, and northwest of Survey Area 1 (OBIS 2017). One record was made on the Mid-Atlantic Ridge at ~56° N, and there are numerous records for the Azores (OBIS 2017). Killer whales could be encountered within the proposed project area during June–July.

False Killer Whale

The false killer whale is distributed worldwide throughout warm temperate and tropical oceans (Jefferson et al., 2008). This species is usually sighted in offshore waters but in some cases inhabits waters closer shore (*e.g.,* Hawaii, Baird et al., 2013). While records from the U.S. western North Atlantic have been uncommon, the combination of sighting, stranding and bycatch records indicates that this species routinely occurs in the western North Atlantic. The pelagic range in the North Atlantic is usually southward of ~30° N but wanderers have been recorded as far north as Norway (Jefferson et al., 2015). There is one record just to the west of Survey Areas 3 and 4, two records on the Mid-Atlantic Ridge between 51° and 52° N, and numerous records in and around the Azores (OBIS 2017). Silva et al. (2014) also reported records for the Azores. False killer whales could be encountered in the proposed project area.

Pygmy Killer Whale

The pygmy sperm whale is distributed worldwide in temperate to tropical waters (Caldwell and Caldwell, 1989; McAlpine, 2002). Sightings in the western North Atlantic occur in oceanic waters (Mullin and Fulling, 2003). There are no records of this species near the proposed project area in the OBIS database (OBIS 2017). Pygmy killer whales are expected to be rare within and near the proposed project area.

Short-Finned Pilot Whale

Short-finned pilot whales are found in all oceans, primarily in tropical and warm-temperate waters (Carretta *et al.,* 2016). The species prefers deeper waters, ranging from 324 m to 4,400 m, with most sightings between 500 m and 3,000 m (Baird 2016). Although there are no records near the proposed project area, sightings have been reported for the Azores (OBIS 2017). Short-finned pilot whales could be encountered in the proposed project area.

Long-Finned Pilot Whale

Long-finned pilot whales occur in temperate and sub-polar zones (Jefferson et al. 2015) and can be found in inshore or offshore waters of the North Atlantic (Olson 2009). In the Northern Hemisphere, their range includes the U.S. east coast, Gulf of St. Lawrence, the Azores, Madeira, North Africa, western Mediterranean Sea, North Sea, Greenland and the Barents Sea. Long-finned pilot whales are commonly sighted off Newfoundland and Labrador (DFO Sightings Database 2017; OIBS 2017); although sightings have been reported year-round, most have occurred during July and August (DFO Sightings Database 2017). There are numerous records near the deep waters of the proposed project area, including sightings near SIO's proposed Survey Area 5 and near the end of the seismic transect heading south of Area 5, and on and east of the Flemish Cap (OBIS 2017). Long-finned pilot whales were also sighted ~520 km north of Survey Area 1 during the summer 2004 seismic survey by L–DEO (Haley and Koski 2004). The long-finned pilot whale could be encountered in the proposed study area.

Bottlenose Dolphin

Bottlenose dolphins are widely distributed throughout the world in tropical and warm-temperate waters (Perrin *et al.* 2009). Generally, there are two distinct bottlenose dolphin ecotypes: One mainly found in coastal waters and one mainly found in oceanic waters (Duffield *et al.* 1983; Hoelzel *et al.* 1998; Walker *et al.* 1999). As well as inhabiting different areas, these ecotypes differ in their diving abilities (Klatsky 2004) and prey types (Mead and Potter 1995). Only the offshore ecotype is expected to occur in the proposed survey area. Based on modeling by Mannocci et al. (2017), densities are expected to be low throughout the deep offshore waters of the western North Atlantic. However, in the OBIS database, there are records throughout the North Atlantic, including in offshore waters near the proposed project area between SIO's proposed survey transects at 49.3° N, 42.7° W; near Survey Areas 2, 3, and 4; near Sites 558 and 563; and west of Survey Area 1 near the seismic transect (OBIS 2017). Bottlenose dolphins were sighted ~500 km north of Survey Area 1 during the summer 2004 seismic survey by L–DEO (Haley and Koski 2004). They have also been reported in the Azores (Morato et al. 2008; Silva et al. 2014; OBIS 2017). Bottlenose dolphins could be encountered in the proposed project area.

Pantropical Spotted Dolphin

The pantropical spotted dolphin is distributed worldwide in tropical and some sub-tropical oceans (Perrin et al. 1987; Perrin and Hohn 1994). In the Atlantic, it can occur from ~40° N to 40° S but is much more abundant in the lower latitudes (Jefferson et al. 2015). Pantropical spotted dolphins are usually pelagic, although they occur close to shore where water near the coast is deep (Jefferson et al. 2015). One sighting was made in May 2012 in the proposed project area at 36.3° N, 53.3° W north of the southern-most seismic transect (OBIS 2017). Pantropical spotted dolphins could be encountered in the proposed project area.

Atlantic Spotted Dolphin

Atlantic spotted dolphins are distributed in tropical and warm temperate waters of the western North Atlantic (Leatherwood et al., 1976). Based on density modeling by Mannocci et al. (2017), Atlantic spotted dolphins occur throughout the western North Atlantic up to ~45° N, with slightly higher densities along 40° N and ~32° N. There are sighting records near SIO's proposed Survey Area 2, and between the Grand Banks and the southern-most seismic transect (OBIS 2017). One sighting was made at 34.0° N, 51.7° W just to the northwest of Survey Area 1 during the spring 2013 L–DEO seismic survey in the Mid-Atlantic (Milne et al. 2013). Atlantic spotted dolphins were also sighted ~520 km north of Survey Area 1 during the summer 2004 seismic survey by L–DEO (Haley and Koski 2004). Sightings have also been made near the Azores, including during spring and summer (Morato et al. 2008; Ryan et al. 2013; Silva et al. 2014; OBIS 2017). Atlantic spotted dolphins could be encountered in the proposed project area.

Striped Dolphin

Striped dolphins are found in tropical to warm-temperate waters throughout the world (Carretta *et al.,* 2016). Striped dolphins are a deep water species, preferring depths greater than 3,500 m (Baird 2016), but have been observed approaching shore where there is deep water close to the coast (Jefferson *et al.* 2008). Based on density modeling by Mannocci et al. (2017) for the western North Atlantic, higher densities are expected in offshore waters north of ~38° N, with the lowest densities south of ~30° N. There are sighting records for the deep offshore waters between the coast of Canada and the Mid-Atlantic Ridge for May through August, including near SIO's proposed Survey Areas 2 and 3 (OBIS 2017). Sightings were also made in June 2004 along the Mid-Atlantic Ridge between 41° and 49° N (Doksæter et al. 2008). Striped dolphins also occur in the Azores (Ryan et al. 2013; Silva et al. 2014; OBIS 2017). Striped dolphins could be encountered in the proposed project area.

Common Dolphin

The common dolphin may be one of the most widely distributed species of cetaceans, as it is found world-wide in temperate and subtropical seas. It is common in coastal waters 200–300 m deep (Evans 1994), but it can also occur thousands of kilometers offshore; the pelagic range in the North Atlantic extends south to ~35° N (Jefferson et al. 2015). Based on density modeling by Mannocci et al. (2017) for the western North Atlantic, higher densities occur in offshore areas north of ~40° N; very low densities are expected south of 40° N. There are records throughout the North Atlantic, including sightings on the shelf and offshore of Newfoundland and the deep waters of the proposed project area (OBIS 2017). There are sighting records just south of SIO's proposed Survey Area 5 along the seismic transect and near Survey Areas 1–4 (OBIS 2017). There are numerous records along the Mid-Atlantic Ridge between 35° and 52° N (Doksæter et al. 2008; OBIS 2017). Common dolphins also occur in the Azores (Morato et al. 2008; Ryan et al. 2013; Silva et al. 2014; OBIS 2017). Common dolphins could be encountered in the proposed project area.

Atlantic White-Sided Dolphin

White-sided dolphins are found in temperate and sub-polar waters of the North Atlantic, primarily in continental shelf waters to the 100-m depth contour. In the western North Atlantic the species inhabits waters from central West Greenland to North Carolina (about 35° N) and perhaps as far east as 29° W in the vicinity of the mid-Atlantic Ridge (Evans 1987; Hamazaki 2002; Doksaeter et al. 2008; Waring et al. 2008). Based on density modeling by Mannocci et al. (2017) for the western North Atlantic, densities are highest north of 40° N, with densities gradually decreasing to the south. Sighting records exist within or near the proposed project area, including near SIO's proposed Survey Areas 5 and 6, along the seismic transect heading southwest of Survey Area 6, near Survey Areas 3 and 4, Site 563, and north of Survey Area 1 (OBIS 2017). There are also several records along the Mid-Atlantic Ridge between 35° and 60° N (Doksæter et al. 2008; OBIS 2017). Atlantic white-sided dolphins are likely to be encountered in the proposed project area during June–July.

White-Beaked Dolphin

The white-beaked dolphin is found in waters from southern New England to southern Greenland and Davis Straits (Leatherwood et al. 1976; CETAP 1982), across the Atlantic to the Barents Sea and south to at least Portugal (Reeves et al. 1999). It appears to prefer deep waters along the outer shelf and slope, but can also occur in shallow areas and far offshore (Jefferson et al. 2015). One sighting of white-beaked dolphin was made in the deep waters off Newfoundland, southwest of SIO's proposed Survey Area 6 near the proposed seismic transect, during July 2012 (Ryan et al. 2013). Another sighting was made near the proposed seismic transect southwest of Survey Area 5 at 50.1° N, 40.8° W during March 2011 (OBIS 2017). White-beaked dolphins were observed on the Mid-Atlantic Ridge at 56.4° N during June 2004 (Skov et al. 2004). White-beaked dolphins could be encountered in the proposed project area during June–July.

Risso's Dolphin

Risso's dolphins are found in tropical to warm-temperate waters (Carretta *et al.,* 2016). The species occurs from coastal to deep water but is most often found in depths greater than 3,000 m with the highest sighting rate in depths greater than 4,500 m (Baird 2016). It primarily occurs between 60° N and 60° S where surface water temperatures are at least 10 °C (Kruse *et al.* 1999). Based on density modeling by Mannocci et al. (2017) for the western North Atlantic, higher densities are expected to occur north of 40° N; very low densities are expected south of 40° N. There is one sighting record near SIO's proposed Survey Area 4, just north of the end of the proposed seismic transect; and one sighting has been reported near Survey Area 2 (OBIS 2017). There are numerous records for the Azores (Silva et al. 2014; OBIS 2017). Risso's dolphin could be encountered in the proposed project area during June–July.

Harbor Porpoise

The harbor porpoise inhabits temperate, subarctic, and arctic waters. It is typically found in shallow water (<100 m) nearshore, but it is occasionally sighted in deeper offshore water (Jefferson et al. 2015). In the western North Atlantic, it occurs from the southeastern United States to Baffin Island; in the eastern North Atlantic (Jefferson et al. 2015). The harbor porpoise is generally considered uncommon in the offshore regions of the proposed project area, although sightings have been made along the outer shelf of Newfoundland and the Flemish Cap (DFO Sightings Database 2017; OBIS 2017). Mannocci et al. (2017) reported relatively high densities in offshore waters north of ~40° N; very low densities are expected to occur south of ~38° N. Harbor porpoises have been sighted in the Azores from May through September (OBIS 2017). Given their preference for coastal waters, harbor porpoises are expected to be uncommon near the proposed survey area.

Ringed Seal

Ringed seals have a circumpolar distribution and are found in all seasonally ice-covered seas of the Northern Hemisphere as well as in certain freshwater lakes (King 1983). The subspecies *P.h. hispida* (Arctic ringed seal) occurs in the Northwest Atlantic Ocean. The southern range of the ringed seal extends to the coasts of Labrador and northern Newfoundland, where it most commonly occurs from November to January (Stenson 1994). As the range of this species includes the waters off southern Greenland and the Labrador Sea, it could be encountered in the proposed project area, but ringed seals are likely to be rare within and near the proposed project area.

Harp Seal

The harp seal occurs throughout much of the North Atlantic and Arctic Oceans (Ronald and Healey 1981; Lavigne and Kovacs 1988). Harp seals are highly migratory (Sergeant 1965; Stenson and Sjare 1997). Breeding occurs at different times for each stock between late February and April. Adults then assemble on suitable pack ice to undergo the annual molt. The migration then continues north to Arctic summer feeding grounds. Harp seals have mainly been sighted on the shelf off Newfoundland, but there are no sightings in the OBIS database for the proposed project area (OBIS 2017). Harp seals are likely to be rare within and near the proposed project area during June–July.

Hooded Seal

The hooded seal occurs throughout much of the North Atlantic and Arctic Oceans (King 1983) preferring deeper water and occurring farther offshore than harp seals (Sergeant 1976a; Campbell 1987; Lavigne and Kovacs 1988; Stenson et al. 1996). Hooded seals remain on the Newfoundland continental shelf during winter/spring (Stenson et al. 1996) and breeding occurs in March. Hooded seals have been reported in shelf and offshore waters of Newfoundland throughout the year, including west of Survey Area 6 and near the seismic transect southwest of SIO's proposed Survey Area 6, during summer (Stenson and Kavanagh 1994; Andersen et al. 2009, 2012). Vagrants, especially juveniles, have been reported in the Azores and off northwestern Africa (Jefferson et al. 2015). However, there are no sightings in the OBIS database for the proposed project area (OBIS 2017). Hooded seals are likely to be rare within and near the proposed project area during June–July.

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. Current data indicate that 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) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2016) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 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. The functional groups and the associated frequencies are indicated below (note that these frequency ranges correspond to the range for the composite group, with the entire range not necessarily reflecting the capabilities of every species within that group):

- Low-frequency cetaceans (mysticetes): Generalized hearing is estimated to occur between approximately 7 Hertz (Hz) and 35 kilohertz (kHz);
- Mid-frequency cetaceans (larger toothed whales, beaked whales, and most delphinids): Generalized hearing is estimated to occur between approximately 150 Hz and 160 kHz;
- High-frequency cetaceans (porpoises, river dolphins, and members of the genera Kogia and Cephalorhynchus; including two members of the genus Lagenorhynchus, on the basis of recent echolocation data and genetic data): Generalized hearing is estimated to occur between approximately 275 Hz and 160 kHz; and
- Pinnipeds in water; Phocidae (true seals): Generalized hearing is estimated to occur between approximately 50 Hz to 86 kH.

The pinniped functional hearing group was modified from Southall *et al.* (2007) on the basis of data indicating that phocid species have consistently demonstrated an extended frequency range of hearing compared to otariids, especially in the higher frequency range (Hemilä *et al.,* 2006; Kastelein *et al.,* 2009; Reichmuth and Holt, 2013).

For more detail concerning these groups and associated frequency ranges, please see NMFS (2016) for a review of available information. Thirty-three marine mammal species (thirty cetacean and three pinniped (all phocid) species) have the reasonable potential to co-occur with the proposed survey activities. Please refer to Table 2. Of the cetacean species that may be present, six are classified as low-frequency cetaceans (*i.e.,* all mysticete species), twenty-two are classified as mid-frequency cetaceans (*i.e.,* all delphinid species, beaked whales, and the sperm whale), and three are classified as a high-frequency cetaceans (*i.e.,* harbor porpoise, pygmy and dwarf sperm whales).

Potential Effects of Specified Activities on Marine Mammals and Their Habitat

This section includes a summary and discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The ''Estimated Take by Incidental Harassment'' 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 by Incidental Harassment'' 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 how those impacts on individuals are likely to impact marine mammal species or stocks.

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 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 decibel (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 μPa^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 arrays 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 kilohertz (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 ambient 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 the 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 (defined in the following). 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.,* 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.

As described above, a MBES and a SBP would also be operated from the *Atlantis* continuously throughout the survey, but not during transits to and from the project area. Due to the lower source level of the SBP relative to the *Atlantis's* airgun array, the sounds from the SBP are expected to be effectively subsumed by the sounds from the airgun array. Thus, any marine mammal that was exposed to sounds from the SBP would already have been exposed to sounds from the airgun array, which are expected to propagate further in the water. As such, the SBP is not expected to result in the take of any marine mammal that has not already been taken by the sounds from the airgun array, and therefore we do not consider noise from the SBP further in this analysis. Each ping emitted by the MBES consists of four successive fan-shaped transmissions, each ensonifying a sector that extends 1° fore–aft. Given the movement and speed of the vessel, the intermittent and narrow downward-directed nature of the sounds emitted by the MBES would result in no more than one or two brief ping exposures of any individual marine mammal, if any exposure were to occur. Thus, we conclude that the likelihood of marine mammal take resulting from MBES exposure is discountable and therefore we do not consider noise from the MBES further in this analysis.

Acoustic Impacts

Potential Effects of Underwater Sound—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. Note that, in the following discussion, we refer in many cases to a recent review article concerning studies of noise-induced hearing loss conducted from 1996–2015 (*i.e.,* Finneran, 2015). For study-specific citations, please see that work. 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 will occur almost exclusively for noise within an animal's hearing range. We first describe specific manifestations of acoustic effects before providing discussion specific to the use of airguns.

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 responsiveness. 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 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 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.

1. *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). TS 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 consider TTS to constitute auditory injury.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, and 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 decibels 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 impulse 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 (SEL_{cum}) thresholds are 15 to 20 dB higher than TTS SEL_{cum} 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.

For mid-frequency cetaceans in particular, potential protective mechanisms may help limit onset of TTS or prevent onset of PTS. Such mechanisms include dampening of hearing, auditory adaptation, or behavioral amelioration (*e.g.,* Nachtigall and Supin, 2013; Miller *et al.,* 2012; Finneran *et al.,* 2015; Popov *et al.,* 2016).

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 three captive bottlenose dolphins before and after exposure to ten 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 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, harbor porpoise, and Yangtze finless porpoise) 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 are no 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), Finneran and Jenkins (2012), Finneran (2015), and NMFS (2016).

2. *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; 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.* 2013). Variations in dive behavior may reflect interruptions 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, 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 (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 six 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; Gailey *et al.,* 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 (Miller *et al.,* 2000; Fristrup *et al.,* 2003; Foote *et al.,* 2004), 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 passive acoustic monitoring 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 ten minute sampled period) on singer number. The number of singers significantly decreased with increasing received level of noise, suggesting that humpback whale breeding activity 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 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 a 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 showed 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).

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 five-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 one 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 large arrays of airguns (considered to be 500 in^3 or more) 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.

3. *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).

4. *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, marine mammals experiencing significant masking could also be impaired from maximizing their performance fitness in survival and reproduction. Therefore, when the coincident (masking) sound is man-made, it may be considered harassment when disrupting or altering critical behaviors. 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 determining 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 can be reduced 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.

Ship Strike

Vessel collisions with marine mammals, or ship strikes, can result in death or serious injury of the animal. Wounds resulting from ship 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 ships 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 kn, and exceeded 90 percent at 17 kn. 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 kt. The chances of a lethal injury decline from approximately 80 percent at 15 kt to approximately 20 percent at 8.6 kt. At speeds below 11.8 kt, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward one hundred percent above 15 kt.

The *Atlantis* would travel at a speed of either 5 kt (9.3 km/hour) or 8 kt (14.8 km/hour) while towing seismic survey gear (LGL, 2018). At these speeds, 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. Ship 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 ship 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). Commercial fishing vessels were responsible for three percent of recorded collisions, while no such incidents were reported for geophysical survey vessels during that time period.

It is possible for ship strikes to occur while traveling at slow speeds. For example, a hydrographic survey vessel traveling at low speed (5.5 kt) 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% CI = $0–5.5 \times 10^{-6}$; NMFS, 2013b). 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 require a robust ship strike avoidance protocol (see ''Proposed Mitigation''), which we believe eliminates any foreseeable risk of ship strike. 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 required 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), the presence of marine mammal observers, and the short duration of the survey (25 days), we believe that the possibility of ship strike is discountable and, further, that 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 ship 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 (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) 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 (iii) 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, ship 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 2005; Romero 2004; Sih *et al.* 2004).

Use of military tactical sonar has been implicated in a majority of investigated stranding events, although one stranding event was associated with the use of seismic airguns. This event occurred in the Gulf of California, coincident with seismic reflection profiling by the R/V *Maurice Ewing* operated by Lamont-Doherty Earth Observatory (LDEO) of Columbia University and involved two Cuvier's beaked whales (Hildebrand 2004). The vessel had been firing an array of 20 airguns with a total volume of 8,500 in^3 (Hildebrand 2004; Taylor *et al.* 2004). Most known stranding events have involved beaked whales, though a small number have involved deep-diving delphinids or sperm whales (*e.g.,* Mazzariol *et al.* 2010; Southall *et al.* 2013). In general, long duration (~1 second) and high-intensity sounds (≤235 dB SPL) have been implicated in stranding events (Hildebrand 2004). With regard to beaked whales, mid-frequency sound is typically implicated (when causation can be determined) (Hildebrand 2004). Although seismic airguns create predominantly low-frequency energy, the signal does include a mid-frequency component. We have considered the potential for the proposed survey to result in marine mammal stranding and have concluded that, based on the best available information, stranding is not expected to occur.

Other Potential Impacts

Here, we briefly address the potential risks due to entanglement and contaminant spills. We are not aware of any records of marine mammal entanglement in towed arrays such as those considered here. The discharge of trash and debris is prohibited (33 CFR 151.51–77) unless it is passed through a machine that breaks up solids such that they can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste. Some personal items may be accidentally lost overboard. However, U.S. Coast Guard and Environmental Protection Act regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. There are no meaningful entanglement risks posed by the described activity, and entanglement risks are not discussed further in this document.

Marine mammals could be affected by accidentally spilled diesel fuel from a vessel associated with proposed survey activities. Quantities of diesel fuel on the sea surface may affect marine mammals through various pathways: Surface contact of the fuel with skin and other mucous membranes, inhalation of concentrated petroleum vapors, or ingestion of the fuel (direct ingestion or by the ingestion of oiled prey) (*e.g.,* Geraci and St. Aubin, 1980, 1985, 1990). However, the likelihood of a fuel spill during any particular geophysical survey is considered to be remote, and the potential for impacts to marine mammals would depend greatly on the size and location of a spill and meteorological conditions at the time of the spill. Spilled fuel would rapidly spread to a layer of varying thickness and break up into narrow bands or windrows parallel to the wind direction. The rate at which the fuel spreads would be determined by the prevailing conditions such as temperature, water currents, tidal streams, and wind speeds. Lighter, volatile components of the fuel would evaporate to the atmosphere almost completely in a few days. Evaporation rate may increase as the fuel spreads because of the increased surface area of the slick. Rougher seas, high wind speeds, and high temperatures also tend to increase the rate of evaporation and the proportion of fuel lost by this process (Scholz *et al.,* 1999). We do not anticipate potentially meaningful effects to marine mammals as a result of any contaminant spill resulting from the proposed survey activities, and contaminant spills are not discussed further in this document.

Anticipated Effects on Marine Mammal Habitat

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. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. Hastings and Popper (2005) identified several studies that suggest fish may relocate to avoid certain areas of sound energy. Additional studies have documented effects of pulsed sound on fish, although several are based on studies in support of construction projects (*e.g.,* Scholik and Yan 2001, 2002; Popper and Hastings 2009). Sound pulses at received levels of 160 dB may cause subtle changes in fish behavior. SPLs of 180 dB may cause noticeable changes in behavior (Pearson *et al.* 1992; Skalski *et al.* 1992). SPLs of sufficient strength have been known to cause injury to fish and fish mortality. The most likely impact to fish from survey activities at the project area would be temporary avoidance of the area. 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.

Information on seismic airgun impacts to zooplankton, which represent an important prey type for mysticetes, is limited. However, McCauley *et al.* (2017) reported that experimental exposure to a pulse from a 150 in^3 airgun decreased zooplankton abundance when compared with controls, as measured by sonar and net tows, and caused a two- to threefold increase in dead adult and larval zooplankton. Although no adult krill were present, the study found that all larval krill were killed after air gun passage. Impacts were observed out to the maximum 1.2 km range sampled.

In general, impacts to marine mammal prey are expected to be limited due to the relatively small temporal and spatial overlap between the proposed survey and any areas used by marine mammal prey species. The proposed survey would occur over a relatively short time period (25 days) and would occur over a very small area relative to the area available as marine mammal habitat in the Northwest Atlantic Ocean. We do not have any information to suggest the proposed survey area represents a significant feeding area for any marine mammal, and we believe any impacts to marine mammals due to adverse effects to their prey would be insignificant due to the limited spatial and temporal impact of the proposed survey. However, adverse impacts may occur to a few species of fish and to zooplankton.

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.

In summary, activities associated with the proposed action are not likely to have a permanent, adverse effect on any fish habitat or populations of fish species or on the quality of acoustic habitat. Thus, any impacts to marine mammal habitat are not expected to cause significant or long-term consequences for individual marine mammals or their populations.

Estimated Take

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 determination.

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).

Authorized takes would primarily be by Level B harassment, as use of the seismic airguns 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, primarily for high frequency cetaceans. Auditory injury is unlikely to occur for low- and mid-frequency cetaceans given very small modeled zones of injury for those species. The proposed mitigation and monitoring measures are expected to minimize the severity of such taking to the extent practicable. As described previously, no mortality is anticipated or proposed to be authorized for this activity. Below we describe how the take is estimated.

Described in the most basic way, 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) and the number of days of activities. Below, we describe these components in more detail and present the exposure estimate and associated numbers of take proposed for authorization.

Acoustic Thresholds

Using the best available science, NMFS has developed 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 for non-explosive sources—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 (*e.g.,* frequency, predictability, duty cycle), the environment (*e.g.,* bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall *et al.,* 2007, Ellison *et al.* 2011). Based on the best available science and the practical need to use a threshold based on a factor that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS predicts that marine mammals are likely to be behaviorally harassed in a manner we consider to fall under Level B harassment when exposed to underwater anthropogenic noise above received levels of 120 dB re 1 μPa (rms) for continuous (*e.g.* vibratory pile-driving, drilling) and above 160 dB re 1 μPa (rms) for non-explosive impulsive (*e.g.,* seismic airguns) or intermittent (*e.g.,* scientific sonar) sources. SIO's proposed activity includes the use of impulsive seismic sources. Therefore, the 160 dB re 1 μPa (rms) criteria is applicable for analysis of level B harassment.

Level A harassment for non-explosive sources—NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NMFS, 2016) 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). As described above, SIO's proposed activity includes the use of intermittent and impulsive seismic sources. These thresholds are provided in Table 4.

These thresholds are provided in the table below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS 2016 Technical Guidance, which may be accessed at: *http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm.*

TABLE 4—THRESHOLDS IDENTIFYING THE ONSET OF PERMANENT THRESHOLD SHIFT IN MARINE MAMMALS

Hearing group	PTS Onset thresholds	
	Impulsive *	Non-impulsive
Low-Frequency (LF) Cetaceans	$L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB	$L_{E,LF,24h}$: 199 dB.
Mid-Frequency (MF) Cetaceans	$L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	$L_{E,MF,24h}$: 198 dB.
High-Frequency (HF) Cetaceans	$L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB	$L_{E,HF,24h}$: 173 dB.
Phocid Pinnipeds (PW) (Underwater)	$L_{pk,flat}$: 218 dB; $L_{E,PW,24h}$: 185 dB	$L_{E,PW,24h}$: 201 dB.
Otariid Pinnipeds (OW) (Underwater)	$L_{pk,flat}$: 232 dB; $L_{E,OW,24h}$: 203 dB	$L_{E,OW,24h}$: 219 dB.

Note: * 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 (Lpk) has a reference value of 1 μPa, and cumulative sound exposure level (LE) has a reference value of 1μPa2s. 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 will feed into estimating the area ensonified above the acoustic thresholds.

The proposed survey would entail the use of a 2-airgun array with a total discharge of 90 in³ at a tow depth of 2–4 m. The distances to the predicted isopleths corresponding to the threshold for Level B harassment (160 dB re 1 μPa) were calculated for both proposed array configurations based on results of modeling performed by LDEO. Received sound levels were predicted by LDEO's model (Diebold *et al.* 2010) as a function of distance from the airgun array. The LDEO 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 a 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 (~600–1100 m), and shallow water (~50 m) in the Gulf of Mexico in 2007–2008 (Tolstoy *et al.* 2009; Diebold *et al.* 2010). The estimated distances to Level B harassment isopleths for the two proposed configurations of the *Atlantis* airgun array are shown in Table 5.

TABLE 5—PREDICTED RADIAL DISTANCES FROM R/V ATLANTIS 90 in³ SEISMIC SOURCE TO ISOPLETH CORRESPONDING TO LEVEL B HARASSMENT THRESHOLD

Array configuration	Predicted distance to threshold (160 dB re 1 μPa) (m)
2 m airgun separation	578
8 m airgun separation	539

For modeling of radial distances to predicted isopleths corresponding to harassment thresholds in deep water (≤ 1,000 m), LDEO used the deep-water radii for various Sound Exposure Levels obtained from LDEO model results down to a maximum water depth of 2,000 m (see Figures 2 and 3 in the IHA application). LDEO's modeling methodology is described in greater detail in the IHA application (LGL, 20178) and we refer to the reader to that document rather than repeating it here.

Predicted distances to Level A harassment isopleths, which vary based on marine mammal functional hearing groups (Table 3), were calculated based on modeling performed by LDEO using the Nucleus software program and the NMFS User Spreadsheet, described below. The updated acoustic thresholds for impulsive sounds (such as airguns) contained in the Technical Guidance (NMFS, 2016) were presented as dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure level metrics. 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. In recognition of the fact that the requirement to calculate Level A harassment ensonified areas could be more technically challenging to predict due to the duration component and the use of weighting functions in the new SEL_{cum} thresholds, NMFS developed an optional User Spreadsheet that includes tools to help predict a simple isopleth that can be used in conjunction with marine mammal density or occurrence to facilitate the estimation of take numbers.

The values for SEL_{cum} and peak SPL for the *Atlantis* airgun array were derived from calculating the modified farfield signature (Table 6). 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 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, when the source is an array of multiple airguns separated in space, the source level from the theoretical farfield signature is not necessarily the best measurement of the source level that is physically achieved at the source (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 farfield signature. Because the farfield signature does not take into account the array effect near the source and is calculated as a point source, the modified farfield signature is a more appropriate measure of the sound source level for distributed sound sources, such as airgun arrays. Though the array effect is not expected to be as pronounced in the case of a 2-airgun array as it would be with a larger airgun array, the modified farfield method is considered more appropriate than use of the theoretical farfield signature.

TABLE 6—MODELED SOURCE LEVELS (dB) FOR R/V ATLANTIS 90 in³ AIRGUN ARRAY

Functional hearing group	8-kt survey with 8-m airgun separation: Peak SPL_{flat}	8-kt survey with 8-m airgun separation: SEL_{cum}	5-kt survey with 2-m airgun separation: Peak SPL_{flat}	5-kt survey with 2-m airgun separation: SEL_{cum}
Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	228.8	207	232.8	206.7
Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB)	N/A	206.7	229.8	206.9
High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	233	207.6	232.9	207.2
Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	230	206.7	232.8	206.9
Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)	N/A	203	225.6	207.4

In order to more realistically incorporate the Technical Guidance's weighting functions over the seismic array's full acoustic band, unweighted spectrum data for the *Atlantis's* airgun array (modeled in 1 Hz bands) was used to make adjustments (dB) to the unweighted spectrum levels, by frequency, according to the weighting functions for each relevant marine mammal hearing group. These adjusted/weighted spectrum levels were then converted to pressures (μPa) in order to integrate them over the entire broadband spectrum, resulting in broadband weighted source levels by hearing group that could be directly incorporated within the User Spreadsheet (*i.e.,* to override the Spreadsheet's more simple weighting factor adjustment). Using the User Spreadsheet's "safe distance" methodology for mobile sources (described by Sivle *et al.,* 2014) with the hearing group-specific weighted source levels, and inputs assuming spherical spreading propagation, a source velocity of 2.06 m/second (for the 2 m airgun separation) and 5.14 m/second (for the 8 m airgun separation), and a shot interval of 12.15 seconds (for the 2 m airgun separation) and 9.72 seconds (for the 8 m airgun separation) (LGL, 2018), potential radial distances to auditory injury zones were calculated for SEL_{cum} thresholds, for both array configurations. Inputs to the User Spreadsheet are shown in Table 6. Outputs from the User Spreadsheet in the form of estimated distances to Level A harassment isopleths are shown in Table 7. As described above, the larger distance of the dual criteria (SEL_{cum} or Peak SPL_{flat}) is used for estimating takes by Level A harassment. The weighting functions used are shown in Table 3 of the IHA application.

TABLE 7—MODELED RADIAL DISTANCES (m) FROM R/V ATLANTIS 90 in³ AIRGUN ARRAY TO ISOPLETHS CORRESPONDING TO LEVEL A HARASSMENT THRESHOLDS

Functional hearing group (Level A harassment thresholds)	8-kt survey with 8-m airgun separation: Peak SPL_{flat}	8-kt survey with 8-m airgun separation: SEL_{cum}	5-kt survey with 2-m airgun separation: Peak SPL_{flat}	5-kt survey with 2-m airgun separation: SEL_{cum}
Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	3.08	2.4	4.89	6.5
Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB)	0	0	0.98	0
High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	34.84	0	34.62	0
Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	4.02	0	5.51	0.1
Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)	0	0	0.48	0

Note that because of some of the assumptions included in the methods used, isopleths produced may be overestimates to some degree, which will ultimately result in some degree of overestimate of Level A 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. For mobile sources, such as the proposed seismic survey, the User Spreadsheet predicts the closest distance at which a stationary animal would not incur PTS if the sound source traveled by the animal in a straight line at a constant speed.

Marine Mammal Occurrence

In this section we provide the information about the presence, density, or group dynamics of marine mammals that will inform the take calculations. The best available scientific information was considered in conducting marine mammal exposure estimates (the basis for estimating take). For all cetacean species, densities calculated by Mannocci *et al.* (2017) were used. These represent the most comprehensive and recent density data available for cetacean species in the survey area. Mannocci *et al.* (2017) modeled marine mammal densities using available line transect survey data and habitat-based covariates and extrapolated model predictions to unsurveyed regions, including the proposed survey area. The authors considered line transect surveys that used two or more protected species observers and met the assumptions of the distance sampling methodology as presented by Buckland *et al.* (2001), and included data from shipboard and aerial surveys conducted from 1992 to 2014 by multiple U.S. organizations (details provided in Roberts *et al.* (2016)). The data underlying the model predictions for the proposed survey area originated from shipboard survey data presented in Waring *et al.* (2008). To increase the success of model transferability to new regions, the authors considered biological covariates expected to be related directly to cetacean densities (Wenger & Olden, 2012), namely biomass and production of epipelagic micronekton and zooplankton predicted with the Spatial Ecosystem and Population DYnamics Model (SEAPODYM) (Lehodey *et al.* 2010). Zooplankton and epipelagic micronekton (*i.e.,* squid, crustaceans, and fish) constitute potential prey for many of the cetaceans considered, in particular dolphins and mysticetes (Pauly *et al.* 1998), and all these covariates correlate with cetacean distributions (*e.g.,* Ferguson *et al.* 2006; Doniol-Valcroze *et al.* 2007; Lambert *et al.* 2014). There is some uncertainty related to the estimated density data and the assumptions used in their calculations, as with all density data estimates. However, the approach used is based on the best available data.

Take Calculation and Estimation

Here we describe how the information provided above is brought together to produce a quantitative take estimate. In order to estimate the number of marine mammals predicted to be exposed to sound levels that would result in Level B harassment or Level A harassment, radial distances to predicted isopleths corresponding to the Level A harassment and Level B harassment thresholds are calculated, as described above (Table 8). Those distances are then used to calculate the area(s) around the airgun array predicted to be ensonified to sound levels that exceed the Level A and Level B harassment thresholds. The areas estimated to be ensonified in a single day of the survey are then calculated, based on the areas predicted to be ensonified around the array and the estimated trackline distance traveled per day (Table 9). This number is then multiplied by the number of survey days (*i.e.,* 7.5 days for the 5-kt survey with 2-m airgun separation and 17.5 days for the 8-kt survey with 8-m airgun separation). The product is then multiplied by 1.25 to account for an additional 25 percent contingency for potential additional seismic operations, as described above. This results in an estimate of the total areas (km²) expected to be ensonified to the Level A harassment and Level B harassment thresholds. For purposes of Level B take calculations, areas estimated to be ensonified to Level A harassment thresholds are subtracted from total areas estimated to be ensonified to Level B harassment thresholds in order to avoid double counting the animals taken (*i.e.,* if an animal is taken by Level A harassment, it is not also counted as taken by Level B harassment). Areas estimated to be ensonified over the duration of the survey are shown in Table 10. The marine mammals predicted to occur within these respective areas, based on estimated densities, are assumed to be incidentally taken. Estimated takes for all marine mammal species are shown in Table 11.

TABLE 8—DISTANCES (m) TO ISOPLETHS CORRESPONDING TO LEVEL A AND LEVEL B HARASSMENT THRESHOLDS

Survey	Level B harassment threshold	Level A harassment threshold [1]				
	All marine mammals	Low frequency cetaceans	Mid frequency cetaceans	High frequency cetaceans	Otariid pinnipeds	Phocid pinnipeds
5-kt survey with 2-m airgun separation ...	539	6.5	0.98	34.62	5.51	0.48
8-kt survey with 8-m airgun separation ...	578	3.08	0	34.84	4.02	0

[1] Level A ensonified areas are estimated based on the greater of the distances calculated to Level A isopleths using dual criteria (SEL_{cum} and peak PL).

TABLE 9—AREAS (km²) ESTIMATED TO BE ENSONIFIED TO LEVEL A AND LEVEL B HARASSMENT THRESHOLDS PER DAY

Survey	Level B harassment threshold	Level A harassment threshold [1]				
	All marine mammals	Low frequency cetaceans	Mid frequency cetaceans	High frequency cetaceans	Otariid pinnipeds	Phocid pinnipeds
5-kt survey with 2-m airgun separation ...	240.68	2.90	0.44	15.40	2.45	0.21
8-kt survey with 8-m airgun separation ...	412.10	2.19	0	24.78	2.86	0

[1] Level A ensonified areas are estimated based on the greater of the distances calculated to Level A isopleths using dual criteria (SEL_{cum} and peak PL).

Note: Estimated areas shown for single day do not include additional 25 percent contingency.

TABLE 10—AREAS (km²) ESTIMATED TO BE ENSONIFIED TO LEVEL A AND LEVEL B HARASSMENT THRESHOLDS OVER DURATION OF SURVEY

Survey	Level B harassment threshold	Level A harassment threshold [1]				
	All marine mammals	Low frequency cetaceans	Mid frequency cetaceans	High frequency cetaceans	Otariid pinnipeds	Phocid pinnipeds
5-kt survey with 2-m airgun separation ...	2256.33	27.10	4.09	144.40	22.97	2.0
8-kt survey with 8-m airgun separation ...	9014.56	47.84	0	542.09	62.50	0

[1] Level A ensonified areas are estimated based on the greater of the distances calculated to Level A isopleths using dual criteria (SEL_{cum} and peak PL).

Note: Estimated areas shown include additional 25 percent contingency.

TABLE 11—NUMBERS OF POTENTIAL INCIDENTAL TAKE OF MARINE MAMMALS PROPOSED FOR AUTHORIZATION

Species	Density (#/1,000 km²)	Estimated Level A takes	Proposed Level A takes	Estimated Level B takes	Proposed Level B takes	Total proposed Level A and Level B takes	Total proposed instances of takes as a percentage of SAR abundance [1]
Humpback whale [2]	10	1	0	112	113	113	0.9 *.
Minke whale	4	0	0	45	45	45	0.2 *.
Bryde's whale	0.1	0	0	1	1	1	unknown.
Sei whale [2]	10	1	0	112	113	113	31.4.
Fin whale	8	1	0	89	90	90	2.6 *.
Blue whale	0	0	0	0	1	1	0.2.
Sperm whale	40	0	0	451	451	451	19.7.
Cuvier's beaked whale [3]	60	0	0	135	135	135	2.0.
Northern bottlenose whale [4].	0.8	0	0	9	9	9	unknown.
True's beaked whale [3]	60	0	0	135	135	135	1.9.

TABLE 11—NUMBERS OF POTENTIAL INCIDENTAL TAKE OF MARINE MAMMALS PROPOSED FOR AUTHORIZATION—Continued

Species	Density (#/1,000 km^2)	Estimated Level A takes	Proposed Level A takes	Estimated Level B takes	Proposed Level B takes	Total proposed Level A and Level B takes	Total proposed instances of takes as a percentage of SAR abundance [1]
Gervais beaked whale [3]	60	0	0	135	135	135	1.9.
Sowerby's beaked whale [3].	60	0	0	135	135	135	1.9.
Blainville's beaked whale [3].	60	0	0	135	135	135	1.9.
Rough-toothed dolphin ...	3	0	0	34	34	34	12.5.
Bottlenose dolphin	60	0	0	677	677	677	0.9.
Pantropical spotted dolphin.	10	0	0	113	113	113	3.4.
Atlantic spotted dolphin ..	40	0	0	451	451	451	1.0.
Striped dolphin	80	0	0	902	902	902	1.6.
Atlantic white-sided dolphin.	60	0	0	677	677	677	1.4.
White-beaked dolphin	1	0	0	11	11	11	0.6.
Common dolphin	800	3	0	9014	9017	9017	5.2 *.
Risso's dolphin	20	0	0	226	226	226	1.2.
Pygmy killer whale [4 5]	1.5	0	0	17	17	17	unknown.
False killer whale	2	0	0	23	23	23	5.2.
Killer whale [4 thnsp;6]	0.2	0	0	2	5	5	unknown.
Long-finned/short-finned Pilot whale [7].	200	1	0	2253	2254	2254	8.3.
Pygmy/dwarf sperm whale.	0.6	0	0	7	7	7	0.2.
Harbor porpoise	60	41	41	635	635	676	0.8.
Ringed seal [4]	0	0	0	0	1	1	unknown.
Hooded seal	0	0	0	0	1	1	<0.1.
Harp seal	0	0	0	0	1	1	<0.1.

[1] While we have in most cases provided comparisons of the proposed instances of takes as a percentage of SAR abundance as the best available information regarding population abundance, we note that these are likely underestimates of the relevant North Atlantic populations, as the proposed survey area is outside the U.S. EEZ. Asterisks denote that instances of takes are shown as a percentage of abundance as described by TNASS or NMFS Status Review, as described above.

[2] We have determined Level A take of these species is not likely, therefore estimated Level A takes have been added to the number of Level B takes proposed for authorization.

[3] Density value represents the value for all beaked whales combined. Requested take and take proposed for authorization based on proportion of all beaked whales expected to be taken (677 total estimated beaked whale takes divided by 5 species of beaked whales).

[4] The population abundance for the species is unknown.

[5] The density estimate for pygmy killer whales shown in Table 8 in the IHA application is incorrect; the correct density is 1.5 animals/km^2 as shown here.

[6] Proposed take number for killer whales has been increased from the calculated take to mean group size for the species. Source for mean group size is Waring *et al.* (2008).

[7] Values for density, proposed take number, and percentage of population proposed for authorization are for short-finned and long-finned pilot whales combined.

For some marine mammal species, we propose to authorize a different number of incidental takes than the number of incidental takes requested by SIO (see Table 8 in the IHA application for requested take numbers). For instance, SIO requested 1 take of a North Atlantic right whale and 3 takes of bowhead whales; however, we have determined the likelihood of the survey encountering these species is so low as to be discountable, therefore we do not propose to authorize takes of these species. Also, SIO requested Level A takes of humpback whales, sei whales, fin whales, common dolphins, and pilot whales; however, due to very small zones corresponding to Level A harassment for low-frequency and mid-frequency cetaceans (Table 7) we have determined the likelihood of Level A take occurring for species from these functional hearing groups is so low as to be discountable, therefore we do not propose to authorize Level A take of these species. Note that the Level A takes that were calculated for these species (humpback whales, sei whales, fin whales, common dolphins, and pilot whales) have been included in the proposed number of Level B takes. Finally, SIO requested 2,254 takes of short-finned pilot whales and 2,254 takes of long-finned pilot whales (total 4,508 pilot whale takes requested); however, as Mannocci *et al.* (2017) presents one single density estimate for all pilot whales (the pilot whale ''guild''), a total of 2,254 takes of pilot whales were calculated as potentially taken by the proposed survey. Thus SIO's request take number is actually double the number of take that was calculated. We do not think doubling the take estimate is warranted, thus we propose to authorize a total of 2,254 takes of pilot whales (short-finned and long-finned pilot whales combined).

Species With Take Estimates Less Than Mean Group Size: Using the approach described above to estimate take, the take estimate for killer whales was less than the average group size estimated for the species (Waring *et al.,* 2008). Information on the social structure and life history of the species indicates it is common for the species to be encountered in groups. The results of take calculations support the likelihood that SIO's survey may encounter and incidentally take the species, and we believe it is likely that the species may be encountered in groups; therefore it is reasonable to conservatively assume that one group of the species will be taken during the proposed survey. We therefore propose to authorize the take of the average (mean) group size for the species to account for the possibility that SIO's survey encounters a group of killer whales.

Species With No Available Density Data: No density data were available for the blue whale; however, blue whales have been observed in the survey area (Waring *et al.,* 2008), thus we determined there is a possibility that the proposed survey may encounter one blue whale and that one blue whale may be taken by Level B harassment by the proposed survey; we therefore propose to authorize one take of blue whale as requested by SIO. No density data were available for ringed seal, hooded seal or harp seal; however based on the ranges of these species we have determined it is possible they may be encountered and taken by Level B harassment by the proposed survey, therefore we propose to authorize one take of each species as requested by SIO.

It should be noted that the proposed take numbers shown in Table 11 are believed to be conservative for several reasons. First, in the calculations of estimated take, 25 percent has been added in the form of operational survey days (equivalent to adding 25 percent to the proposed line km to be surveyed) to account for the possibility of additional seismic operations associated with airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. Additionally, marine mammals would be expected to move away from a sound source that represents an aversive stimulus. However, the extent to which marine mammals would move away from the sound source is difficult to quantify and is therefore not accounted for in take estimates shown in Table 8.

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 such activity, and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such 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 such 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, we carefully consider 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, impact on operations, and, in the case of a military readiness activity, personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

SIO has reviewed mitigation measures employed during seismic research surveys authorized by NMFS under previous incidental harassment authorizations, as well as recommended best practices in Richardson *et al.* (1995), Pierson *et al.* (1998), Weir and Dolman (2007), Nowacek *et al.* (2013), Wright (2014), and Wright and Cosentino (2015), and has incorporated a suite of proposed mitigation measures into their project description based on the above sources.

To reduce the potential for disturbance from acoustic stimuli associated with the activities, SIO has proposed to implement the following mitigation measures for marine mammals:

(1) Vessel-based visual mitigation monitoring;

(2) Establishment of a marine mammal exclusion zone (EZ);

(3) Shutdown procedures;

(4) Ramp-up procedures; and

(5) Vessel strike avoidance measures.

In addition to the measures proposed by SIO, NMFS has proposed the following mitigation measure: Establishment of a marine mammal buffer zone.

PSO observations would take place during all daytime airgun operations and nighttime start ups (if applicable) of the airguns. If airguns are operating throughout the night, observations would begin 30 minutes prior to sunrise. If airguns are operating after sunset, observations would continue until 30 minutes following sunset. Following a shutdown for any reason, observations would occur for at least 30 minutes prior to the planned start of airgun operations. Observations would also occur for 30 minutes after airgun operations cease for any reason. Observations would also be made during daytime periods when the *Atlantis* is underway without seismic operations, such as during transits, to allow for comparison of sighting rates and behavior with and without airgun operations and between acquisition periods. Airgun operations would be suspended when marine mammals are observed within, or about to enter, the designated EZ (as described below).

During seismic operations, three visual PSOs would be based aboard the *Atlantis.* PSOs would be appointed by SIO with NMFS approval. During the majority of seismic operations, two PSOs would monitor for marine mammals around the seismic vessel. A minimum of one PSO must be on duty at all times when the array is active. PSO(s) would be on duty in shifts of duration no longer than 4 hours. Other crew would also be instructed to assist in detecting marine mammals and in implementing mitigation requirements (if practical). Before the start of the seismic survey, the crew would be given additional instruction in detecting marine mammals and implementing mitigation requirements.

The *Atlantis* is a suitable platform from which PSOs would watch for marine mammals. Standard equipment for marine mammal observers would be 7 x 50 reticule binoculars and optical range finders. At night, night-vision equipment would be available. The observers would be in communication with ship's officers on the bridge and scientists in the vessel's operations laboratory, so they can advise promptly of the need for avoidance maneuvers or seismic source shutdown.

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 would be provided to NMFS for approval. At least one PSO must have a minimum of 90 days at-sea experience working as PSOs during a seismic survey. One ''experienced'' visual PSO will be designated as the lead for the entire protected species observation team. The lead will serve as primary point of contact for the vessel operator. The PSOs must have successfully completed relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training program, and must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate training, including (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

Exclusion Zone and Buffer Zone

An EZ 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 EZ with a 100 m radius for the airgun array. The 100 m EZ would be based on radial distance from any element 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, enters, or appears on a course to enter this zone, the acoustic source would be shut down (see Shutdown Procedures below).

The 100 m radial distance of the standard EZ is precautionary in the sense that it would be expected to contain sound exceeding injury criteria for all marine mammal hearing groups (Table 7) while also providing a consistent, reasonably observable zone within which PSOs would typically be able to conduct effective observational effort. In this case, the 100 m radial distance would also be expected to contain sound that would exceed the Level A harassment threshold based on sound exposure level (SEL_{cum}) criteria for all marine mammal hearing groups (Table 7). In the 2011 Programmatic Environmental Impact Statement for marine scientific research funded by the National Science Foundation or the U.S. Geological Survey (NSF–USGS 2011), Alternative B (the Preferred Alternative) conservatively applied a 100 m EZ for all low-energy acoustic sources in water depths >100 m, with low-energy acoustic sources defined as any towed acoustic source with a single or a pair of clustered airguns with individual volumes of ≤250 in^3. Thus the 100 m EZ proposed for this survey is consistent with the PEIS.

Our intent in prescribing a standard EZ distance is to (1) encompass zones within which auditory injury could occur on the basis of instantaneous exposure; (2) provide additional protection from the potential for more severe behavioral reactions (*e.g.,* panic, antipredator response) for marine mammals at relatively close range to the acoustic source; (3) provide consistency for PSOs, who need to monitor and implement the EZ; and (4) define a distance within which detection probabilities are reasonably high for most species under typical conditions.

PSOs would also establish and monitor a 200 m buffer zone. During use of the acoustic source, occurrence of marine mammals within the buffer zone (but outside the EZ) would be communicated to the operator to prepare for potential shutdown of the acoustic source. The buffer zone is discussed further under *Ramp Up Procedures* below.

Shutdown Procedures

If a marine mammal is detected outside the EZ but is likely to enter the EZ, the airguns would be shut down before the animal is within the EZ. Likewise, if a marine mammal is already within the EZ when first detected, the airguns would be shut down immediately.

Following a shutdown, airgun activity would not resume until the marine mammal has cleared the 100 m EZ. The animal would be considered to have cleared the 100 m EZ if the following conditions have been met:

- It is visually observed to have departed the 100 m EZ, or
- it has not been seen within the 100 m EZ for 15 min in the case of small odontocetes, or
- it has not been seen within the 100 m EZ for 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, and beaked whales.

This shutdown requirement would be in place for all marine mammals, with the exception of small delphinoids under certain circumstances. As defined here, the small delphinoid 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 would apply solely to specific genera of small dolphins—*Tursiops, Steno, Stenella, Lagenorhynchus* and *Delphinus*—and would only apply if the animals were traveling, including approaching the vessel. If, for example, an animal or group of animals is stationary for some reason (*e.g.,* feeding) and the source vessel approaches the animals, the shutdown requirement applies. An animal with sufficient incentive to remain in an area rather than avoid an otherwise aversive stimulus could either incur auditory injury or disruption of important behavior. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, the shutdown would be implemented.

We propose this small delphinoid exception because shutdown requirements for small delphinoids under all circumstances represent practicability concerns without likely commensurate benefits for the animals in question. Small delphinoids 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 below, auditory injury is extremely unlikely to occur for mid-frequency cetaceans (*e.g.,* 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). Please see ''Potential Effects of the Specified Activity on Marine Mammals'' above for further discussion of sound metrics and thresholds and marine mammal hearing.

A large body of anecdotal evidence indicates that small delphinoids commonly approach vessels and/or towed arrays during active sound production for purposes of bow riding, with no apparent effect observed in those delphinoids (*e.g.,* Barkaszi *et al.,* 2012). The potential for increased shutdowns resulting from such a measure would require the *Atlantis* 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 delphinoids) are no more likely to incur auditory injury than are small delphinoids, they are much less likely to approach vessels. Therefore, retaining a shutdown requirement for large delphinoids 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 delphinoids 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 source vessel.

At any distance, shutdown of the acoustic source would also be required upon observation of any of the following:

- A large whale (*i.e.,* sperm whale or any baleen whale) with a calf; or
- an aggregation of large whales of any species (*i.e.,* sperm whale or any baleen whale) that does not appear to be traveling (*e.g.,* feeding, socializing, etc.).

These would be the only two potential situations that would require shutdown of the array for marine mammals observed beyond the 100 m EZ.

Ramp-Up Procedures

Ramp-up of an acoustic source is intended to provide a gradual increase in sound levels following a shutdown, enabling animals to move away from the source if the signal is sufficiently aversive prior to its reaching full intensity. Ramp-up would be required after the array is shut down for any reason. Ramp-up would begin with the activation of one 45 in^3 airgun, with the second 45 in^3 airgun activated after 5 minutes.

At least two PSOs would be required to monitor during ramp-up. During ramp up, the PSOs would monitor the EZ, and if marine mammals were observed within the EZ or buffer zone, a shutdown would be implemented as though the full array were operational. If airguns have been shut down due to PSO detection of a marine mammal within or approaching the 100 m EZ, ramp-up would not be initiated until all marine mammals have cleared the EZ, during the day or night. Criteria for clearing the EZ would be as described above.

Thirty minutes of pre-clearance observation are required prior to ramp-up for any shutdown of longer than 30 minutes (*i.e.,* if the array were shut down during transit from one line to another). This 30 minute pre-clearance period may occur during any vessel activity (*i.e.,* transit). If a marine mammal were observed within or approaching the 100 m EZ during this pre-clearance period, ramp-up would not be initiated until all marine mammals cleared the EZ. Criteria for clearing the EZ would be as described above. If the airgun array has been shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for a period of less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant visual observation and no detections of any marine mammal have occurred within the EZ or buffer zone. Ramp-up would be planned to occur during periods of good visibility when possible. However, ramp-up would be allowed at night and during poor visibility if the 100 m EZ and 200 m buffer zone have been monitored by visual PSOs for 30 minutes prior to ramp-up.

The operator would be required to 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. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed. The operator must provide information to PSOs documenting that appropriate procedures were followed. Following deactivation of the array for reasons other than mitigation, the operator would be required to communicate the near-term operational plan to the lead PSO with justification for any planned nighttime ramp-up.

Vessel Strike Avoidance Measures

Vessel strike avoidance measures are intended to minimize the potential for collisions with marine mammals. 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.

The proposed measures include the following: Vessel operator and crew would maintain a vigilant watch for all marine mammals and slow down or stop the vessel or alter course to avoid striking any marine mammal. A visual observer aboard the vessel would monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone would be either third-party observers or crew members, but crew members responsible for these duties would be provided sufficient training to distinguish marine mammals from other phenomena. Vessel strike avoidance measures would be followed during surveys and while in transit.

The vessel would maintain a minimum separation distance of 100 m from large whales (*i.e.,* baleen whales and sperm whales). If a large whale is within 100 m of the vessel the vessel would reduce speed and shift the engine to neutral, and would not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established. If the vessel is stationary, the vessel would not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m. The vessel would maintain a minimum separation distance of 50 m from all other marine mammals (with the exception of delphinids of the genera *Tursiops, Steno, Stenella, Lagenorhynchus* and *Delphinus* that approach the vessel, as described above). If an animal is encountered during transit, the vessel would attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course. Vessel speeds would be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near the vessel.

Based on our evaluation of the applicant's proposed measures, NMFS has preliminarily determined that the proposed mitigation measures provide the means 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 in the proposed action area. 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 action; or (4) biological or behavioral context of exposure (*e.g.,* age, calving or feeding areas);
- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors;
- How anticipated responses to stressors impact either: (1) Long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks;
- Effects on marine mammal habitat (*e.g.,* marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat); and
- Mitigation and monitoring effectiveness.

SIO submitted a marine mammal monitoring and reporting plan in their IHA application. Monitoring that is designed specifically to facilitate mitigation measures, such as monitoring of the EZ to inform potential shutdowns of the airgun array, are described above and are not repeated here.

SIO's monitoring and reporting plan includes the following measures:

Vessel-Based Visual Monitoring

As described above, PSO observations would take place during daytime airgun operations and nighttime start-ups (if applicable) of the airguns. During seismic operations, three visual PSOs would be based aboard the *Atlantis.* PSOs would be appointed by SIO with NMFS approval. During the majority of seismic operations, one PSO would monitor for marine mammals around the seismic vessel. PSOs would be on duty in shifts of duration no longer than 4 hours. Other crew would also be instructed to assist in detecting marine mammals and in implementing mitigation requirements (if practical). During daytime, PSOs would scan the area around the vessel systematically with reticle binoculars (*e.g.,* 7x50 Fujinon) and with the naked eye. At night, PSOs would be equipped with night-vision equipment.

PSOs would record data to estimate the numbers of marine mammals exposed to various received sound levels and to document apparent disturbance reactions or lack thereof. Data would be used to estimate numbers of animals potentially 'taken' by harassment (as defined in the MMPA). They would also provide information needed to order a shutdown of the airguns when a marine mammal is within or near the EZ. When a sighting is made, the following information about the sighting would be recorded:

(1) Species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from seismic vessel, sighting cue, apparent reaction to the airguns or vessel (*e.g.,* none, avoidance, approach, paralleling, etc.), and behavioral pace; and

(2) Time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare.

All observations and shutdowns would be recorded in a standardized format. Data would be entered into an electronic database. The accuracy of the data entry would be verified by computerized data validity checks as the data are entered and by subsequent manual checking of the database. These procedures would allow initial summaries of data to be prepared during and shortly after the field program and would facilitate transfer of the data to statistical, graphical, and other programs for further processing and archiving. The time, location, heading, speed, activity of the vessel, sea state, visibility, and sun glare would also be recorded at the start and end of each observation watch, and during a watch whenever there is a change in one or more of the variables.

Results from the vessel-based observations would provide:

(1) The basis for real-time mitigation (*e.g.,* airgun shutdown);

(2) Information needed to estimate the number of marine mammals potentially taken by harassment, which must be reported to NMFS;

(3) Data on the occurrence, distribution, and activities of marine mammals in the area where the seismic study is conducted;

(4) Information to compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity; and

(5) Data on the behavior and movement patterns of marine mammals seen at times with and without seismic activity.

Reporting

A report would be submitted to NMFS within 90 days after the end of the survey. The report would describe the operations that were conducted and sightings of marine mammals near the operations. The report would provide full documentation of methods, results, and interpretation pertaining to all monitoring and would summarize the dates and locations of seismic operations, and all marine mammal sightings (dates, times, locations, activities, associated seismic survey activities). The report would also include estimates of the number and nature of exposures that occurred above the harassment threshold based on PSO observations, including an estimate of those on the trackline but not detected.

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 responses (*e.g.,* intensity, duration), the context of any responses (*e.g.,* critical reproductive time or location, migration), 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's 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 environmental 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, our analysis applies to all the species listed in Table 2, given that NMFS expects the anticipated effects of the proposed seismic survey to be similar in nature. Where there are meaningful differences between species or stocks, or groups of species, in anticipated individual responses to activities, impact of expected take on the population due to differences in population status, or impacts on habitat, NMFS has identified species-specific factors to inform the analysis.

NMFS does not anticipate that serious injury or mortality would occur as a result of SIO's proposed seismic survey, even in the absence of proposed mitigation. Thus the proposed authorization does not authorize any mortality. As discussed in the *Potential Effects* section, non-auditory physical effects, stranding, and vessel strike are not expected to occur.

We propose to authorize a limited number of instances of Level A harassment (Table 11) for one species. However, we believe that any PTS incurred in marine mammals as a result of the proposed activity would be in the form of only a small degree of PTS and not total deafness that would not be likely to affect the fitness of any individuals, because of the constant movement of both the *Atlantis* and of the marine mammals in the project area, 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 (*i.e.,* since the duration of exposure to loud sounds will be relatively short). Also, as described above, we expect that marine mammals would be likely to 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 *Atlantis's* approach due to the vessel's relatively low speed when conducting seismic surveys. We expect that the majority of takes would be in the form of short-term Level B behavioral harassment in the form of temporary avoidance of the area or decreased foraging (if such activity were occurring), reactions that are considered to be of low severity and with no lasting biological consequences (*e.g.,* Southall *et al.,* 2007).

Potential impacts to marine mammal habitat were discussed previously in this document (see *Potential Effects of the Specified Activity on Marine Mammals and their Habitat*). Marine mammal habitat may be impacted by elevated sound levels, but these impacts would be temporary. Feeding behavior is not likely to be significantly impacted, as marine mammals appear to be less likely to exhibit behavioral reactions or avoidance responses while engaged in feeding activities (Richardson *et al.,* 1995). Prey species are mobile and are broadly distributed throughout the project 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 temporary nature of the disturbance, the availability of similar habitat and resources in the surrounding area, and the lack of important or unique marine mammal habitat, the impacts to marine mammals and the food sources that they utilize are not expected to cause significant or long-term consequences for individual marine mammals or their populations. In addition, there are no feeding, mating or calving areas known to be biologically important to marine mammals within the proposed project area.

As described above, though marine mammals in the survey area would not be assigned to NMFS stocks, for purposes of the small numbers analysis we rely on stock numbers from the U.S. Atlantic SARs as the best available information on the abundance estimates for the species of marine mammals that could be taken. The activity is expected to impact a very small percentage of all marine mammal populations that would be affected by SIO's proposed survey (less than 34 percent each for all marine mammal stocks, when compared with stocks from the U.S. Atlantic as described above). 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 (25 days) would further limit potential impacts that may occur as a result of the proposed activity.

The proposed mitigation measures are expected to reduce the number and/or severity of takes by allowing for detection of marine mammals in the vicinity of the vessel by visual and acoustic observers, and by minimizing the severity of any potential exposures via shutdowns of the airgun array. Based on previous monitoring reports for substantially similar activities that have been previously authorized by NMFS, we expect that the proposed mitigation will be effective in preventing at least some extent of potential PTS in marine mammals that may otherwise occur in the absence of the proposed mitigation.

Of the marine mammal species under our jurisdiction that are likely to occur in the project area, the following species are listed as endangered under the ESA: Fin, sei, blue, and sperm whales. There are currently insufficient data to determine population trends for these species (Hayes *et al.,* 2017); however, we are proposing to authorize very small numbers of takes for these species (Table 11), relative to their population sizes (again, when compared to U.S. Atlantic stocks, for purposes of comparison only), therefore we do not expect population-level impacts to any of these species. The other marine mammal species that may be taken by harassment during SIO'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; of the non-listed marine mammals for which we propose to authorize take, none are considered ''depleted'' or ''strategic'' by NMFS under the MMPA.

NMFS concludes that exposures to marine mammal species due to SIO's proposed seismic survey would result in only short-term (temporary and short in duration) effects to individuals exposed, or some small degree of PTS to a very small number of individuals of four species. Marine mammals may temporarily avoid the immediate area, but are not expected to permanently abandon the area. Major shifts in habitat use, distribution, or foraging success are not expected. NMFS does not anticipate the proposed take estimates to impact annual rates of recruitment or survival.

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 the species or stock through effects on annual rates of recruitment or survival:

- No mortality is anticipated or authorized;
- The anticipated impacts of the proposed activity on marine mammals would primarily be temporary behavioral changes due to avoidance of the area around the survey vessel. The relatively short duration of the proposed survey (25 days) would further limit the potential impacts of any temporary behavioral changes that would occur;
- The number of instances of PTS that may occur are expected to be very small in number (Table 11). Instances of PTS that are incurred in marine mammals would be of a low level, due

to constant movement of the vessel and of the marine mammals in the area, and the nature of the survey design (not concentrated in areas of high marine mammal concentration);

- The availability of alternate 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;
- The proposed project area does not contain areas of significance for feeding, mating or calving;
- 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
- The proposed mitigation measures, including visual and acoustic monitoring and shutdowns, are expected to minimize potential impacts to marine mammals.

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 total marine mammal take from the proposed activity will have a negligible impact on all affected marine mammal species or stocks.

Small Numbers

As noted above, only small numbers of incidental take may be authorized under Section 101(a)(5)(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 stock in our determination of whether an authorization is limited to small numbers of marine mammals. Additionally, other qualitative factors may be considered in the analysis, such as the temporal or spatial scale of the activities.

Marine mammals potentially taken by the proposed survey would not be expected to originate from the U.S. Atlantic stocks as defined by NMFS (Hayes *et al.,* 2017). However, population abundance data for marine mammal species in the survey area is not available, therefore in most cases the U.S. Atlantic SARs represent the best available information on marine mammal abundance in the Northwest Atlantic Ocean. For certain species (*i.e.,* fin whale, minke whale and common dolphin) the 2007 Canadian Trans-North Atlantic Sighting Survey (TNASS), which provided full coverage of the Atlantic Canadian coast (Lawson and Gosselin, 2009) represents the best available information on abundance. Abundance estimates from TNASS were corrected for perception and availability bias, when possible. In general, where the TNASS survey effort provided more extensive coverage of a stock's range (as compared with NOAA shipboard survey effort), we elected to use the resulting abundance estimate over the current NMFS abundance estimate (derived from survey effort with more limited coverage of the stock range). For the humpback whale, NMFS defines a stock of humpback whales in the Atlantic only on the basis of the Gulf of Maine feeding population; however, multiple feeding populations originate from the DPS of humpback whales that is expected to occur in the proposed survey area (the West Indies DPS). As West Indies DPS whales from multiple feeding populations may be encountered in the proposed survey area, the total abundance of the West Indies DPS best reflects the abundance of the population that may encountered by the proposed survey. The West Indies DPS abundance estimate used here reflects the latest estimate as described in the NMFS Status Review of the Humpback Whale under the Endangered Species Act (Bettridge *et al.,* 2015). Therefore, we use abundance data from the SARs in most cases, as well as from the TNASS and NMFS Status Review, for purposes of the small numbers analysis. The numbers of takes that we propose for authorization to be taken, for all species and stocks are less than a third of the population abundance for all species and stocks, when compared to abundance estimates from U.S. Atlantic SARs and TNASS and NMFS Status Review (Table 11). We again note that while some animals from U.S. stocks may occur in the proposed survey area, the proposed survey area is outside the geographic boundaries of the U.S. Atlantic SARs, thus populations of marine mammals in the proposed survey area would not be limited to the U.S. stocks and those populations may in fact be larger than the U.S. stock abundance estimates. In addition, it should be noted that take numbers represent instances of take, not individuals taken. Given the relatively small survey grids (Figure 1 in the IHA application), it is reasonable to expect that some individuals may be exposed more than one time, which would mean that the number of individuals taken is somewhat smaller than the total instances of take indicated in Table 1.

No known current regional population estimates are available for 5 marine mammal species that could be incidentally taken as a result of the proposed survey: The Bryde's whale, killer whale, pygmy killer whale, Northern bottlenose whale, and ringed seal. NMFS has reviewed the geographic distributions of these species in determining whether the numbers of takes proposed for authorization herein are likely to represent small numbers. Bryde's whales are distributed worldwide in tropical and sub-tropical waters (Kato and Perrin, 2009). Killer whales are broadly distributed in the Atlantic from the Arctic ice edge to the West Indies (Waring *et al.,* 2015). The pygmy killer whale is distributed worldwide in tropical to sub-tropical waters (Jefferson *et al.* 1994). Northern bottlenose whales are distributed in the North Atlantic from Nova Scotia to about 70° N in the Davis Strait, along the east coast of Greenland to 77° N and from England, Norway, Iceland and the Faroe Islands to the south coast of Svalbard (Waring *et al.,* 2015). The harp seal occurs throughout much of the North Atlantic and Arctic Oceans (Lavigne and Kovacs 1988). Based on the broad spatial distributions of these species relative to the areas where the proposed surveys would occur, NMFS preliminarily concludes that the authorized take of these species represent small numbers relative to the affected species' overall population sizes, though we are unable to quantify the proposed take numbers as a percentage of population.

Based on the analysis contained herein of the proposed activity (including the proposed mitigation and monitoring measures) and the anticipated take of marine mammals, NMFS preliminarily finds that small numbers of marine mammals will be taken relative to the population size of the affected species or stocks.

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 preliminarily 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 (ESA)

Section 7(a)(2) of the ESA of 1973 (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, in this case with the ESA Interagency Cooperation Division, whenever we propose to authorize take for endangered or threatened species.

The NMFS Permits and Conservation Division is proposing to authorize the incidental take of 4 species of marine mammals which are listed under the ESA: the sei whale, fin whale, blue whale and sperm whale. We have requested initiation of Section 7 consultation with the Interagency Cooperation Division for the issuance of this IHA. NMFS will conclude the ESA section 7 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 SIO for conducting a low-energy seismic survey in the Northwest Atlantic Ocean in June-July 2018, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. This section contains a draft of the IHA itself. The wording contained in this section is proposed for inclusion in the IHA (if issued).

1. This IHA is valid for a period of one year from the date of issuance.

2. This IHA is valid only for marine geophysical survey activity, as specified in the SIO IHA application and using an airgun array aboard the R/V *Atlantis* with characteristics specified in the application, in the Northwest Atlantic Ocean.

3. General Conditions

(a) A copy of this IHA must be in the possession of SIO, the vessel operator and other relevant personnel, the lead PSO, and any other relevant designees of SIO operating under the authority of this IHA.

(b) The species authorized for taking are listed in Table 11. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 11. Any taking exceeding the authorized amounts listed in Table 11 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(c) The taking by serious injury or death of any species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) During use of the airgun(s), if marine mammal species other than those listed in Table 11 are detected by PSOs, the acoustic source must be shut down to avoid unauthorized take.

(e) SIO shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations.

4. Mitigation Requirements

The holder of this Authorization is required to implement the following mitigation measures:

(a) SIO must use at least three (3) dedicated, trained, NMFS-approved PSOs. The PSOs must have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements. PSO resumes shall be provided to NMFS for approval.

(b) At least one PSO must have a minimum of 90 days at-sea experience working as a PSO during a deep penetration seismic survey, with no more than eighteen months elapsed since the conclusion of the at-sea experience. One ''experienced'' visual PSO 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.

(c) Visual Observation

(i) During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), typically two, and minimally one, PSO(s) 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).

(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up, including for nighttime ramp-ups of the airgun array, and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

(iii) 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.

(iv) PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24 hour period.

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

(d) Exclusion Zone and buffer zone—PSOs shall establish and monitor a 100 m EZ and 200 m buffer zone. The zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals outside the EZ but within 200 m from any element of the airgun array shall be communicated to the operator to prepare for potential further mitigation measures as described below. During use of the acoustic source, occurrence of marine mammals within the EZ, or on a course to enter the EZ, shall trigger further mitigation measures as described below.

(i) Ramp-up—A ramp-up procedure is required at all times as part of the activation of the acoustic source. Ramp-up would begin with one 45 in^3 airgun, and the second 45 in^3 airgun would be added after 5 minutes.

(ii) If the airgun array has been shut down due to a marine mammal detection, ramp-up shall not occur until all marine mammals have cleared the EZ. A marine mammal is considered to have cleared the EZ if:

(A) It has been visually observed to have left the EZ; or

(B) It has not been observed within the EZ, for 15 minutes (in the case of small odontocetes) or for 30 minutes (in the case of mysticetes and large odontocetes including sperm, pygmy sperm, and beaked whales).

(iii) Thirty minutes of pre-clearance observation of the 100 m EZ and 200 m buffer zone are required prior to ramp-up for any shutdown of longer than 30 minutes. This pre-clearance period may occur during any vessel activity. If any marine mammal (including delphinids) is observed within or approaching the EZ or buffer zone during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the EZ or buffer zone or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species).

(iv) During ramp-up, at least two PSOs shall monitor the 100 m EZ and 200 m buffer zone. Ramp-up may not be initiated if any marine mammal (including delphinids) is observed within or approaching the 100 m EZ. If a marine mammal is observed within or approaching the 100 m EZ during ramp-up, a shutdown shall be implemented as though the full array were operational. Ramp-up may not begin again until the animal(s) has been observed exiting the 100 m EZ or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for mysticetes and large odontocetes including sperm, pygmy sperm, and beaked whales).

(v) If the airgun array has been shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for a period of less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant visual observation and no visual detections of any marine mammal have occurred within the buffer zone.

(vi) Ramp-up at night and at times of poor visibility shall only occur where operational planning cannot reasonably avoid such circumstances. Ramp-up may occur at night and during poor visibility if the 100 m EZ and 200 m buffer zone have been continually monitored by visual PSOs for 30 minutes prior to ramp-up with no marine mammal detections.

(vii) The vessel operator must notify a designated PSO of the planned start of ramp-up. The designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.

(e) Shutdown requirements—An exclusion zone of 100 m shall be established and monitored by PSOs. If a marine mammal is observed within, entering, or approaching the 100 m exclusion zone all airguns shall be shut down.

(i) Any PSO on duty has the authority to call for shutdown of the airgun array. When there is certainty regarding the need for mitigation action on the basis of visual detection, the relevant PSO(s) must call for such action immediately.

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

(iii) When a shutdown is called for by a PSO, the shutdown must occur and any dispute resolved only following shutdown.

(iv) The shutdown requirement is waived for dolphins of the following genera: *Tursiops, Steno, Stenella, Lagenorhynchus* and *Delphinus.* The shutdown waiver only applies if animals are traveling, including approaching the vessel. If animals are stationary and the vessel approaches the animals, the shutdown requirement applies. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, shutdown must be implemented.

(v) Upon implementation of a shutdown, the source may be reactivated under the conditions described at 4(e)(vi). Where there is no relevant zone (*e.g.,* shutdown due to observation of a calf), a 30-minute clearance period must be observed following the last observation of the animal(s).

(vi) Shutdown of the array is required upon observation of a whale (*i.e.,* sperm whale or any baleen whale) with calf, with ''calf'' defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult, at any distance.

(vii) Shutdown of the array is required upon observation of an aggregation (*i.e.,* six or more animals) of large whales of any species (*i.e.,* sperm whale or any baleen whale) that does not appear to be traveling (*e.g.,* feeding, socializing, etc.) at any distance.

(f) Vessel Strike Avoidance—Vessel operator and crew must maintain a vigilant watch for all marine mammals and slow down or stop the vessel or alter course, as appropriate, to avoid striking any marine mammal. 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. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena.

(i) The vessel must maintain a minimum separation distance of 100 m from large whales. The following avoidance measures must be taken if a large whale is within 100 m of the vessel:

(A) The vessel must reduce speed and shift the engine to neutral, when feasible, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.

(B) If the vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.

(ii) The vessel must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for animals described in 4(e)(iv) that approach the vessel. If an animal is encountered during transit, the vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

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

(g) Miscellaneous Protocols

(i) The airgun array must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Operational capacity of 90 in^3 (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.,* ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

(a) The operator must provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.

(b) PSOs must also be equipped with reticle binoculars (*e.g.,* 7x50) of appropriate quality (*i.e.,* Fujinon or equivalent), GPS, compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.

(c) PSO Qualifications

(i) PSOs must have successfully completed relevant training, including completion of all required coursework and passing a written and/or oral examination developed for the training program.

(ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection—PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. We require that, at a minimum, the following information be reported:

(i) PSO names and affiliations

(ii) Dates of departures and returns to port with port name

(iii) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort

(iv) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts

(v) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change

(vi) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon

(vii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.,* vessel traffic, equipment malfunctions)

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

(ix) If a marine mammal is sighted, the following information should be recorded:

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

(B) PSO who sighted the animal;

(C) Time of sighting;

(D) Vessel location at time of sighting;

(E) Water depth;

(F) Direction of vessel's travel (compass direction);

(G) Direction of animal's travel relative to the vessel;

(H) Pace of the animal;

(I) Estimated distance to the animal and its heading relative to vessel at initial sighting;

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

(K) Estimated number of animals (high/low/best);

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

(M) 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);

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

(O) Animal's closest point of approach and/or closest distance from the center point of the acoustic source;

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

(Q) Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up, speed or course alteration, etc.) and time and location of the action.

6. Reporting

(a) SIO 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 near the activities, 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). Geospatial data regarding locations where the acoustic source was used must be provided as an ESRI shapefile with all necessary files and appropriate metadata. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the data collected as required under condition 5(d) of this IHA. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments from NMFS on the draft report.

(b) Reporting injured or dead marine mammals:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not prohibited by this IHA (if issued), such as serious injury or mortality, SIO shall immediately cease the specified activities and immediately report the incident to the NMFS Office of Protected Resources. The report must include the following information:

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

(B) Vessel's speed during and leading up to the incident;

(C) Description of the incident;

(D) Status of all sound source use in the 24 hours preceding the incident;

(E) Water depth;

(F) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(G) Description of all marine mammal observations in the 24 hours preceding the incident;

(H) Species identification or description of the animal(s) involved;

(I) Fate of the animal(s); and

(J) Photographs or video footage of the animal(s).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take.

NMFS will work with SIO to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. SIO may not resume their activities until notified by NMFS.

(ii) In the event that SIO discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), SIO shall immediately report the incident to the NMFS Office of Protected Resources. The report must include the same information identified in condition 6(b)(i) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with SIO to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iii) In the event that SIO discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), SIO shall report the incident to the NMFS Office of Protected Resources within 24 hours of the discovery. SIO shall provide photographs or video footage or other documentation of the sighting to NMFS.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

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 survey. We also request comment on the potential for 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 our final decision on the request for MMPA authorization.

On a case-by-case basis, NMFS may issue a second one-year IHA without additional notice when (1) another year of identical or nearly identical activities as described in the Specified Activities section is planned or (2) the activities would not be completed by the time the IHA expires and a second IHA would allow for completion of the activities beyond that described in the Dates and Duration section, provided all of the following conditions are met:

- A request for renewal is received no later than 60 days prior to expiration of the current IHA.
- The request for renewal must include the following:

(1) An explanation that the activities to be conducted beyond the initial dates either are identical to the previously analyzed activities or include changes so minor (*e.g.,* reduction in pile size) that the changes do not affect the previous analyses, take estimates, or mitigation and monitoring requirements.

(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 remain the same and appropriate, and the original findings remain valid.

Dated: April 24, 2018.

Donna S. Wieting,

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

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