BILLING CODE 3510-22-P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648-XG170

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine 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 United States Geological Survey (USGS) for authorization to take marine mammals incidental to a 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 authorizations, and agency responses will be summarized in the final notice of our decision.

DATES: Comments and information must be received no later than [*INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER*].

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.molineaux@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: Jonathan Molineaux, 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: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities*. In case of problems accessing these documents, please call the contact listed 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.

Accordingly, NMFS is preparing an Environmental Assessment (EA) to consider the environmental impacts associated with the issuance of the proposed IHA. We will review all comments submitted in response to this notice prior to concluding our NEPA process or making a final decision on the IHA request.

Summary of Request

On March 20, 2018, NMFS received a request from USGS for an IHA to take marine mammals incidental to a marine geophysical survey in the northwest Atlantic Ocean. On April 11, 2018, we deemed USGS's application for authorization to be adequate and complete. USGS's request is for take a small number of 29 species of marine mammals by Level B harassment only. Neither USGS nor NMFS expects serious injury or 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

The USGS intends to conduct a seismic survey aboard the *R/V Hugh R. Sharp*, a University National Oceanographic Laboratory (UNOLS) Federal fleet vessel that is owned and operated by the University of Delaware, during a cruise up to 22 days long on the northern U.S. Atlantic margin in August 2018. The program is named MATRIX, for "Mid-Atlantic Resource Imaging Experiment." The seismic survey will take place in water depths ranging from ~100 meters (m) to 3500 m, entirely within the U.S. Exclusive Economic Zone (EEZ), and acquire ~ 6 dip lines (roughly perpendicular to the orientation of the shelf-break) and ~3 strike lines (roughly parallel to the shelf-break) between about 35 nautical miles (nmi) south of Hudson Canyon on the north and Cape Hatteras on the south. In addition, multichannel seismic (MCS) data will be acquired along some linking/transit/interseismic lines between the main survey lines. Total data acquisition could be up to ~2400 kilometers (km) of trackline. Exemplary seismic lines for the program are shown in Figure 1. Some deviation in actual tracklines and timing could be necessary for reasons such as science drivers, poor data quality, inclement weather, or mechanical issues with the research vessel and/or equipment.

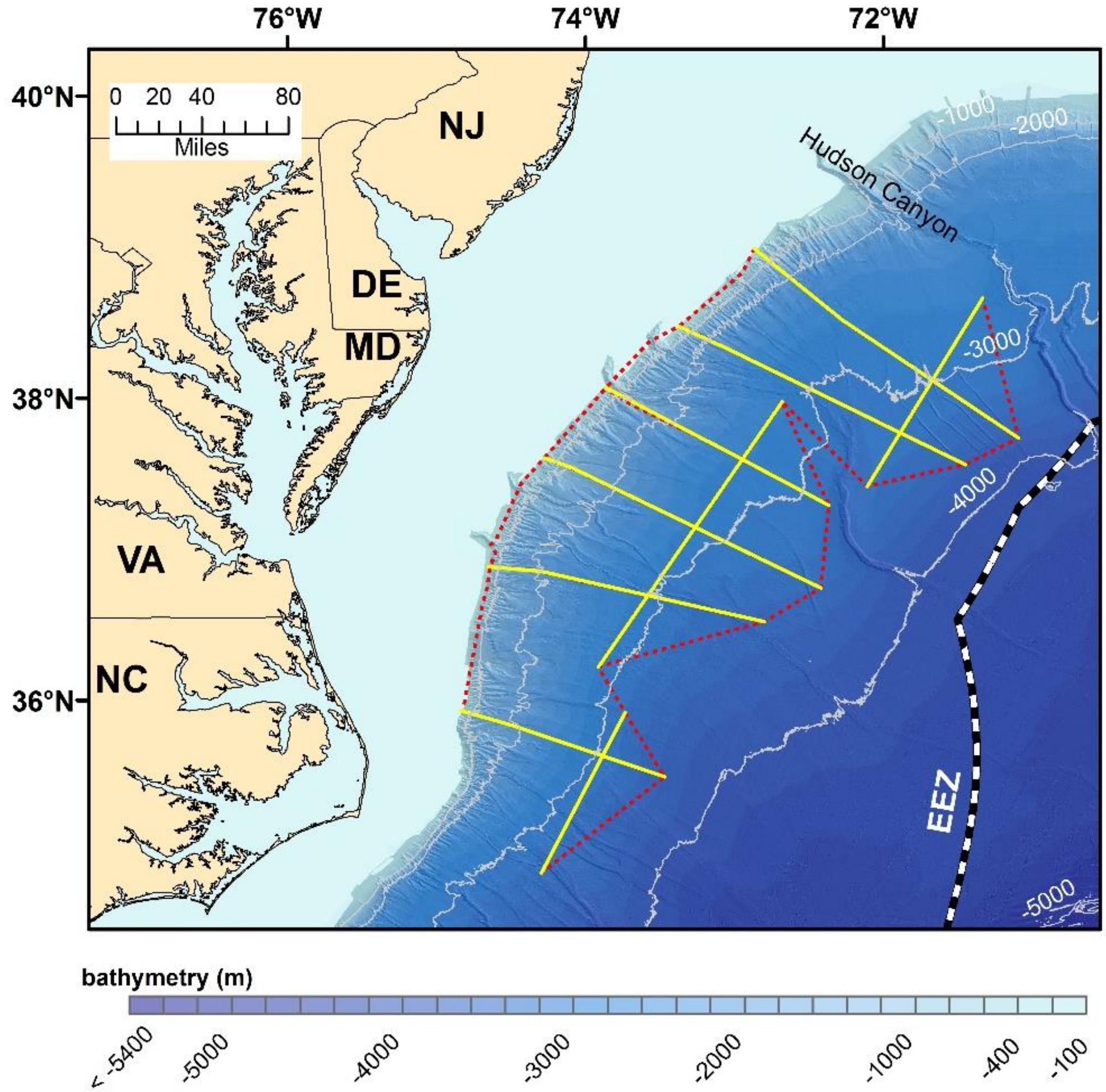

Figure 1. Exemplary seismic lines (solid) to be acquired by the USGS during the Proposed Action, superposed on the USGS high-resolution bathymetric grid (Andrews *et al*., 2016).

Dashed lines are linking/transit/interseismic lines, and data will be acquired along only half of these lines.

The purpose of the proposed MATRIX survey is to collect data to constrain the lateral and vertical distribution of gas hydrates and shallow natural gas in marine sediments relative to seafloor gas seeps, slope failures, and geological and erosional features.

Dates and Duration

The seismic survey's airgun operations are scheduled to occur for up to 19 days during a cruise that may be as long as 22 days, departing port on August 8, 2018. Some minor deviation from these dates is possible, depending on logistics and especially weather.

Specific Geographic Region

The survey is bound within the region ~34.75º N–40° N, ~71–75° W in the northwest Atlantic Ocean (See Figure 1), with the closest approach to the U.S. coastline at 70 km (North Carolina) to 130 km (New Jersey). The survey area starts 35 nmi south of Hudson Canyon on the north and is bound by Cape Hatteras on the south, the nominal shelf break (~100 m water depth) on the west, and the ~3500 m bathymetric contour on the east.

Detailed Description of Specific Activity

The procedures that will be used for the seismic surveys would be similar to those used during previous research seismic surveys funded by the National Science Foundation (NSF) or conducted by the USGS and would utilize a conventional seismic methodology. The survey will involve only one source vessel, the R/V *Hugh R. Sharp*. The source vessel will deploy two to four low-energy Generator-Injector (GI) airguns (each with a discharge volume of 105 cubic inches (in^3)) as an energy source. The GI guns could sometimes be fired in a mode that gives them a discharge volume of 210 in^3 each, but only at water depths greater than 1000 m (See description of Optimal Survey below for more details). A hydrophone streamer 750- to 1300-m-long and consisting of up to 160 channels will be continuously towed to receive the seismic signals. In addition, up to 90 disposable sonobuoy receivers will be deployed at water depths greater than 1000 m to provide velocity control and possibly wide-angle reflections along the highest priority transects. Below we provide a description of each of the airgun modes during the survey.

The Optimal Survey (GG mode) (See Table 1) for the Proposed Action would acquire the portion of the solid lines in Figure 1 at water depths greater than 1000 m using the GI-guns in "GG" mode. In this mode, the four GI guns would produce a total of 840 in^3 of air and sonobuoys would be deployed to passively record data at long distances. When shooting to sonobuoys while in GG mode, the GI guns will be operated with both chambers releasing air simultaneously (*i.e.*, "generator-generator" or "GG" mode). The rest of the survey, including the portion shallower than 1000 m water depth on the uppermost slope and the interseismic linking lines (dashed lines in Figure 1), would be acquired with four GI guns operated in normal mode (also called GI mode), producing a total of 420 in^3 of air.

The Base Survey (GI mode) (See Table 1) assumes that all of the solid lines in Figure 1, as well as all of the interseismic connecting lines, would be acquired using four GI guns operating in normal mode (GI mode), producing a total air volume of 420 in^3. Only a maximum of half of the interseismic linking lines (dashed lines in Figure 1) would be acquired. These lines are longer and geometrically more complex at the deepwater side than near the shelf-break.

Table 1. General characteristics of exemplary survey scenarios for the Proposed Action.

	GI mode (4x105 in^3)		**GG mode (4x210 in^3)**	
	Depth and line type	Track line distance	Depth and line type	Track line distance
Optimal Survey	100-1000 m water depth on exemplary lines AND 50% of interseismic, linking lines	~750 km	Greater than 1000 m on exemplary lines	~1600 km
Base Survey	Exemplary lines plus 50% of interseismic, linking lines	2350 km		

During the cruise, the USGS would continuously use an echosounder (EK60/EK80) with 38 kHz transducer at water depths less than ~1800 m to locate water column anomalies associated with seafloor seeps emitting gas bubbles. The 38 kHz transducer would be mounted in the *R/V Sharp*'s retractable keel and would typically ping 0.5 to 2 Hz with pings of 0.256 to 1.024 millisecond (m/s) duration. The returned signals would be detected on an EK60 or EK80 (broadband) transceiver. Based on past USGS experience with this instrument, it is unlikely to acquire useful data at water depths greater than 1800 m, although it could be used in passive mode at these depths to record broadband ambient signals in the water column.

Airgun Array Description

The R/V *Hugh R. Sharp* will tow two or four 105-in^3 Sercel GI airguns at a time as the primary energy source following exemplary survey lines and transit/linking/interseismic lines between the primary exemplary lines. Seismic pulses for the GI guns will be emitted at intervals of ~12 s. At speeds of ~7.4 km/h (4 knots (kn)), the shot intervals correspond to a spacing of ~25 m.

In standard GI mode, the generator chamber of each GI airgun is the primary source, the one responsible for introducing the sound pulse into the ocean, is 105 in^3. The 105 in^3 injector chamber injects air into the previously-generated bubble to reduce bubble reverberations and does not introduce more sound into the water. In GG mode, each gun simultaneously releases an air volume of 105 in^3 + 105 in^3= 210 in^3. On the proposed survey, four GI guns will be operated either in base mode (4x105 in^3) or GG mode (4x210 in^3) as long as compressors are functioning correctly. If compressors are not functioning properly, a backup mode consisting of two GI guns will be used. The text below describes the three preferred modes of operation.

The Base Configuration, Configuration 1, will use 4 GI guns and generate 420 in^3 total volume, as shown in Figure 2 of the IHA Application. Airguns will be towed at 3 m water depth, two on each side of the stern, with 8.6 m lateral (athwartships) separation between the pairs of guns and 2 m front-to-back separation between the guns on each stern tow line.

The GG Configuration, Configuration 2, will use four GI guns and generate 840 in^3 total volume, as shown in Figure 3 of the IHA application. In this configuration, the airguns will be fired in GG mode, as described above. Airguns will be towed at 3 m water depth, two on each side of the stern, with 8.6 m lateral (athwartships) separation between the pairs of airguns and 2 m front-to-back separation between the airguns on each stern tow line. The GG configuration would be used only at greater than 1000 m water depth and on specific exemplary lines on which sonobuoy data are being collected.

The Backup Configuration (Configuration 3) is two GI airguns producing 210 in^3 total volume. If a compressor were offline, this lowest-energy configuration would be used to sustain data acquisition. Airguns will be towed at 3 m water depth of the port towpoint on the stern, with 2 m front-to-back separation between the guns.

As the GI airguns are towed along the survey line, the towed hydrophone array receives the reflected signals and transfers the data to the on-board processing system. Given the short streamer length behind the vessel (1300 m), the turning rate of the vessel while the gear is deployed is much higher than the limit of five degrees per minute for a seismic vessel towing a streamer of more typical length (*e.g.*, 6 km or more). Thus, the maneuverability of the vessel is not strongly limited during operations.

Table 2. GI Airgun Specifications.

Energy Source	Two (backup configuration) to four (base and GG configuration) GI airguns of 105 in^3 each
Tow depth of energy source	3 m
Air discharge volume	Total volume ~210 in^3 (backup configuration, Appendix A) to 840 in^3 (limited use GG

	configuration at greater than 1000 m)
Back-to-front separation of pairs of guns	2 m
Side-to-side separation of pairs of guns	8.6 m
Dominant frequency components	0–188 Hertz
Shot interval	9.72 seconds (2 m airgun separation survey) and 12.15 seconds (8 m airgun separation survey)

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

Sections 3 and 4 of the application summarize available information regarding status and trends, distribution and habitat preferences, and behavior and life history, of the potentially affected species. Additional information regarding population trends and threats may be found in NMFS' Stock Assessment Reports (SAR; *www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region*), and more general information about these species (*e.g.*, physical and behavioral descriptions) may be found on NMFS' website (*www.fisheries.noaa.gov/find-species*).

Table 3 lists all species with expected potential for occurrence in the northwest Atlantic Ocean and summarizes information related to the population or stock, including regulatory status under the MMPA and ESA and potential biological removal (PBR), where known. For taxonomy, we follow Committee on Taxonomy (2016). PBR is 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 (as described in NMFS' SARs). While no mortality is anticipated or authorized here, PBR and annual serious injury and mortality from anthropogenic sources are included here as gross indicators of the status of the species and other threats.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS' stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS' U.S. Atlantic SARs (Hayes *et al*., 2017). All values presented in Table 3 are the most recent available at the time of publication and are available in the draft 2017 SARs (Hayes *et al*., 2017) (available online at: *www.nmfs.noaa.gov/pr/sars/draft.htm*), and Roberts *et. al.* (2016).

Table 3. Marine Mammals that Could Occur in the Project Area.

Common name	Scientific name	Stock	ESA/MMPA status; Strategic (Y/N)[1]	NMFS stock abundance (CV, N_{min}, most recent abundance survey)[2]	Predicted abundance (CV)[5]	PBR	Annual M/SI[3]
Order Cetartiodactyla – Cetacea – Superfamily Mysticeti (baleen whales)							
Family Balaenidae							
North Atlantic right whale	*Eubalaena glacialis*	Western North Atlantic (WNA)	E/D; Y	458 (n/a; 455; n/a)	334(0.25)	1.4	36
Family Balaenopteridae (rorquals)							
Humpback whale	*Megaptera novaeangliae novaeangliae*	Gulf of Maine	-; N	335 (.42; 239; 2012)	1,637(0.07)	3.7	8.5
Minke whale	*Balaenoptera acutorostrata acutorostrata*	Canadian East Coast	-; N	2,591 (0.81; 1,425; 2011)	2,112(0.05)	14	9
Bryde's whale	*B. edeni brydei*	None defined[4]	-; n/a	n/a	7(0.58)	n/a	n/a
Sei whale	*B. borealis borealis*	Nova Scotia	E/D; Y	357 (0.52; 236; 2011)	98(0.25)	0.5	0.8
Fin whale	*B. physalus physalus*	WNA	E/D; Y	1,618 (0.33; 1,234; 2011)	4,633(0.08)	2.5	2.65
Blue whale	*B. musculus musculus*	WNA	E/D; Y	Unknown (n/a; 440; n/a)	11(0.41)	0.9	Unk
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)							
Family Physeteridae							
Sperm whale	*Physeter macrocephalus*	North Atlantic	E/D; Y	2,288 (0.28; 1,815; 2011)	5,353(0.12)	3.6	0.8
Family Kogiidae							
Pygmy sperm whale	*Kogia breviceps*	WNA	-; N	3,785 (0.47; 2,598; 2011)	678(0.23)	21	3.5
Dwarf sperm whale	*K. sima*	WNA	-; N				
Family Ziphiidae (beaked whales)							

Cuvier's beaked whale	*Ziphius cavirostris*	WNA	-; N	6,532 (0.32; 5,021; 2011)	14,491(0.17)	50	0.4
Gervais beaked whale	*Mesoplodon europaeus*	WNA	-; N	7,092 (0.54; 4,632; 2011)		46	0.2
Blainville's beaked whale	*M. densirostris*	WNA	-; N				
Sowerby's beaked whale	*M. bidens*	WNA	-; N				
True's beaked whale	*M. mirus*	WNA	-; N				
Northern bottlenose whale	*Hyperoodon ampullatus*	WNA	-; N	Unknown	90(0.63)	Undet.	0
Family Delphinidae							
Rough-toothed dolphin	*Steno bredanensis*	WNA	-; N	271 (1.0; 134; 2011)	532(0.36)	1.3	0
Common bottlenose dolphin	*Tursiops truncatus truncatus*	WNA Offshore	-; N	77,532 (0.40; 56,053; 2011)	97,476(0.06)	561	39.4
Clymene dolphin	*Stenella clymene*	WNA	-; N	Unknown	12,515(0.56)	Undet.	0
Atlantic spotted dolphin	*S. frontalis*	WNA	-; N	44,715 (0.43; 31,610; 2011)	55,436(0.32)	316	0
Pantropical spotted dolphin	*S. attenuata attenuata*	WNA	-; N	3,333 (0.91; 1,733; 2011)	4,436(0.33)	17	0
Spinner dolphin	*S. longirostris longirostris*	WNA	-; N	Unknown	262(0.93)	Undet.	0
Striped dolphin	*S. coeruleoalba*	WNA	-; N	54,807 (0.3; 42,804; 2011)	75,657(0.21)	428	0
Short-beaked common dolphin	*Delphinus delphis delphis*	WNA	-; N	70,184 (0.28; 55,690; 2011)	86,098(0.12)	557	437
Fraser's dolphin	*Lagenodelphis hosei*	WNA	-; N	Unknown	492(0.76)	Undet.	0
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	WNA	-; N	48,819 (0.61; 30,403; 2011)	37,180(0.07)	304	57
Risso's dolphin	*Grampus griseus*	WNA	-; N	18,250 (0.46; 12,619; 2011)	7,732(0.09)	126	43.2
Melon-headed whale	*Peponocephala electra*	WNA	-; N	Unknown	1,175(0.50)	Undet.	0
Pygmy killer whale	*Feresa attenuata*	WNA	-; N	Unknown	N/A	Undet.	0
False killer whale	*Pseudorca crassidens*	WNA	-; Y	442 (1.06; 212; 2011)	95(0.84)	2.1	Unk
Killer whale	*Orcinus orca*	WNA	-; N	Unknown	11	Undet.	0
Short-finned pilot whale	*Globicephala macrorhynchus*	WNA	-; Y	21,515 (0.37; 15,913; 2011)	18,977(0.11)	159	192
Long-finned pilot whale	*G. melas melas*	WNA	-; Y	5,636 (0.63; 3,464; 2011)		35	38
White-beaked dolphin	*Lagenorhynchus albirostris*	WNA	-; N	2,003 (0.94; 1,023; 2007)	39(0.42)	10	0
Family Phocoenidae (porpoises)							

Harbor porpoise	*Phocoena phocoena phocoena*	Gulf of Maine/Bay of Fundy	-; N	79,833 (0.32; 61,415; 2011)	45,089(0.12)	706	307

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- NMFS marine mammal stock assessment reports online at: www.nmfs.noaa.gov/pr/sars/. CV is coefficient of variation; Nmin is the minimum estimate of stock abundance.
3 - These values, found in NMFS' SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (*e.g*., commercial fisheries, ship strike). Annual M/SI often cannot be determined precisely and is in some cases presented as a minimum value or range. A CV associated with estimated mortality due to commercial fisheries is presented in some cases.
[4]Bryde's whales are occasionally reported off the southeastern U.S. and southern West Indies. NMFS defines and manages a stock of Bryde's whales believed to be resident in the northern Gulf of Mexico, but does not define a separate stock in the Atlantic Ocean.
[5] Predicted mean abundance derived from Roberts *et. al.* (2016)

NOTE - Italicized species are not expected to be taken or proposed for authorization

All species that could potentially occur in the proposed survey areas are included in Table 3. However, density estimates in Roberts *et al.* (2016) present very low density estimates within the proposed action area during the month of August for north Atlantic right whale, harbor porpoise, minke whale, Bryde's whale, blue whale, and white-beaked dolphin (See Table 6 of IHA Application). This, in combination with the short length of the cruise and low level airguns provide reasonable evidence that take authorization is not necessary, nor should they be authorized for these species. Species with expected take are discussed below.

Humpback whale

Humpback whales inhabit all major ocean basins from the equator to subpolar latitudes. They generally follow a predictable migratory pattern in both hemispheres, feeding during the summer in the higher latitudes (40 to 70 degrees latitude) and migrating to lower latitudes (10 to 30 degrees latitude) where calving and breeding take place in the winter (Perry *et al.*, 1999). During the spring, summer, and fall, humpback whales in the North Atlantic Ocean feed over a range that includes the eastern coast of the United States, the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland.

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, and the USGS proposed survey is entirely south of this latitude.
Of the more than 43,000 global sightings of humpback whale individuals or groups dating back more than 50 years in the Ocean Biogeographic Information System (OBIS) database (2017), only 79 occurred within a rectangular block containing the exemplary proposed USGS seismic survey lines. Of these, fourteen sightings occurred during July, August, or September, primarily on the continental shelf between north of Washington Canyon and the mouth of Delaware Bay (See Figure 6 of IHA Application). Three of these sightings have been at or seaward of the shelf break, near the landward ends of the two northernmost exemplary USGS seismic lines.
Humpback whales could be encountered in the proposed project area during an August survey, but this would be an extremely rare occurrence.

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, where the USGS surveys are entirely located.

Of the more than 11,000 sightings of sei whale individuals or groups dating back more than 50 years in the OBIS database, only seven occurred within a rectangular block containing the exemplary proposed USGS seismic survey lines. Of these, only two sightings, comprising three individuals in total, occurred between in July, August, or September (See Figure 6 IHA Application). Sei whales could be encountered in the proposed project area during an August survey, but this would be an extremely rare occurrence.

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, where the USGS surveys are entirely located. Of the more than 68,000 sightings of fin whale individuals or groups dating back more than 50 years in the OBIS database, 131 occurred within a rectangular block containing the exemplary proposed USGS seismic survey lines. Of these, 29 sightings, comprising 60 individuals in total, occurred during July, August, or September (See Figure 6 of IHA Application). Fin whales could be encountered during the proposed August surveys, particularly closer to the shelf edge and near the uppermost continental slope.

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.

The survey slightly intersects with a core abundance area for sperm whales. This area is centered on a large, deepwater valley system that is fed by a complex series of canyons and gullies incising the slope between Hendrickson and Baltimore Canyons (NMFS 2017). In the OBIS database, 686 sperm whale sightings occur within a rectangular area encompassing the survey area, and 395 occurred during July through September. As shown in Figure 6 of the IHA Application, most of these sightings are seaward of the shelf-break in deepwater, overlapping the area of the Proposed Action. Thus, sperm whales are likely to be encountered in the proposed project area during August 2018.

Pygmy/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). Barros *et al*. (1998), on the other hand, suggested that dwarf sperm whales could be more pelagic and dive deeper than pygmy sperm whales. It has also been suggested that the pygmy sperm whale is more temperate and the dwarf sperm whale more tropical, based at least partially on live sightings at sea from a large database from the eastern tropical Pacific (Wade and Gerrodette 1993). This idea is also supported by the distribution of strandings in South American waters (Muñoz-Hincapié *et al.,* 1998).

Only four pygmy sperm whale sightings in the OBIS database occurred within the general area of the survey, and three of these were during the July through September period. Pygmy and dwarf sperm whales would likely 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). It is mostly known from strandings and strands more commonly than any other beaked whale (Heyning 1989). Its inconspicuous blows, deep-diving behavior, and tendency to avoid vessels all help to explain the infrequent sightings (Barlow and Gisiner 2006).

Of the usable records in the OBIS database, 155 sightings of Cuvier's beaked whales overlap with the survey area, and 76 of these were during the July to September period. 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).

Records of Mesoplodont beaked whale observations in the proposed survey area are varied. There are two sightings of Trues beaked whale in the OBIS database which occured in the general survey area, but only one of these was during the summer season that overlaps the Proposed Action. As a result, True's beaked whale would likely be rare in the proposed project area. No OBIS sightings of the Gervais' beaked whale have occurred in the survey area. However, given the geographic and depth range of the species, Gervais' beaked whale could be encountered in the proposed project area.

There are eleven OBIS database sightings of Sowerby's beaked whale in the polygon enclosing the larger area of the proposed surveys, and nine of these were during the summer months. Due to this, Sowerby's beaked whale could be encountered in the proposed project area. In addition, one sighting of Blainsvill occurred in the survey area during the summer months. Blainville's beaked whale could be encountered in the proposed project area.

Northern Bottlenose Whale

Northern bottlenose whales are distributed in the North Atlantic from Nova Scotia to about 70º N in the Davis Strait, along the east coast of Greenland to 77º 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). Of the sightings in the OBIS database, one occurred within the survey area and none during July through September. Nonetheless, northern bottlenose whales could be encountered in the proposed project area.

Rough-toothed dolphin

The rough-toothed dolphin occurs in tropical and subtropical waters, rarely ranging farther north than 40º N (Jefferson *et al.,* 2015). It is considered a pelagic species, but it can also occur in shallow coastal waters (Jefferson *et al.*, 2015). Nine sightings in the OBIS database occur within the survey area, and seven of these were doing the summer. Rough-toothed dolphins could occur in the proposed project area.

Common 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. In the OBIS database, 1873 sightings of bottlenose dolphins occurred within a polygon enclosing the general survey area, and 776 are within the summer months. Common bottlenose dolphins are very likely to be encountered in the proposed project area.

Clymene dolphin

The Clymene dolphin only occurs in tropical and subtropical waters of the Atlantic Ocean (Jefferson *et al.,* 2008). In the western Atlantic, it occurs from New Jersey to Florida, the Caribbean Sea, the Gulf of Mexico, and south to Venezuela and Brazil (Würsig *et al.*, 2000; Fertl *et al.*, 2003). It is generally sighted in deep waters beyond the shelf edge (Fertl *et al.*, 2003). Based on the USGS analyses, 23 sightings of the 140 that are usable in the OBIS database are within the overall rectangular area that encloses the surveys, and 14 of these are during the summer months.

Atlantic spotted dolphin

The Atlantic spotted dolphin is distributed in tropical and warm temperate waters of the North Atlantic from Brazil to New England and to the coast of Africa (Jefferson *et al.*, 2015). There are two forms of Atlantic spotted dolphin – a large, heavily spotted coastal form that is usually found in shelf waters, and a smaller and less-spotted offshore form that occurs in pelagic offshore waters and around oceanic islands (Jefferson *et al.*, 2015). In the OBIS database, 125 sightings are in the general area of the surveys, and 58 were during the summer. Atlantic spotted dolphins would likely 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). Of over 4200 usable sightings in the OBIS database, 48 were in the polygon encompassing the entire survey area, and 29 of these were during the summer months. Pantropical spotted dolphins could be encountered in the proposed project area.

Spinner dolphin

The spinner dolphin is pantropical in distribution, with a range nearly identical to that of the pantropical spotted dolphin, including oceanic tropical and sub-tropical waters between 40º N and 40º S (Jefferson *et al.*, 2008). The distribution of spinner dolphins in the Atlantic is poorly known, but they are thought to occur in deep waters along most of the U.S. coast; sightings off the northeast U.S. coast have occurred exclusively in offshore waters >2000 m (Waring *et al.*, 2010). Within the OBIS database of over 2000 usable sightings, the USGS found that none occurred in the survey area in any season. However, based on the abundance grids from Roberts *et al*. (2016), spinner dolphins could be encountered in the survey area in August 2018. Note that spinner and Clymene dolphins are often considered together in analyses but were separated here due to the availability of density grids for each species.

Striped dolphin

Striped dolphins are found in tropical to warm-temperate waters throughout the world (Carretta *et al.*, 2016a). 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). The striped dolphin is typically found in waters outside the continental shelf and is often associated with convergence zones and areas of upwelling (Archer 2009). However, it has also been observed approaching shore where there is deep water close to the coast (Jefferson *et al.*, 2015). Of over 15600 sightings in the OBIS database, 183 were in the area of the survey, and 95 of these were during the summer. Striped dolphins would likely be encountered in the proposed project area.

Short-beaked common dolphin

The short-beaked common dolphin is distributed in tropical to cool temperate waters of the Atlantic and the Pacific oceans from 60º N to ~50º S (Jefferson *et al.,* 2015). 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). It appears to have a preference for areas with upwelling and steep sea-floor relief (Doksæter *et al.,* 2008; Jefferson *et al.,* 2015). Fewer than 0.1 percent of the nearly 43,000 of short-beaked common dolphins in the OBIS database occur in the general area of the survey, and only three were during the summer months. Short-beaked common dolphins could be encountered in the proposed project area.

Fraser's dolphin

Fraser's dolphin is a deepwater (> 1000 m) species that occurs in subtropical to tropical waters, nominally as far north as 30° N. This species can dive to substantial water depths in search of prey. The dolphins often occur in large groups (100 or more). The OBIS database has fewer than 200 sightings of Fraser dolphins. Only three sightings were within the larger project area, and only two of those were during the summer months. Fraser's dolphins could be encountered within the survey area during the Proposed Action.

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. In the OBIS database, 28 sightings of the Atlantic white-sided dolphin occur in the general area of the survey, and nine of these are during the summer months. Atlantic white-sided dolphins could be encountered in the proposed project area.

Risso's dolphin

Risso's dolphins are found in tropical to warm-temperate waters (Carretta *et al.*, 2016a). 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 60º N and 60º S where surface water temperatures are at least 10ºC (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 were 471 sightings of Risso's dolphins in the general area of the project in the OBIS database, and 238 of these were during the summer. Risso's dolphin is likely to be encountered in the proposed project area during August.

Melon-headed whale

The melon-headed whale is a pantropical species usually occurring between 40º N and 35º S (Jefferson *et al.*, 2008). Occasional occurrences in temperate waters are extralimital, likely associated with warm currents (Perryman *et al.*, 1994; Jefferson *et al.*, 2008). Melon-headed whales are oceanic and occur in offshore areas (Perryman *et al.*, 1994), as well as around oceanic islands. Off the east coast of the United States, sightings have been made of two groups (20 and 80) of melon-headed whales off Cape Hatteras in waters 2500 m deep during vessel surveys in 1999 and 2002 (NMFS 1999, 2002 in Waring *et al.*, 2010). The OBIS database contains more than 300 sightings records for the melon-headed whale, and none of these are within the survey area.

The Roberts *et al*. (2015b) model density grid for the melon-headed whale has only two values for abundance: zero in most of the U.S. EEZ and 0.240833 animals per 100 square kilometers (km^2) in the rest of the modeled area. There are no melon-headed whales in waters shallower than 1000 m in the model in the area of the Proposed Action, meaning that take calculations only capture potential animals in deeper waters. Melon-headed whales may be encountered during the seismic surveys, but they would likely be almost exclusively in deeper water and are more likely near the southern survey transects than the northern ones.

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).

Killer whales are large and conspicuous, often traveling in close-knit matrilineal groups of a few to tens of individuals (Dahlheim and Heyning 1999). Killer whales appear to prefer coastal areas but are also known to occur in deep water (Dahlheim and Heyning 1999). In over 3000 usable killer whale sightings in the OBIS database, only 0.1 percent were within the larger rectangular area enclosing the survey, and none was during the summer months. Killer whales could be encountered within the proposed project area.

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). Of more than 1100 usable sightings recorded in the OBIS database, two occurred within the rectangle enclosing the survey area, and one of those was during the summer months. False killer whales could be encountered in the proposed project area.

Pygmy killer whale

The pygmy killer 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). Pygmy killer whales are usually found in deep water and rarely are found close to shore except where deepwater approaches the shore (Jefferson *et al.,* 2015). Three sightings of pygmy killer whales are found in the OBIS database for the general area of the survey, and all of these occurred during the summer. Pygmy killer whales could occur in the survey area.

Short-finned pilot whale

Short-finned pilot whales are found in all oceans, primarily in tropical and warm-temperate waters (Carretta *et al.,* 2016a). 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). Pilot whales are generally nomadic but may be resident in certain locations (Olson 2009). There is some overlap of range with *G. melas* in temperate waters (Jefferson *et al.,* 2015). Water temperature appears to be the primary factor determining the relative distribution of these two species (Fullard *et al.,* 2000). The short-finned pilot whale inhabits pelagic as well as nearshore waters (Olson 2009). Of over 2500 usable sightings in the OBIS database, 414 were within the rectangular area encompassing the survey lines, and 105 of these were during the summer months. Thus, short-finned pilot whales would likely be encountered in the proposed project area. Note that pilot whales are dealt with as an entire guild by Roberts *et al*. (2015), meaning that there are no specific model density grids applicable to short-finned pilot whales.

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. Despite this range, which would appear to overlap with that of the Proposed Action, over 9000 records in the OBIS database yielded 51 that occurred in the rectangular box enclosing the larger survey area. Sixteen of these occurred during the summer months, mostly on the upper continental slope. The long-finned pilot whale could be encountered in the proposed study area. Note that pilot whales are dealt with as an entire guild by Roberts *et al*. (2015c), meaning that there are no specific model density grids applicable to short-finned pilot whales.

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 decibels (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.

- Pinnipeds in water; Phocidae (true seals): generalized hearing is estimated to occur between approximately 50 Hz to 86 kHz;
- Pinnipeds in water; Otariidae (eared seals): generalized hearing is estimated to occur between 60 Hz and 39 kHz.

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. Twenty nine marine mammal species (all cetaceans) have the reasonable potential to co-occur with the proposed survey activities. Please refer to Table 3. Of the cetacean species that may be present, three are classified as low-frequency cetaceans (*i.e*., all mysticete species), 24 are classified as mid-frequency cetaceans (*i.e*., all delphinid and ziphiid species and the sperm whale), and two are classified as high-frequency cetaceans (*i.e*., Kogia spp.).

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 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). It should be noted that differences in the reference pressure, density, and sound velocity for water and air give the result that dB levels in water are 61.5 dB greater than the same absolute intensity in air.

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.

In addition to airguns, the USGS would continuously use a fisheries echosounder (EK60/EK80) with 38 kHz transducer at water depths less than ~1800 m from the *R/V Hugh R. Sharp*. Due to the lower source level of the EK60/EK80 relative to the *R/V Hugh R. Sharp's* airgun array, the sounds from the EK60/EK80 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 EK60/EK80 would already have been exposed to sounds from the airgun array, which are expected to propagate further in the water. As such, the EK60/EK80 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 EK60/EK80 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 TS 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, l*et al*one 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; 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 kn. The chances of a lethal injury decline from approximately 80 percent at 15 kn to approximately 20 percent at 8.6 kn. At speeds below 11.8 kn, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward one hundred percent above 15 kn.

The *R/V Hugh R. Sharp* would travel at a speed of ~7.4 km/h (4 kn) 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 kn) 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 x 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 (22 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- milimeter (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 ship crews 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 airgun 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 (22 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 be by Level B harassment only, in the form of disruption of behavioral patterns for individual marine mammals resulting from exposure to airguns. Based on the nature of the activity, the cryptic behavior and low density for kogia spp (the only high-frequency cetacean authorized for take) within the action areas, and the anticipated effectiveness of the mitigation measures (*i.e.*, shutdown and a minimum vessel distance of 100 m from large whales – discussed in detail below in the Proposed Mitigation section), Level A harassment is neither anticipated nor proposed to be authorized.

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 proposed take estimate.

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 what the available science indicates 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 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. USGS'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 (Technical Guidance, 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, USGS'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.

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

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

Note: Peak sound pressure (L_{pk}) has a reference value of 1 μPa, and cumulative sound exposure level (L_E) has a reference value of 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 identifying the area ensonified above the acoustic thresholds.

The proposed survey would entail the use of a 4-airgun array with a total maximum discharge of 840 in^3 for operations that occur at water depths greater than 1,000 m and 420 in^3 for operations that occur at water depths of 1,000 m or less with at a tow depth of 3 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's Nucleus Model. 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 *R/V Hugh R. Sharp* airgun array are shown in Table 5.

Table 5. Modeled radial distances [m(km^2)] from R/V Hugh R. Sharp's airgun array to isopleths corresponding to Level B harassment thresholds.

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted RMS Radii (m) 160 dB
Base Configuration (Configuration 1) Four 105 in^3 GI-guns	3	>1000 m	1091m (3.7km^2)[1]
		100–1000 m	1637m(8.42 km^2)[2]
GG Configuration (Configuration 2) Four 210 in^3 GI-guns	3	>1000 m	1244m(4.86km^2)[1]
		100–1000 m	1866m(10.94km^2)[2]

[1] Distance is based on L-DEO model results.
[2] Distance is based on L-DEO model results with a 1.5 x correction factor between deep and intermediate water depths.

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 SELs obtained from LDEO model results down to a maximum water depth of 2,000 m (see Figures 4 and 5 in the IHA application). LDEO's modeling methodology is described in greater detail in the IHA application (USGS, 2018) 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 4), 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 *R/V Hugh R. Sharp* 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 4-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.

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 *R/V Hugh R. Sharp*'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 and a shot interval of 12.15 seconds, potential radial distances to auditory injury zones were calculated for Peak SPL_{flat} and SEL_{cum} thresholds, for both array configurations. Source level Inputs to the User Spreadsheet are shown in Table 6 (inputs to the user spreadsheet also included the source velocity and shot interval listed above). Outputs from the User Spreadsheet in the form of estimated distances to Level A harassment isopleths are shown in Table 7. 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 Appendix C of the IHA application.

Table 6. Modeled Source Levels (dB) for the R/V Hugh R. Sharp's Airgun Array.**

Functional Hearing Group	Configuration 1* 4x105cu^3 SEL_{cum}	Configuration 1* 4x105cu^3 Peak SPL_{flat}	Configuration 2* 4x210cu^3 SEL_{cum}	Configuration 2* 4x210cu^3 Peak SPL_{flat}	Configuration 3* 2x105cu^3 SEL_{cum}	Configuration 3* 2x105cu^3 Peak SPL_{flat}
Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	214	239	215	240	208	235
Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB)	214	N/A	215	N/A	208	234
High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	214	239	215	240	208	235

*All configurations have the following airgun specifications: 3m tow depth; 2m separation in the fore-aft direction; 8.6 m separation in the port (starboard direction).
**Source Levels were rounded to nearest whole number. See Appendix C of IHA Application for exact value.

Table 7. Modeled radial distances [m(m2)] from R/V Hugh R. Sharp's airgun array to isopleths corresponding to Level A harassment thresholds.

Functional Hearing Group	Configuration 1 4x105cu^3 SEL_{cum}	Configuration 1 4x105cu^3 3m tow depth, Peak SPL_{flat}	Configuration 2 4x210cu^3 SEL_{cum}	Configuration 2 4x210cu^3 Peak SPL_{flat}	Configuration 3 2x105cu^3 SEL_{cum}	Configuration 3 2x105cu^3 Peak SPL_{flat}
Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$:	31m(3,019m^2)	10.03m(316m^2)	39.5m(4,902m^2)	11.56m(420m^2)	10.6m(353m^2)	6.52m(134m^2)

183 dB)						
Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB)	0	0	0	0	0	1.58m(8m^2)
High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	0	70.426m(15,582m^2)	0.1(.03m^2)	80.50m(20,358m^2)	0	42.32m(5,627m^2)

Note that because of some of the assumptions included in the methods used, isopleths produced may be overestimates to some degree. 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 Roberts *et al*. (2016) were used. These represent the most comprehensive and recent density data available for cetacean species in the survey area. Roberts *et al*. (2016) retained 21,946 cetacean sightings for analysis, omitted 4,786 sightings, and modeled 25 individual species and 3 multi-species guilds. In order to procure density models for species, Roberts *et al*. (2016) used an approach known as density surface modeling, as seen in DoN (2007) and Roberts *et al*. (2016). This couples traditional distance sampling with multivariate regression modeling to produce density maps predicted from fine-scale environmental covariates (*e.g.*, Becker *et al*., 2014).

In addition to the density information provided by Roberts *et al*. (2016), best available data on average group sizes taken from sightings in the western North Atlantic were also used. This is discussed more in the section below.

Take Calculation and Estimation

Here we describe how the information provided above is brought together to produce a quantitative take estimate. To estimate marine mammal exposures, the USGS used published, quantitative density models by Roberts *et al*. (2016) for the Survey Area, which is entirely within the U.S. EEZ. These models are provided at 10 km x 10 km resolution in ArcGIS compatible IMG grids on the Duke University cetacean density website (*http://seamap.env.duke.edu/models/Duke-EC-GOM-2015*). When available, the cetacean density models for Month 8 (August) were used. Otherwise, the generic annual density model was employed. Only a single density model is provided for the *Kogia* guild (dwarf and sperm pygmy whales), beaked whale guild (Blainville's, Cuvier's, Gervais', Sowerby's, and True's beaked whales), and for pilot whales.

To determine takes, the USGS combined the Duke density grids with Level A and B zones (See Tables 5 and 7) arrayed on either side of each exemplary seismic line and linking/interseismic line. The Level B and Level A takes for each species in each 10 km x 10 km block of the IMG density grids were calculated based on the fractional area of each block intersected by the Level A and Level B zones for LF, MF, and HF cetaceans. Summing takes along all of the lines yields the total take for each species for the Proposed Action for the Base

(Configuration 1) and Optimal (Configuration 2) surveys. The method also yields take for each survey line individually, allowing examination of those exemplary lines that will yield the largest or smallest take. No Level A takes were calculated while using this method.

As indicated earlier, estimated numbers of individuals potentially exposed to sound above the Level B harassment threshold are based on the 160-dB re 1μPa (rms) criterion for all cetaceans. It is assumed that marine mammals exposed to airgun sounds that strong could change their behavior sufficiently to be considered taken by harassment. Table 8 shows the estimates of the number of cetaceans that potentially could be exposed to ≥160 dB re 1 μPa (rms) during the Proposed Action for the Base Survey and the Optimal Survey if no animals moved away from the survey vessel. The proposed takes in Table 8 represents 25 percent more than the number of takes calculated using the ArcGIS-based quantitative method devised by the USGS. This was used as a preventive measure to account for potential additional seismic operations that may occur after repeat coverage of any areas where initial data quality is sub-standard.

Also, as shown in Table 8, rough toothed dolphin, sei whale, and humpback whale calculated takes were increased to account for the average size of one group for each species. Takes for rare species of marine mammals in the action area were also increased to the average size of one group. Rare species that could be encountered and taken during the surveys are not presented in Table 8, but are presented in Table 9. These species were omitted from Table 8 due to their low reported densities in the action area (Roberts *et al*. 2016) resulting in low calculated incidents of potential exposures. As a result, NMFS relied on average group size data to propose the take of a single group of these species as a precautionary measure in case the survey encounters them. This is discussed further below Table 8.

The calculated takes in Table 8 also assume that the proposed surveys would be completed. However, it is unlikely that the entire survey pattern (exemplary lines plus 50 percent of the interseismic, linking lines) would be completed given the limitations on ship time, likely logistical challenges (compressor and GI gun repairs), time spent on transits and refueling, and the historical problems with weather during August in the Northwest Atlantic. The USGS calculated timelines indicate that 25 days, including contingency, could be required to complete the full survey pattern. However, only 22 days or fewer would be scheduled for this USGS survey. The lines that are actually acquired would be dependent on weather, strength of the Gulf Stream (affects ability to tow the streamer in the appropriate geometry), and other considerations.

Table 8. Calculated Incidents of Potential Exposure for Level B and Level A Harassment Based on Density Estimates from Roberts *et al.* (2016) and USGS GIS Take Methodology. As Discussed, Table Omits Rare Species Discussed Below.

Species	Base Survey		Optimal Survey		Max Level A Take for Optimal or Base Surveys +25%	Max Level B Take for Optimal or Base Surveys +25%	Proposed Take (all Level B)[6]	Proposed Take as % of Pop.[1]
	Level A	Level B	Level A	Level B				
LOW FREQUENCY CETACEANS								
Humpback whale	0	0	0	0	0	0	2[5]	<0.1
Sei whale	0	*1*	*0*	*1*	0	1	2[7]	2.04
Fin whale	0	*4*	*0*	*4*	0	5	5	0.1
MID-FREQUENCY CETACEANS								
Sperm whale	*0*	*119*	*0*	*128*	0	*160*	160	2.9
Cuvier's beaked whale	0		0		0			
True's beaked whale	0		0		0			
Gervais beaked whale	0	94[2]	0	103[2]	0	128[2]	128[2]	<0.1
Sowerby's beaked whale	0		0		0			
Blainville's beaked whale	0		0		0			
Rough-toothed dolphin	0	4	0	5	0	8	10[3]	1.9
Common bottlenose dolphin	0	572	0	606	0	757	757	0.8
Pantropical spotted dolphin	0	38	0	40	0	50	50	1.1
Atlantic spotted dolphin	0	1191	0	1278	0	1598	1598	2.9
Striped dolphin	0	1086	0	1167	0	1458	1458	1.9
Short-beaked common dolphin	0	1253	0	1296	0	1620	1620	1.9
Risso's dolphin	0	181	0	189	0	236	236	3

Long-finned pilot whale	0	215[4]	0	231[4]	0	288[4]	288[4]	1.5
Short-finned pilot whale					0			
Clymene’s dolphin	0	91	0	97	0	121	121	1
HIGH-FREQUENCY CETACEANS								
Pygmy/dwarf sperm whale	0	6	0	7	0	9	9	0.2

[1]Based on mean abundance estimates from Roberts *et al.* (2016)

[2] Values for density, proposed take number, and percentage of population proposed for authorization are for all beaked whales combined.

[3]Based on one average group size for rough toothed dolphin (Jefferson 2015).

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

[5] Based on one average group size for humpback whales (Waring 2008). Very small take requested because these species are very abundant, but the calculated take is zero based on the Duke density maps, which cannot capture all of the complexity in species distribution. Summer seasonal sightings compiled from the OBIS database (See Figure 6 of IHA Application) show that humpback whales have been seen in the northern part of the Proposed Action area during August.

[6] Values are the same proposed take numbers shown in Table 9 below. Table 9 includes proposed take of rare species discussed below.

[7] Based on one average group size for sei whale in the western Atlantic (NMFS 2017).

Certain species potentially present in the proposed survey areas are expected to be encountered only extremely rarely, if at all. Although Roberts *et al*. (2016) provide density models for these species (with the exception of the pygmy killer whale), due to the small numbers of sightings that underlie these models’ predictions we believe it appropriate to account for the small likelihood that these species would be encountered by assuming that one group of each of these species might be encountered once by a given survey. With the exception of the northern bottlenose whale, none of these species should be considered cryptic (*i.e.*, difficult to observe when present) versus rare (*i.e.*, not likely to be present). Average group size was determined by considering known sightings in the western North Atlantic (CETAP, 1982; Hansen *et al*, 1994; NMFS, 2010a, 2011, 2012, 2013a, 2014, 2015a; Waring *et al*., 2007, 2015). It is important to note that our proposal to authorize take equating to harassment of one group of each of these species is not equivalent to expected exposure. We do not expect that these rarely occurring (in the proposed survey area) species will be exposed at all but provide a precautionary authorization of take. We provide a brief description for each of these species below.

Northern Bottlenose Whale – Northern bottlenose whales are considered extremely rare in U.S. Atlantic waters, with only five NMFS sightings. The southern extent of distribution is generally considered to be approximately Nova Scotia (though Mitchell and Kozicki (1975) reported stranding records as far south as Rhode Island), and there have been no sightings within the proposed survey areas. Whitehead and Wimmer (2005) estimated the size of the population on the Scotian Shelf at 163 whales (95 percent CI 119-214). Whitehead and Hooker (2012) report that northern bottlenose whales are found north of approximately 37.5° N and prefer deep waters along the continental slope. Roberts *et al*. (2016) produced a stratified density model on the basis of four sightings in the vicinity of Georges Bank (Roberts *et al*., 2015b). The five sightings in U.S. waters yield a mean group size of 2.2 whales, while MacLeod and D'Amico report a mean group size of 3.6. Here, we propose take of one group of with a maximum group size of four whales.

Killer Whale – Killer whales are also considered rare in U.S. Atlantic waters (Katona *et al*., 1988; Forney and Wade, 2006), constituting 0.1 percent of marine mammal sightings in the 1978-81 Cetacean and Turtle Assessment Program surveys (CETAP, 1982). Roberts *et al*. (2016) produced a stratified density model on the basis of four killer whale sightings (Roberts *et al*., 2015g), though Lawson and Stevens (2014) provide a minimum abundance estimate of 67 photo-identified individual killer whales. Available information suggests that survey encounters with killer whales would be unlikely but could occur anywhere within the proposed survey area and at any time of year (*e.g.*, Lawson and Stevens, 2014). Silber *et al*. (1994) reported observations of two and 15 killer whales in the Gulf of California (mean group size 8.5), while May-Collado *et al*. (2005) described mean group size of 3.6 whales off the Pacific coast of Costa Rica. Based on 12 CETAP sightings and one group observed during NOAA surveys (CETAP, 1982; NMFS, 2014), the average group size in the Atlantic is 6.8 whales. Therefore, we propose take of one group with a maximum group size of seven whales.

False Killer Whale – Although records of false killer whales from the U.S. Atlantic are uncommon, a combination of sighting, stranding, and bycatch records indicates that this species does occur in the western North Atlantic (Waring *et al*., 2015). Baird (2009) suggests that false killer whales may be naturally uncommon throughout their range. Roberts *et al*. (2016) produced a stratified density model on the basis of two false killer whale sightings (Roberts *et al*., 2015m), and NMFS produced the first abundance estimate for false killer whales on the basis of one sighting during 2011 shipboard surveys (Waring *et al*., 2015). Similar to the killer whale, we believe survey encounters would be unlikely but could occur anywhere within the proposed survey area and at any time of year. Mullin *et al*. (2004) reported a mean false killer whale group size of 27.5 from the Gulf of Mexico, and May-Collado *et al*. (2005) described mean group size of 36.2 whales off the Pacific coast of Costa Rica. The few sightings from CETAP (1982) and from NOAA shipboard surveys give an average group size of 10.3 whales. As a precaution, we propose take of one group with a maximum group size of 28 whales, as reported from the Gulf of Mexico.

Pygmy Killer Whale – The pygmy killer whale is distributed worldwide in tropical to sub-tropical waters, and is assumed to be part of the cetacean fauna of the tropical western North Atlantic (Jefferson *et al*., 1994; Waring *et al*., 2007). Pygmy killer whales are rarely observed by NOAA surveys outside the Gulf of Mexico—one group was observed off of Cape Hatteras in 1992—and the rarity of such sightings may be due to a naturally low number of groups compared to other cetacean species (Waring *et al*., 2007). NMFS has never produced an abundance estimate for this species and Roberts *et al*. (2016) were not able to produce a density model for the species. The 1992 sighting was of six whales; therefore, we propose take of one group with a maximum group size of six whales.

Melon-headed Whale – Similar to the pygmy killer whale, the melon-headed whale is distributed worldwide in tropical to sub-tropical waters, and is assumed to be part of the cetacean fauna of the tropical western North Atlantic (Jefferson *et al.*, 1994; Waring *et al*., 2007). Melon-headed whales are rarely observed by NOAA surveys outside the Gulf of Mexico—groups were observed off of Cape Hatteras in 1999 and 2002—and the rarity of such sightings may be due to a naturally low number of groups compared to other cetacean species (Waring *et al*., 2007). NMFS has never produced an abundance estimate for this species and Roberts *et al*. (2016) produced a stratified density model on the basis of four sightings (Roberts *et al*., 2015d). The two sightings reported by Waring *et al*. (2007) yield an average group size of 50 whales; therefore, we propose take of a single group of a maximum of 50 whales.

Spinner Dolphin – Distribution of spinner dolphins in the Atlantic is poorly known, but they are thought to occur in deep water along most of the U.S. coast south to the West Indies and Venezuela (Waring *et al*., 2014). There have been a handful of sightings in deeper waters off the northeast United States and one sighting during a 2011 NOAA shipboard survey off North Carolina, as well as stranding records from North Carolina south to Florida and Puerto Rico (Waring *et al*., 2014). Roberts *et al*. (2016) provide a stratified density model on the basis of two sightings (Roberts *et al*., 2015i). Regarding group size, Mullin *et al*. (2004) report a mean of 91.3 in the Gulf of Mexico; May-Collado (2005) describe a mean of 100.6 off the Pacific coast of Costa Rica; and CETAP (1982) sightings in the Atlantic yield a mean group size of 42.5 dolphins. As a precaution, we will propose taking a single group with a maximum size of 91 dolphins (derived from mean group size reported in Mullin *et al*. 2004).

Fraser's Dolphin – As was stated for both the pygmy killer whale and melon-headed whale, the Fraser's dolphin is distributed worldwide in tropical waters, and is assumed to be part of the cetacean fauna of the tropical western North Atlantic (Perrin *et al*., 1994; Waring *et al*., 2007). The paucity of sightings of this species may be due to naturally low abundance compared to other cetacean species (Waring *et al*., 2007). Despite possibly being more common in the Gulf of Mexico than in other parts of its range (Dolar 2009), there were only five reported sightings during NOAA surveys from 1992-2009. In the Atlantic, NOAA surveys have yielded only two sightings (Roberts *et al*., 2015f). May-Collado *et al*. (2005) reported a single observation of 158 Fraser's dolphins off the Pacific coast of Costa Rica, and Waring *et al*. (2007) describe a single observation of 250 Fraser's dolphins in the Atlantic, off Cape Hatteras. Therefore, we propose take of a single group with a maximum group size of 204 dolphins (derived from average of May-Collado *et al*. 2005 and Waring *et al*. 2007 sightings data).

Atlantic White-sided Dolphin – White-sided dolphins are found in temperate and sub-polar continental shelf waters of the North Atlantic, primarily in the Gulf of Maine and north into Canadian waters (Waring *et al*., 2016). Palka *et al*. (1997) suggest the existence of stocks in the Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea. Stranding records from Virginia and North Carolina suggest a southerly winter range extent of approximately 35° N (Waring *et al*., 2016); therefore, it is possible that the proposed surveys could encounter white-sided dolphins. Roberts *et al*. (2016) elected to split their study area at the north wall of the Gulf Stream, separating the cold northern waters, representing probable habitat, from warm southern waters, where white-sided dolphins are likely not present (Roberts *et al*., 2015k). Over 600 observations of Atlantic white-sided dolphins during CETAP (1982) and during NMFS surveys provide a mean group size estimate of 47.7 dolphins, while Weinrich *et al*. (2001) reported a mean group size of 52 dolphins. Due to this data, we propose take of a single group with a maximum group size of 48 dolphins.

Table 9. Numbers of Incidental Take Proposed for Authorization.

Species	Proposed Level B take **	Proposed Level A take
Humpback whale	2	0
Sei whale	2	0
Fin whale	5	0
Sperm whale	160	0
Kogia spp.	9	0
Beaked whales	128	0
Northern bottlenose whale*	4*	0
Rough-toothed dolphin	10	0
Common bottlenose dolphin	757	0
Clymene dolphin	121	0
Atlantic spotted dolphin	1598	0
Pantropical spotted dolphin	50	0
Spinner dolphin*	91*	0
Striped dolphin	1458	0
Short-beaked common dolphin	1620	0
Fraser’s dolphin*	204*	0
Atlantic white-sided dolphin*	48*	0
Risso’s dolphin	236	0
Melon-headed whale*	50*	0
Pygmy killer whale*	6*	0
False killer whale*	28*	0
Killer whale*	7*	0
Pilot whales	288	0

*Proposed Level B take for rare species represent take of a single group. The value given for the proposed Level B take is the maximum group size allowed for take.
** Proposed take numbers for non-rare species are the same as those reported 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.

USGS 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, USGS 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 USGS, NMFS has proposed the following mitigation measure: Establishment of a marine mammal buffer zone.

Protected Species Observer (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 *R/V Hugh R. Sharp* 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 Exclusion Zone (EZ) (as described below).

During seismic operations, three visual PSOs would be based aboard the *R/V Hugh R. Sharp*. PSOs would be appointed by USGS with NMFS approval. During the majority of seismic operations, two PSOs would monitor for marine mammals around the seismic vessel. PSO(s) would be on duty in shifts of duration no longer than four 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 *R/V Hugh R. Sharp* is a suitable platform from which PSOs would watch for marine mammals. Standard equipment for marine mammal observers would be 7 x 50 reticle binoculars, optical range finders, and Big Eye binoculars. 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 USGS scientist-in-charge or his/her designee. 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 from 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 (Level A thresholds) 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. As a result no Level A harassment is expected nor proposed for this action.

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 an additional 100 m buffer zone beginning from the outside extant of the 100 m EZ. During use of the acoustic source, occurrence of marine mammals within the 100 m buffer zone would be communicated to the USGS scientist-in-charge or his/her designee to prepare for potential shutdown of the acoustic source. The 100 m 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;
- 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 and dwarf sperm, beaked whales, and large delphinids.

This shutdown requirement would be in place for all marine mammals, with the exception of small delphinoids under certain circumstances. 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. 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). 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 of small dolphins 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 *R/V Hugh R. Sharp* 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 impacts. In addition, the required shutdown measure may prevent more severe behavioral reactions for any large delphnoids in close proximity to the source vessel.

Shutdown of the acoustic source would also be required upon observation beyond the 100 m EZ of any of the following:

- A large whale (*i.e.*, sperm whale or any baleen whale) with a calf;
- 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.); or
- A marine mammal species not authorized (*i.e*. a north Atlantic right whale) for take that is approaching or entering the Level B zone.
- An authorized marine mammal species that has reached its total allotted Level B take that is approaching or entering the Level B zone.

These would be the only four 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 to the full array would take 20 minutes, starting with operation of a single airgun and with one additional airgun added every 5 minutes.

At least two PSOs would be required to monitor during ramp-up. During ramp up, the PSOs would monitor the 100 m EZ, and if marine mammals were observed within or approaching the 100 m EZ, 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 or 100 m buffer zone during this pre-clearance period, ramp-up would not be initiated until all marine mammals cleared the 100 m EZ or 100 m buffer zone. 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 100 m 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 100 m buffer zone have been monitored by visual PSOs for 30 minutes prior to ramp-up.

The USGS scientist-in-charge or his/her designee 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 USGS scientist-in-charge or his/her designee must receive confirmation from the PSO to proceed. The USGS scientist-in-charge or his/her designee must provide information to PSOs documenting that appropriate procedures were followed. Following deactivation of the array for reasons other than mitigation, the USGS scientist-in-charge or his/her designee 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: The USGS scientist-in-charge or his/her designee, the vessel operator (The University of Delaware) 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 kn or less when mother/calf pairs, pods, or large assemblages of cetaceans (what constitues "large" will vary depending on species) are observed within 500 m of the vessel. Mariners may use professional judgment as to when such circumstances warranting additional caution are present.

Actions to Minimize Additional Harm to Live-Stranded (or Milling) Marine Mammals

In the event of a live stranding (or near-shore atypical milling) event within 50 km of the survey operations, where the NMFS stranding network is engaged in herding or other interventions to return animals to the water, the Director of OPR, NMFS (or designee) will advise the IHA-holder of the need to implement shutdown procedures for all active acoustic sources operating within 50 km of the stranding. Shutdown procedures for live stranding or milling marine mammals include the following:

- If at any time, the marine mammal(s) die or are euthanized, or if herding/intervention efforts are stopped, the Director of OPR, NMFS (or designee) will advise the IHA-holder that the shutdown is no longer needed.
- Otherwise, shutdown procedures will remain in effect until the Director of OPR, NMFS (or designee) determines and advises the IHA-holder that all live animals involved have left the area (either of their own volition or following an intervention).
- If further observations of the marine mammals indicate the potential for re-stranding, additional coordination with the IHA-holder will be required to determine what measures are necessary to minimize that likelihood (*e.g.*, extending the shutdown or moving operations farther away) and to implement those measures as appropriate.

Shutdown procedures are not related to the investigation of the cause of the stranding and their implementation is not intended to imply that the specified activity is the cause of the stranding. Rather, shutdown procedures are intended to protect marine mammals exhibiting indicators of distress by minimizing their exposure to possible additional stressors, regardless of the factors that contributed to the stranding.

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.

USGS 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.

USGS'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 *R/V Hugh R. Sharp*. PSOs would be appointed by USGS 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 four 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, Big Eye binoculars, 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 Injured or Dead Marine Mammals

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

- Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);
- Species identification (if known) or description of the animal(s) involved;
- Condition of the animal(s) (including carcass condition if the animal is dead);
- Observed behaviors of the animal(s), if alive;
- If available, photographs or video footage of the animal(s); and
- General circumstances under which the animal was discovered.

Vessel Strike – In the event of a ship strike of a marine mammal by any vessel involved in the activities covered by the authorization, the IHA-holder shall report the incident to OPR, NMFS and to regional stranding coordinators as soon as feasible. The report must include the following information:

- Time, date, and location (latitude/longitude) of the incident;
- Species identification (if known) or description of the animal(s) involved;

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

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

- Status of all sound source use in the 48 hours preceding the estimated time of stranding and within 50 km of the discovery/notification of the stranding by NMFS; and
- If available, description of the behavior of any marine mammal(s) observed preceding (*i.e.*, within 48 hours and 50 km) and immediately after the discovery of the stranding.

Examples of circumstances that could trigger the additional information request include, but are not limited to, the following:

- Atypical nearshore milling events of live cetaceans;
- Mass strandings of cetaceans (two or more individuals, not including cow/calf pairs);
- Beaked whale strandings;
- Necropsies with findings of pathologies that are unusual for the species or area; or
- Stranded animals with findings consistent with blast trauma.

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

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' 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).

NMFS does not anticipate that serious injury or mortality would occur as a result of USGS'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.

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 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 during the time of the survey (Ferguson *et al.*, 2015). Also, as stated, the survey slightly intersects with a core abundance area for sperm whales. However, due to the low energy-source of the airguns for the action and the proposed mitigation measures listed above, NMFS does not exclude USGS from this area during its survey, nor does it foresee the survey having effects, greater than negligible impact, on the core abundance area.

As described previously, there are multiple species that should be considered rare in the proposed survey areas and for which we propose to authorize only nominal and precautionary take of a single group. We do not expect meaningful impacts to these species (*i.e.,* killer whale, false killer whale, pygmy killer whale, melon-headed whale, northern bottlenose whale, spinner dolphin, Fraser's dolphin, Atlantic white-sided dolphin) because wepreliminarily find that the total marine mammal take from each of the specified activities will have a negligible impact on these marine mammal species. Therefore, we do not discuss these eight species further in this negligible impact analysis.

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 (22 days with 19 days of airgun operations) 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 all Level A harassment and most Level B harassment.

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, 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 8), relative to their population sizes (again, when compared to mean abundance estimates, 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 USGS'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 USGS'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 injury (Level A take), serious injury or 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 (22 days with 19 days of airgun operations) would further limit the potential impacts of any temporary behavioral changes that would occur;

- 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.

Please see Tables 8 and 9 and the related text for information relating to the basis for our small numbers analyses. Table 8 provides the numbers of predicted exposures above specified received levels, while Table 9 provides numbers of take proposed for authorization. For the northern bottlenose whale, Fraser's dolphin, melon-headed whale, false killer whale, pygmy killer whale, killer whale, spinner dolphin, and white-sided dolphin, we propose to authorize take resulting from a single exposure of one group of each species or stock, as appropriate (using average group size), for each applicant. As stated earlier, we believe that a single incident of take of one group of any of these species represents take of small numbers for that species. Therefore, based on the analyses contained herein of the specified activity, we preliminarily find that small numbers of marine mammals will be taken for each of these eight affected species or stocks for the specified activity. We do not discuss these eight species further in this small numbers analysis.

As shown in Table 8, we used mean abundance estimates from Roberts (2016) to calculate the percentage of population that is estimated to be taken during the proposed activities for non-rare species. These data present the best available abundance estimates for cetacean populations off of the Western Atlantic for this proposed activity. The activity is expected to impact a very small percentage of all marine mammal populations. As presented in Table 8, take of all 21 marine mammal species authorized for take is less than three percent of the abundance estimate.

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

NMFS is proposing to authorize take of three species of marine mammals which are listed under the ESA: the sei whale, fin whale, and sperm whale. The Permits and Conservation Division has requested initiation of Section 7 consultation with the ESA Interagency Cooperation Division for the issuance of this IHA. NMFS will conclude the ESA consultation prior to reaching a determination regarding the proposed issuance of the authorization.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to USGS for conducting a marine geophysical survey in the Northwest Atlantic Ocean in August 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 USGS IHA application and using an airgun array aboard the *R/V Hugh R. Sharp* 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 USGS, the vessel operator (The University of Delaware) and other relevant personnel, the lead PSO, and any other relevant designees of USGS operating under the authority of this IHA.

(b) The species authorized for taking are listed in Table 9. The taking, by Level B harassment only, is limited to the species and numbers listed in Table 9. Any taking exceeding the authorized amounts listed in Table 9 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 9 are detected by PSOs, the acoustic source must be shut down to avoid unauthorized take.

(e) The USGS scientist-in-charge or his/her designee 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) USGS 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 USGS scientist-in-charge or his/her designee.

(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), at least 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 (except during transits across the shelf where no seismic activity will occur during the survey) 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 an additional 100 m buffer zone beginning from the outside extant of the 100 m EZ. 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 100 m buffer zone from any element of the airgun array shall be communicated to the USGS scientist-in-charge or his/her designee to prepare for potential further mitigation measures as described below. During use of the acoustic source, occurrence of marine mammals within 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 shall begin with starting one 105 in^3 airgun with additional 105 in^3airguns being turned on every 5 minutes until all four airguns are in operation.

(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 and dwarf sperm, beaked whales, and large delphinids).

(iii) Thirty minutes of pre-clearance observation of the 100 m EZ and 100 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 100 m 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 100 m 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 mysticetes and large odontocetes including sperm, pygmy and dwarf sperm, beaked whales, and large delphinids).

(iv) During ramp-up, at least two PSOs shall conduct monitoring. Ramp-up may not be initiated if any marine mammal (including delphinids) is observed within or approaching the 100 m EZ or 100 m buffer zone. 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 in the 100 m EZ (*i.e.*, 15 minutes for small odontocetes and 30 minutes for mysticetes and large odontocetes including sperm, pygmy and dwarf sperm, beaked whales, and large delphinids).

(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 100 m EZ or 100 m 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 100 m buffer zone have been continually monitored by visual PSOs for 30 minutes prior to ramp-up with no marine mammal detections.

(vii) The USGS scientist-in-charge or his/her designee 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 USGS scientist-in-charge or his/her designee must receive confirmation from the PSO to proceed.

(e) Shutdown requirements – A 100 m EZ 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 USGS scientist-in-charge or his/her designee 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 these 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.

(viii) Shutdown of the array is required upon observations of a marine mammal species not authorized (*i.e*. a north Atlantic right whale) for take that is entering or approaching the vessel's respective Level B zone (See Table 5).

(ix) Shutdown of the array is required upon observations of an authorized marine mammal species that has reached its total allotted Level B take that is entering or approaching the vessel's respective Level B zone (See Table 5).

(f) Vessel Strike Avoidance – The USGS, PSOs, vessel operator, and crew must maintain a vigilant watch for all marine mammals and the vessel operator must 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 or large assemblages of cetaceans (what constitues "large" will vary depending on species) are observed within 500 m of the vessel. Mariners may use professional judgment as to when such circumstances warranting additional caution are present.

(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 840 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 USGS scientist-in-charge or his/her designee 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.*, 7 x 50) of appropriate quality (*i.e.*, Fujinon or equivalent), Big Eye binoculars, 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.); and

(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) USGS 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, USGS shall immediately cease the specified activities and immediately report the incident to the NMFS Office of Protected Resources and to regional stranding coordinators as soon as feasible. 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) Vessel's course/heading and what operations were being conducted (if

(D) applicable);

(E) Status of all sound sources in use;

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

(G) Description of the incident;

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

(I) Water depth;

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

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

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

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

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

(ii) Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with USGS to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. USGS may not resume their activities until notified by NMFS.

(iii) In the event that USGS 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), USGS 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 USGS to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iv) In the event that USGS 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), USGS shall report the incident to the NMFS Office of Protected Resources within 24 hours of the discovery. USGS 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 [action]. 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.

Dated: May 24, 2018.

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Donna S. Wieting,

Director, Office of Protected Resources,

National Marine Fisheries Service.

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