BILLING CODE 3510-22-P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648-XG144

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

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

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

SUMMARY: NMFS has received a request from the Lamont-Doherty Earth Observatory of Columbia University (L-DEO) for authorization to take marine mammals incidental to a marine geophysical survey in the North Pacific Ocean. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an incidental harassment authorization (IHA) to incidentally take marine mammals during the specified activities. NMFS will consider public comments prior to making any final decision on the issuance of the requested MMPA authorization and agency responses will be summarized in the final notice of our decision.

DATES: Comments and information must be received no later than **[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.Pauline@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 *https://www.fisheries.noaa.gov/node/23111* 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: Rob Pauline, 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/node/23111*. 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 plans to adopt the National Science Foundation's EA, provided our independent evaluation of the document finds that it includes adequate information analyzing the effects on the human environment of issuing the 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 16, 2018, NMFS received a request from the L-DEO for an IHA to take marine mammals incidental to conducting a marine geophysical survey in the North Pacific Ocean. L-DEO submitted a revised application on June 11, 2018. On June 13, 2018 we deemed L-DEO's application for authorization to be adequate and complete. L-DEO's request is for take of small numbers of 39 species of marine mammals by Level A and Level B harassment. Underwater sound associated with airgun use may result in the behavioral harassment or auditory injury of marine mammals in the ensonified areas. Mortality is not an anticipated outcome of airgun surveys such as this, 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 specified activity consists of two high-energy seismic surveys conducted at different locations in the North Pacific Ocean. Researchers from Lamont-Doherty Earth Observatory (L-DEO) and University of Hawaii, with funding from the U.S. National Science Foundation (NSF), in collaboration with researchers from United States Geological Survey (USGS), Oxford University, and GEOMAR Helmholtz Centre for Ocean Research Kiel (GEOMAR), propose to conduct the surveys from the Research Vessel (R/V) *Marcus G. Langseth* (*Langseth*) in the North Pacific Ocean. The NSF-owned *Langseth* is operated by Columbia University's L-DEO under an existing Cooperative Agreement. The first proposed seismic survey would occur in the vicinity of the Main Hawaiian Islands, and a subsequent survey would take place at the Emperor Seamounts in 2019. The proposed timing for the Hawaii survey is summer/early fall 2018; the timing for the Emperor Seamounts survey would likely be spring/early summer 2019. Both surveys would use a 36-airgun towed array with a total discharge volume of ~6,600 in^3.

The main goal of the surveys proposed by L-DEO and the University of Hawaii is to gain fundamental insight into the formation and evaluation of Hawaiian-Emperor Seamount chain, and inform a more comprehensive assessment of geohazards for the Hawaiian Islands region.

Dates and Duration

The Hawaii survey would be expected to last for 36 days, including ~19 days of seismic operations, 11 days of equipment deployment/retrieval, ~3 days of operational contingency time (*e.g.*, weather delays, etc.), and ~3 days of transit. The *Langseth* would leave out of and return to port in Honolulu during summer (likely mid-August) 2018. The Emperor Seamounts survey would be expected to last 42 days, including ~13 days of seismic operations, ~11 days of equipment deployment/retrieval, ~5.5 days of operational contingency time, and 12.5 days of transit. The *Langseth* would leave Honolulu and return to port likely in Adak or Dutch Harbor, Alaska. The dates for this cruise have not yet been determined, although late spring/early summer 2019 is most likely.

Specific Geographic Region

The specified activity consists of two seismic surveys in the North Pacific Ocean—one at the Main Hawaiian Islands (Fig. 1 in application) and the other at the Emperor Seamounts (Fig. 2 in application). The proposed Hawaii survey would occur within ~18–24° N, ~153–160° W, and the proposed Emperor Seamounts survey would occur within ~43–48° N, ~166–173° E.

The Hawaiian–Emperor Seamount chain is a mostly undersea mountain range in the Pacific Ocean that reaches above sea level in Hawaii. It is composed of the Hawaiian ridge, consisting of the islands of the Hawaiian chain northwest to Kure Atoll, and the Emperor Seamounts: together they form a vast underwater mountain region of islands and intervening seamounts, atolls, shallows, banks and reefs along a line trending southeast to northwest beneath the northern Pacific Ocean. The seamount chain, containing over 80 identified undersea volcanoes, stretches over 5,800 kilometers (km) or 3,600 miles (mi) from the Aleutian Trench in the far northwest Pacific to the Lo‘ihi seamount, the youngest volcano in the chain, which lies about 35 km (22 mi) southeast of the Island of Hawaii. The Emperor Seamounts seismic survey location is located approximately 4,100 km (2,200 mi) northwest of the Hawaii seismic survey location.

Representative survey tracklines are shown in Figures 1 and 2 in the application. As described further in this document, however, some deviation in actual track lines, including order of survey operations, could be necessary for reasons such as science drivers, poor data quality, inclement weather, or mechanical issues with the research vessel and/or equipment. Thus, for the Emperor Seamounts survey, the tracklines could occur anywhere within the coordinates noted above and illustrated by the box in the inset map on Figure 2. The tracklines for the Hawaii survey could shift slightly, but would stay within the coordinates noted above and general vicinity of representative lines depicted in Figure 1. Water depths in the proposed Hawaii survey area range from ~700 to more than 5,000 m. The water depths in the Emperor Seamounts survey area range from 1,500–6,000 m. The proposed Hawaii seismic survey would be conducted within the U.S. exclusive economic zone (EEZ); the Emperor Seamounts survey would take place in International Waters.

Detailed Description of Specific Activity

The procedures to be used for the proposed surveys would be similar to those used during previous seismic surveys by L-DEO and would use conventional seismic methodology. The surveys would involve one source vessel, the *Langseth*, which is owned by NSF and operated on its behalf by Columbia University's L-DEO. The *Langseth* would deploy an array of 36 airguns as an energy source with a total volume of ~6,600 in^3. The receiving system would consist of OBSs and a single hydrophone streamer 15 km in length and OBSs. As the airgun arrays are towed along the survey lines, the hydrophone streamer would transfer the data to the on-board processing system, and the OBSs would receive and store the returning acoustic signals internally for later analysis.

The proposed study consists of two seismic surveys in the North Pacific Ocean. There would be a total of four seismic transects for the Hawaii survey – two North (N)-South (S) tracklines (Lines 1 and 2), and two East (E)-West (W) tracklines (Lines 3 and 4). An optional trackline (Line 5) could be acquired instead of Line 4 (Fig. 1). Lines 1 and 2 would be acquired twice – seismic refraction data would be acquired first, followed by multichannel seismic (MCS) reflection data. Only MCS reflection profiling would occur along Lines 3, 4, or 5. The location of the E-W tracklines (Lines 3, 4, or 5) could shift from what is currently depicted in Figure 1 depending on the science objectives; however, the E-W lines would remain in water >3,200 m deep.

The *Langseth* would first deploy 70 ocean bottom seismometers (OBS)s required for the refraction profiling – the vessel would transit from Honolulu to the north end of Line 2, deploy 35 OBSs along Line 2, ~15 km apart, and then transit to the south end of Line 1 to deploy 35 OBSs (~15 km apart) along Line 1. The streamer and airgun array would then be deployed. Refraction data would then be acquired from north to south on Line 1 followed by MCS profiling along the same line. If Lines 3 and 4 are to be surveyed (preferred option), MCS profiles would then be acquired along Line 3, followed by refraction data acquisition in a north-south direction along Line 2, followed by MCS profiles along Line 2 from south to north. The vessel would then acquire MCS profiles from the north end of Line 2 to the west end of Line 4, and along Line 4. After seismic acquisition ceases, the streamer, airgun source, and all OBSs would be recovered by the *Langseth*.

There would be three seismic transects for the Emperor Seamounts survey (Fig. 2). Data would be acquired twice along the two OBS lines – once for seismic refraction data and once for MCS reflection profiling. Only MCS reflection profiling would occur along the third transect that connects the two OBS lines. The *Langseth* would first acquire MCS reflection data for all three lines – from north to south, then along the connecting transect, and from west to east. After recovering the streamer and airgun array, the *Langseth* would deploy 32 OBSs required for the refraction profiling from east to west along the first line. After seismic acquisition along the first OBS line from west to east, the OBSs would be recovered and re-deployed along the second OBS line, which would then be surveyed from north to south. The *Langseth* would then recover all OBSs, the streamer, and the airgun array.

In addition to the operations of the airgun array, a multibeam echosounder (MBES), a sub-bottom profiler (SBP), and an Acoustic Doppler Current Profiler (ADCP) would be operated from the *Langseth* continuously during the seismic surveys, but not during transit to and from the survey areas. All planned geophysical data acquisition activities would be conducted by L-DEO with on-board assistance by the scientists who have proposed the studies. The vessel would be self-contained, and the crew would live aboard the vessel.

During the two surveys, the *Langseth* would tow the full array, consisting of four strings with 36 airguns (plus 4 spares) and a total volume of ~6,600 in^3. The 4-string array would be towed at a depth of 12 m, and the shot intervals would range from 50 m for MCS acquisition and 150 m for OBS acquisition. To retrieve OBSs, an acoustic release transponder (pinger) is used to interrogate the instrument at a frequency of 8–11 kHz, and a response is received at a frequency of 11.5–13 kHz. The burn-wire release assembly is then activated, and the instrument is released to float to the surface from the anchor which is not retrieved.

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 the Specified Activity

Section 4 of the IHA application summarizes available information regarding status and trends, distribution and habitat preferences, and behavior and life history of the potentially affected species. More general information about these species (*e.g.*, physical and behavioral descriptions) may be found on NMFS’ website (*https://www.fisheries.noaa.gov/find-species*). Table 1 lists all species with expected potential for occurrence in the North Pacific Ocean and summarizes information related to the population, including regulatory status under the MMPA and ESA. Some of the populations of marine mammals considered in this document occur within the U.S. EEZ and are therefore assigned to stocks and are assessed in NMFS’ Stock Assessment Reports (*www.nmfs.noaa.gov/pr/sars/*). As such, information on potential biological removal (PBR; defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population) and on annual levels of serious injury and mortality from anthropogenic sources are not available for these marine mammal populations.

Twenty-eight cetacean species, including 21 odontocetes (dolphins and small- and large-toothed whales) and seven mysticetes (baleen whales), and one pinniped species, could occur in the proposed Hawaii survey area (Table 4). In the Emperor Seamounts survey area, 27 marine mammal species could occur, including 15 odontocetes (dolphins and small- and large-toothed whales), eight mysticetes (baleen whales), and four pinniped species. Some species occur in both locations. In total, 39 species are expected to occur in the vicinity of the specified activity.

Baird *et al.* (2015) described numerous Biologically Important Areas (BIAs) for cetaceans for the Hawaii region. BIAs were identified for small resident populations of cetaceans based on sighting data, photo-identification, genetics, satellite tagging, and expert opinion, and one reproductive area for humpbacks was identified as a BIA; these are described in the following section for each marine mammal species. The BIAs range from ~700–23,500 km^2 in area (Baird *et al.* 2015).

Marine mammal abundance estimates presented in this document represent the total number of individuals estimated within a particular study or survey area. All values presented in Table 1 are the most recent available at the time of publication.

Table 1. Marine Mammals that Could Occur in the Proposed Survey Areas.

Common Name	Scientific Name	Stock	ESA/MMPA status; Strategic (Y/N)1	Stock abundance (CV, Nmin, most recent abundance survey)2	PBR	Annual M/SI3	Present at Time of Survey (Y/N)	
							HI	Emperor Seamounts
Order Cetartiodactyla-Cetacea-Superfamily Mysticeti (baleen whales)								
Family Eschrichtiidae								
Gray whale	*Eschrichtius robustus*	Western North Pacific	E/D; Y	140 (0.04, 135, 2011)[4]	0.06	unk	N	Y
Family Balaenidae								

North Pacific right whale	*Eubalaena japonica*	Eastern North Pacific	E/D; Y	31 (0.226, 26, 2013)[6]	N/A	0	N	Y
		N/A	--	450[5]	--	--		
Family Balaenopteridae (rorquals)								
Humpback whale	*Megaptera novaeangliae*	Central North Pacific	-/-; N	10,103 (0.03, 7,890, 2006)[6]	83	25	Y	Y
		Western North Pacific	E/D; Y	1,107 (0.30, 865,2006)[6]	3	3.2		
Minke whale	*Balaenoptera acutorostrata*	Hawaii	--	UNK	--	--	N	Y
		N/A	--	22,000[7]	--	--		
Bryde's whale	*(Balaenoptera edeni/brydei*	Hawaii	-/-; N	1,751 (0.29, 1,378, 2010)[17]	13.8	0	Y	Y
		Eastern Tropical Pacific	-/-; N --	UNK	--UND	UNK--		
Sei whale	*Balaenoptera borealis*	Hawaii	E/D; Y	178 (0.9, 93, 2010)[4]	0.2 --	0.2 --	Y	Y
Fin whale	*Balaenoptera physalus physalus*	Hawaii	E/D; Y	154 (1.05, 75, 2010)[17]	0.1	0	Y	Y
		N/A	--	13,620-18,680[9]	--	--		
Blue whale	*Balaenoptera musculus musculus)*	Central North Pacific	E/D; Y	133 (1.09, 63, 2010)[17]	0.1	0	Y	Y
Superfamily Odontoceti (toothed whales, dolphins, porpoises)								
Family Physeteridae								
Sperm whale	*Physeter macrocephalus*	Hawaii	E/D; Y	4,559 (0.33, 3,478, 2010)[17]	13.9	0.7	Y	Y
		N/A	N/A	29,674[10]-26,300[11]	--	--		
Family Kogiidae								
Pygmy sperm whale	*Kogia breviceps*	Hawaii	-/-; N	7,138[4]	UND	0	Y	Y
Dwarf sperm whale	*Kogia sima*	Hawaii	-/-; N	17,519[4]	UND	0	Y	Y
Family Ziphiidae (beaked whales)								
Cuvier's beaked whale	*Ziphius cavirostris*	Hawaii	-, -, N	723 (0.69, 428, 2010)[17]	4.3	0	Y	Y
		N/A	-	20,000[12]	--	--		

Longman's beaked whale	*Indopacetus pacificus*	Hawaii	-, -, N	7,619 (0.66, 4,592, 2010)[17]	46	0	y	N
Blainville's beaked whale	*Mesoplodon densirostris*	Hawaii	-, -, N	2,105 (1.13,1, 980, 2010)[17]	10	0	Y	N
Stejneger's beaked whale	*Mesoplodon stejnegeri*	Alaska	N	UNK	UND	0	N	Y
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*	N/A	--	25,300[12]	--	--	Rare	Absent
Deraniyagala's beaked whale	*Mesoplodon hotaula*	N/A	--	25,300[12]	--	--	Y	N
Hubb's beaked whale	*Mesoplodon carlhubbsi*	N/A	--	25,300[12]	--	--	Y	N
Baird's beaked whale	*Berardius bairdii*	N/A	--	10,190[13]			N	Y
Family Delphinidae								
Rough-toothed dolphin	*Steno bredanensis*	Hawaii	-, -, N	72,528 (0.39, 52,033, 2010)[17]	46	UNK	Common	N
Common bottlenose dolphin	*Tursiops truncatus*	Hawaii Pelagic	-/-; N	21,815 (0.57, 13,957, 2010)[17]	140	0.2	Common	N
		Kaua'i and Ni'ihau	-/-; N	184 (0.11, 168, 2005)[4]	1.7	unk	Common	N
		O'ahu	-/-; N	743 (0.54, 485, 2006)4	4.9	unk	Common	N
		4 Islands Region	-/-; N	191 (0.24, 156, 2006)	unk	unk	Common	N
		Hawaii Island	-/-; N	128 (0.13, 115, 2006)[4]	1.6	unk	Common	N
Common dolphin	*Delphinus delphis*	N/A	--	2,963,000[14]	--	--	N	Y
Pantropical spotted dolphin	*Stenella attenuata*	Hawaii Pelagic	-/-; N	55,795 (0.40, 40,338, 2010)[17]	403	0	Y	N
		O'ahu	-/-; N	unk	unk	unk		
		4 Island Region	-/-; N	unk	unk	unk		
		Hawaii Island	-/-; N	unk	unk	≥ 0.2		
Spinner dolphin	*Stenella longirostris*	Hawaii Pelagic	-/-; N	unk	unk	unk	Y	N
		Hawaii Island	-/-; N	631 (0.04, 585, 2013)[4]	5.9	unk	Common	N
		Oahu/4-Islands	-/-; N	355 (0.09, 329, 2013)[4]	3.3	unk	Y	N

Striped dolphin	*Stenella coeruleoalba*	Hawaii	-/-; N	61,021 (0.38, 44,922, 2010)[17]	449	unk	Y	Y
		N/A	--	964,362[15]	--	--		
Fraser's dolphin	*Lagenodelphis hosei*	Hawaii	-/-; N	51,491 (0.66, 31,034, 2010)[17]	310	0	Y	N
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	Central North Pacific	--	988,333[16]	--	--	N	Y
Northern right whale dolphin	*Lissodelphis borealis*	N/A	--	307,784[16]	--	--	N	Y
Risso's dolphin	*Grampus griseus*	Hawaii	-/-; N	11,613 (0.39, 8,210, 2010)[17]	82	0	Y	Y
		N/A/	--	110,457[15]	--	--		
Melon-headed whale	*Peponocephala electra*	Hawaii	-/-; N	8,666 (1.00, 4,299, 2010)[17]	43	0	Y	N
		Kohala Resident	-/-; N	447 (0.12, 404, 2009)[4]	4	0		
Pygmy killer whale	*Feresa attenuata*	Hawaii	-/-; N	10,640 (0.53, 6,998, 2010)[17]	56	1.1	Y	N
False killer whale	*Pseudorca crassidens*	Hawaii Insular	E/D;Y	167 (0.14, 149, 2015)[17]	0.3	0	Y	Y
		Northwest Hawaiian Islands	-/-; N	617 (1.11, 290, 2010)[17]	2.3	0.4		
		Hawaii Pelagic	-/-; N	1,540 (0.66, 928, 2010)[17]	9.3	7.6		
		N/A	--	16,668[18]	--	--		
Killer whale	*Orcinus orca*	Hawaii	-/-; N	146 (0.96, 74, 2010)	0.7	0	Y	Y
		N/A	--	8,500[19]	--	--		
Short-finned pilot whale	*Globicephala macrorhynchus*	Hawaii	-/-; N	19,503 (0.49, 13,197, 2010)	106	0.9	Y	Y
		N/A	--	53,608[16]	--	--		
Family Phoenidae (porpoises)								
Dall's porpoise	*Phocoenoides dalli*	N/A	--	1,186,000[20]			N	Y
Order Carnivora-Superfamily Pinnipedia								

Family Otariidae (eared seals and sea lions)								
Steller sea lion	*Eumetopias jubatus*	Western DPS	E/D; Y	50,983 (-,50,983, 2015)			N	Y
Northern fur seal	*Callorhinus ursinus*	Eastern Pacific	-/D; Y	626,734 (0.2, 530,474, 2014)	11,405	437	N	Y
		N/A	--	1,100,000[5]	--	--		
Family Phocidae (earless seals)								
Hawaiian monk seal	*Neomonachus schauinslandi*	Hawaii	E/D; Y	1,324 (0.03, 1,261, 2015)[17]	4.4	≥1.6	Y	N
Northern elephant seal	*Mirounga angustirostris*	--	--	210,000-239,000[21]	--	--	N	Y
Ribbon seal	*Histriophoca fasciata*	Alaska	-/-; N	184,000 (0.12, 163,000, 2013)	9,785	3.8	N	Y

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's 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 - Carretta et. al. 2017.
5 - Jefferson *et al.* 2015.
6 - Muto *et al.*, 2017.
7 - IWC 2018.
8 - Central and Eastern North Pacific (Hakamada and Matsuoka 2015a)
9- Ohsumi and Wada, 1974.
10 - Whitehead 2002
11 - Barlow and Taylor 2005.
12 - Wade and Gerrodette 1993.
13 - Western Pacific Ocean (Okamura *et al.* 2012).
14 - ETP (Gerrodette and Forcada 2002 in Hammond *et al.* 2008b).
15 - Gerrodette *et al.* 2008.
16 - North Pacific (Miyashita 1993b).
17 – Carretta *et al.* 2018.
18 - Western North Pacific (Miyashita 1993a).
19 - Ford 2009.
20 - Buckland *et al.* 1993.
21 - Lowry *et al.* 2014
NOTE - Italicized species are not expected to be taken or proposed for authorization

All species that could potentially occur in the proposed survey area are included in Table 1. With the exception of Steller sea lions, these species or stocks temporally and spatially co-occur with the activity to the degree that take is reasonably likely to occur. However, the temporal and/or spatial occurrence of Steller sea lions is such that take is not expected to occur, and they are not discussed further beyond the explanation provided here. The Steller sea lion occurs along the North Pacific Rim from northern Japan to California (Loughlin *et al.* 1984). They are distributed around the coasts to the outer shelf from northern Japan through the Kuril Islands and Okhotsk Sea, through the Aleutian Islands, central Bering Sea, southern Alaska, and south to California (NMFS 2016c). There is little information available on at-sea occurrence of Steller sea lions in the northwestern Pacific Ocean. The Emperor Seamounts survey area is roughly 1,200 kilometers away from the Aleutian Islands in waters 2,000 to more than 5,000 meters deep. Steller sea lions are unlikely to occur in the proposed offshore survey area based on their known distributional range and habitat preference. Therefore, it is extremely unlikely that Steller sea lions would be exposed to the stressors associated with the proposed seismic activities and will not be discussed further.

We have reviewed L-DEO's species descriptions, including life history information, distribution, regional distribution, diving behavior, and acoustics and hearing, for accuracy and completeness. Below, for the 39 species that are likely to be taken by the activities described, we offer a brief introduction to the species and relevant stock as well as available information regarding population trends and threats, and describe any information regarding local occurrence.

Gray Whale

Two separate populations of gray whales have been recognized in the North Pacific (LeDuc *et al.* 2002): the eastern North Pacific and western North Pacific (or Korean-Okhotsk) stocks. However, the distinction between these two populations has been recently debated owing to evidence that whales from the western feeding area also travel to breeding areas in the eastern North Pacific (Weller *et al.* 2012, 2013; Mate *et al.* 2015). Thus, it is possible that whales from both the *endangered* Western North Pacific and the delisted Eastern North Pacific DPS could occur in the proposed survey area in the Emperor Seamounts survey area.

The western population is known to feed in the Okhotsk Sea along the northeast coast of Sakhalin Island (Weller *et al.* 1999, 2002a, 2008), eastern Kamchatka, and the northern Okhotsk Sea in the summer and autumn (Vladimirov *et al.* 2008). Winter breeding grounds are not known; however, it has been postulated that wintering areas occur along the south coast of the Korean Peninsula, but it is more likely that they are located in the South China Sea, along the coast of Guangdong province and Hainan (Wang 1984 and Zhu 1998 *in* Weller *et al.* 2002a; Rice 1998). Winter records exist for Japan, North Korea, and South Korea (Weller *et al.* 2002a,b). Migration into the Okhotsk Sea may occur through the Sea of Japan via the Tatar Strait and/or La Perouse Strait (see Reeves *et al.* 2008). If migration timing is similar to that of the better-known eastern gray whale, southbound migration probably occurs mainly in December–January and northbound migration mainly in February–April, with northbound migration of newborn calves and their mothers probably concentrated at the end of that period. The eastern North Pacific gray whale breeds and winters in Baja, California, and migrates north to summer feeding grounds in the northern Bering Sea, Chukchi Sea, and western Beaufort Sea (Rice and Wolman 1971; Jefferson *et al.* 2015).

In the western North Pacific, gray whales migrate along the coast of Japan (Weller *et al.* 2008), and records have been reported there from November through August, with the majority for March through May (Weller *et al.* 2012). Although the offshore limit of this route is not well documented, gray whales are known to prefer nearshore coastal waters. However, some exchange between populations in the eastern and western North Pacific has been reported (Weller *et al.* 2012, 2013; Mate *et al.* 2015); thus, migration routes could include pelagic waters of the Pacific Ocean, including the proposed Emperor Seamounts survey area. Nonetheless, given their small population size and preference for nearshore waters, only very small numbers are likely to be encountered during the proposed Emperor Seamounts survey during any time of the year. Additionally, during summer, most gray whales would be feeding near Sakhalin Island. The gray whale does not occur in Hawaiian waters.

North Pacific Right Whale

North Pacific right whales summer in the northern North Pacific, primarily in the Okhotsk Sea (Brownell *et al.* 2001) and in the Bering Sea (Shelden *et al.* 2005; Wade *et al.* 2006). The eastern North Pacific stock that occurs in U.S. waters numbers only ~31 individuals (Wade *et al.* 2011), and critical habitat has been designated in the eastern Bering Sea and in the Gulf of Alaska, south of Kodiak Island (NMFS 2017b). Wintering and breeding areas are unknown, but have been suggested to include the Hawaiian Islands, Ryukyu Islands, and Sea of Japan (Allen 1942; Gilmore 1978; Reeves *et al.* 1978; Herman *et al.* 1980; Omura 1986). The Hawaiian Islands were not a major calving ground for right whales in the last 200 years, but mid-ocean whaling records of right whales during winter suggest that right whales may have wintered and calved far offshore in the Pacific Ocean (Scarff 1986, 1991; Clapham *et al.* 2004). In April 1996, a right whale was sighted off Maui, the first documented sighting of a right whale in Hawaiian waters since 1979 (Salden and Mickelsen 1999).

Whaling records indicate that right whales once ranged across the entire North Pacific Ocean north of 35ºN and occasionally occurred as far south as 20ºN (*e.g.*, Scarff 1986, 1991). In the western Pacific, most sightings in the 1900s were reported from Japanese waters, followed by the Kuril Islands, and the Okhotsk Sea (Brownell *et al.* 2001). Significant numbers of right whales have been seen in the Okhotsk Sea during the 1990s, suggesting that the adjacent Kuril Islands and Kamchatka coast are a major feeding ground (Brownell *et al.* 2001). Right whales were also seen near Chichi-jima Island (Bonin Islands), Japan, in the 1990s (Mori *et al.* 1998). During 1994–2014, right whale sightings were reported off northern Japan, the Kuril Islands, and Kamchatka during April through August, with highest densities in May and August (Matsuoka *et al.* 2015). All sightings were north of 38ºN, and in July–August, the main distribution was north of 42ºN (Matsuoka *et al.* 2015). Right whale sightings were made within the Emperor Seamounts survey area during August, and adjacent to the survey area during May and July (Matsuoka *et al.* 2015). Ovsyanikova *et al.* (2015) also reported right whale sightings in the western Pacific Ocean during 1977–2014; although they also reported sightings off eastern Japan, the Kuril Islands, and southeast Kamchatka, including sightings to the west of the proposed Emperor Seamounts survey area, no sightings were reported within the proposed survey area. Sekiguchi *et al.* (2014) reported several sightings just to the north and west of the proposed survey area during June 2012.

Although there are a few historical records of North Pacific right whales in Hawaiian waters (Brownell *et al.* 2001), they are very unlikely to occur in the Hawaiian survey area, especially during the summer. However, right whales could be encountered in the Emperor Seamounts survey area during spring and summer, and likely fall. Individuals that could occur there would likely be from a western North Pacific stock rather than the eastern North Pacific stock.

Humpback Whale

The humpback whale is found throughout all oceans of the World (Clapham 2009), with recent genetic evidence suggesting three separate subspecies: North Pacific, North Atlantic, and Southern Hemisphere (Jackson *et al.* 2014). Nonetheless, genetic analyses suggest some gene flow (either past or present) between the North and South Pacific (*e.g.*, Jackson *et al.* 2014;

Bettridge *et al.* 2015). Although considered to be mainly a coastal species, the humpback whale often traverses deep pelagic areas while migrating (*e.g.*, Mate *et al.* 1999; Garrigue *et al.* 2015).

North Pacific humpback whales migrate between summer feeding grounds along the Pacific Rim and the Bering and Okhotsk seas, and winter calving and breeding areas in subtropical and tropical waters (Pike and MacAskie 1969; Rice 1978; Winn and Reichley 1985; Calambokidis *et al.* 2000, 2001, 2008). In the North Pacific, humpbacks winter in four different breeding areas: (1) along the coast of Mexico; (2) along the coast of Central America; (3) around the Main Hawaiian Islands; and (4) in the western Pacific, particularly around the Ogasawara and Ryukyu islands in southern Japan and the northern Philippines (Calambokidis *et al.* 2008; Fleming and Jackson 2011; Bettridge *et al.* 2015).

Humpback whales were listed as endangered under the Endangered Species Conservation Act (ESCA) in June 1970. In 1973, the ESA replaced the ESCA, and humpbacks continued to be listed as endangered. NMFS recently evaluated the status of the species, and on September 8, 2016, NMFS divided the species into 14 distinct population segments (DPS), removed the current species-level listing, and in its place listed four DPSs as endangered and one DPS as threatened (81 FR 62259, September 8, 2016). The remaining nine DPSs were not listed. There are two DPSs that occur in the action area: The Hawaii DPS, which is not listed under the ESA (81 FR 62259) and the Western North Pacific DPS which is listed as ***endangered***.

The proposed seismic activity for the Emperor Seamount survey would take place in late spring or early summer 2019. Humpbacks were reported within the proposed action area in May, July, and August (Matsuoka *et al.* 2015). Based on the timing of the action, it is likely that humpback whales from the Western North Pacific DPS would be migrating north through the action area to the feeding grounds, and thus be exposed to the action. Hawaii DPS and Mexico

DPS humpbacks would also be migrating north at that time of year, but due to the location of the breeding areas of these DPSs, we do not expect their migratory path to take them through the action area.

There is potential for the mixing of the western and eastern North Pacific humpback populations, as several individuals have been seen in the wintering areas of Japan and Hawaii in separate years (Darling and Cerchio 1993; Salden *et al.* 1999; Calambokidis *et al.* 2001, 2008). Whales from these wintering areas have been shown to travel to summer feeding areas in British Columbia, Canada, and Kodiak Island, Alaska (Darling *et al.* 1996; Calambokidis *et al.* 2001), but feeding areas in Russian waters may be most important (Calambokidis *et al.* 2008). There appears to be a very low level of interchange between wintering and feeding areas in Asia and those in the eastern and central Pacific (Calambokidis *et al.* 2008; Baker *et al.* 2013).

Humpbacks use Hawaiian waters for breeding from December to April; peak abundance occurs from late-February to early-April (Mobley *et al.* 2001). Most humpbacks have been sighted there in water depths <180 m (Fleming and Jackson 2011), but Frankel *et al.* (1995) detected singers up to 13 km from shore at depths up to 550 m. During vessel-based line-transect surveys in the Hawaiian Islands EEZ in July–December 2002, one humpback whale was sighted on 21 November at ~20.3° N, 154.9° W just north of the Island of Hawaii (Barlow *et al.* 2004). Another sighting was made during summer–fall 2010 surveys, but the date and location of that sighting were not reported (Bradford *et al.* 2017).

The Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) was established in 1992 by the U.S. Congress to protect humpback whales and their habitat in Hawaii (NOAA 2018a). The sanctuary provides essential breeding, calving, and nursing areas necessary for the long-term recovery of the North Pacific humpback whale population. The HIHWNMS provides protection to humpbacks in the shallow waters (from the shoreline to a depth of 100 fathoms or 183 m) around the four islands area of Maui, Penguin Bank; off the north shore of Kauai, the north and south shores of Oahu, and the north Kona and Koahal coast of the island of Hawaii (NOAA 2018a). These areas, as well as some of the waters surrounding them, are also considered breeding BIAs (Baird *et al.* 2015). The proposed seismic lines are located at least 10 km from the HIHWNMS (Fig. 1). However, humpback whales are not expected to be encountered in the Hawaiian survey area during the summer.

During Japanese surveys in the western North Pacific from 1994–2014, humpbacks were seen off northern Japan, the Kuril Islands, and Kamchatka (Miyashita 2006; Matsuoka *et al.* 2015). Sightings were reported for the months of April through September, with lowest densities in April and September (Matsuoka *et al.* 2015). In May and June, sightings were concentrated east of northern Japan between 37° and 43° N; concentrations moved north of 45°N during July and August, off the Kuril Islands and Kamchatka (Mutsuoka *et al.* 2015). Humpback whales were encountered within the proposed Emperor Seamount study area in May, July, and August (Matsuoka *et al.* 2015).

Thus, humpbacks could be encountered in the Emperor Seamounts survey area during spring and summer, as individuals are migrating to northern feeding grounds at that time. They could also be encountered in the survey area during fall, on their southbound migration. Humpback whale occurrences in the Hawaii survey area during the time of the proposed survey would be rare.

Bryde's Whale

Bryde's whale occurs in all tropical and warm temperate waters in the Pacific, Atlantic, and Indian oceans, between 40° N and 40° S (Kato and Perrin 2009). It is one of the least known large baleen whales, and its taxonomy is still under debate (Kato and Perrin 2009). *B. brydei* is commonly used to refer to the larger form or "true" Bryde's whale and *B. edeni* to the smaller form; however, some authors apply the name *B. edeni* to both forms (Kato and Perrin 2009). Although there is a pattern of movement toward the Equator in the winter and the poles during the summer, Bryde's whale does not undergo long seasonal migrations, remaining in warm (>16°C) water year-round (Kato and Perrin 2009). Bryde's whales are known to occur in both shallow coastal and deeper offshore waters (Jefferson *et al.* 2015).

In the Pacific United States, a Hawaii and an Eastern Tropical Pacific stock are recognized (Carretta *et al.* 2017). In Hawaii, Bryde's whales are typically seen offshore (*e.g.*, Barlow *et al.* 2004; Barlow 2006), but Hopkins *et al.* (2009) reported a Bryde's whale within 70 km of the Main Hawaiian Islands. During summer–fall surveys of the Hawaiian Islands EEZ, 13 sightings were made in 2002 (Barlow 2006), and 32 sightings were reported during 2010 (Bradford *et al.* 2017). Bryde's whales were primarily sighted in the western half of the Hawaiian Islands EEZ, with the majority of sightings associated with the Northwestern Hawaiian Islands; none was made in the proposed survey area (Barlow *et al.* 2004; Barlow 2006; Bradford *et al.* 2013; Forney *et al.* 2015; Carretta *et al.* 2017).

Bryde's whales have been regularly seen during Japanese summer sighting surveys in the western North Pacific, south of 43° S (Hakamada *et al.* 2009, 2017), and individual movements have been tracked with satellite tags in offshore waters off Japan (Murase *et al.* 2016). No recent sightings have been made in the proposed Emperor Seamounts survey area, but commercial catches have been reported there (IWC 2007a).

Limited numbers of Bryde's whale could occur in the Emperor Seamounts survey area, but its distributional range is generally to the south of this region. However, it could occur in the

Hawaiian survey area at any time of the year.

Common Minke Whale

The common minke whale has a cosmopolitan distribution ranging from the tropics and subtropics to the ice edge in both hemispheres (Jefferson *et al.* 2015). In the Northern Hemisphere, minke whales are usually seen in coastal areas, but can also be seen in pelagic waters during northward migrations in spring and summer, and southward migration in autumn (Stewart and Leatherwood 1985). In the North Pacific, the summer range extends to the Chukchi Sea; in the winter, minke whales move further south to within 2° of the Equator (Perrin and Brownell 2009). The International Whaling Commission (IWC) recognizes three stocks in the North Pacific: the Sea of Japan/East China Sea, the rest of the western Pacific west of 180ºN, and the remainder of the Pacific (Donovan 1991).

In U.S. Pacific waters, three stocks are recognized: Alaska, Hawaii, and California/Oregon/ Washington stocks (Carretta *et al.* 2017). In Hawaii, the minke whale is thought to occur seasonally from November through March (Rankin and Barlow 2005). It is generally believed to be uncommon in Hawaiian waters; however, several studies using acoustic detections suggest that minke whales may be more common than previously thought (Rankin *et al.* 2007; Oswald *et al.* 2011). Acoustic detections have been recorded around the Hawaiian Islands during fall–spring surveys in 1997 and 2000–2006 (Rankin and Barlow 2005; Barlow *et al.* 2008; Rankin *et al.* 2008), and from seafloor hydrophones positioned ~50 km from the coast of Kauai during February–April 2006. Similarly, passive acoustic detections of minke whales have been recorded at the ALOHA station (22.75° N, 158° W) from October–May for decades (Oswald *et al.* 2011).

A lack of sightings is likely related to misidentification or low detection capability in poor sighting conditions (Rankin *et al.* 2007). Two minke whale sightings were made west of 167° W, one in November 2002 and one in October 2010, during surveys of the Hawaiian Islands EEZ (Barlow *et al.* 2004; Bradford *et al.* 2013; Carretta *et al.* 2017). Numerous additional sightings in the EEZ were made by observers on Hawaii-based longline fishing vessels, including four near the proposed survey area to the north and south of the Main Hawaiian Islands (Carretta *et al.* 2017).

Minke whales have been seen regularly during Japanese sighting surveys in the western North Pacific during summer (Miyashita 2006; Hakamada *et al.* 2009), and one sighting was made in August 2010 in offshore waters off Japan during the Shatsky Rise cruise (Holst and Beland 2010). Minke whales were sighted within the Emperor Seamounts survey area in the greatest numbers in August, with the lowest numbers occurring during May and June (Hakamada *et al.* 2009).

Thus, minke whales could be encountered in the Emperor Seamounts survey area during spring and summer, and likely fall, and could occur in limited numbers in the Hawaiian survey area during the summer.

Sei Whale

The sei whale occurs in all ocean basins (Horwood 2009), but appears to prefer mid-latitude temperate waters (Jefferson *et al.* 2015). 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).

During summer in the North Pacific, the sei whale can be found from the Bering Sea to the Gulf of Alaska and down to southern California, as well as in the western Pacific from Japan to Korea. In the U.S. Pacific, an Eastern North Pacific and a Hawaii stock are recognized (Carretta *et al.* 2017). In Hawaii, the occurrence of sei whales is considered rare (DoN 2005). However, six sightings were made during surveys in the Hawaiian Islands EEZ in July–December 2002 (Barlow 2006), including several along the north coasts of the Main Hawaiian Islands (Barlow *et al.* 2004). All sightings occurred in November, with one sighting reported near proposed seismic Line 3 north of Hawaii Island (Barlow *et al.* 2004). Bradford *et al.* (2017) reported two sightings in the northwestern portion of the Hawaiian Islands EEZ during summer–fall surveys in 2010. Hopkins *et al.* (2009) sighted one group of three subadult sei whales northeast of Oahu in November 2007. Sei whale vocalizations were also detected near Hawaii during November 2002 (Rankin and Barlow 2007). Breeding and calving areas for this species in the Pacific are unknown, but those sightings suggest that Hawaii may be an important reproductive area (Hopkins *et al.* 2009).

Sei whales have been regularly seen during Japanese surveys during the summer in the western North Pacific (Miyashita 2006; Hakamada *et al.* 2009; Sasaki *et al.* 2013). Sei whales have been sighted in and near the Emperor Seamounts survey area, with the greatest numbers reported for July and August; few sightings were made during May and June (Hakamada *et al.* 2009).

Thus, sei whales could be encountered in both the Emperor Seamounts and Hawaii survey areas during spring and summer.

Fin Whale

The fin whale is widely distributed in all the World's oceans (Gambell 1985), although it is most abundant in temperate and cold waters (Aguilar 2009). Nonetheless, its overall range and distribution are not well known (Jefferson *et al.* 2015). A recent review of fin whale distribution in the North Pacific noted the lack of sightings across the pelagic waters between eastern and western winter areas (Mizroch *et al.* 2009). The fin whale most commonly occurs 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).

The fin whale is known to use the shelf edge as a migration route (Evans 1987). Sergeant (1977) suggested that fin whales tend to follow steep slope contours, either because they detect them readily, or because the contours are areas of high biological productivity. However, fin whale movements have been reported to be complex (Jefferson *et al.* 2015). Stafford *et al.* (2009) noted that sea-surface temperature is a good predictor variable for fin whale call detections in the North Pacific.

North Pacific fin whales summer from the Chukchi Sea to California and winter from California southwards (Gambell 1985). In the U.S., three stocks are recognized in the North Pacific: California/Oregon/Washington, Hawaii, and Alaska (Northeast Pacific) (Carretta *et al.* 2017). Information about the seasonal distribution of fin whales in the North Pacific has been obtained from the detection of fin whale calls by bottom-mounted, offshore hydrophone arrays along the U.S. Pacific coast, in the central North Pacific, and in the western Aleutian Islands (Moore *et al.* 1998, 2006; Watkins *et al.* 2000a,b; Stafford *et al.* 2007, 2009). Fin whale calls are recorded in the North Pacific year-round, including near the Emperor Seamounts survey area (*e.g.*, Moore *et al.* 2006; Stafford *et al.* 2007, 2009; Edwards *et al.* 2015). In the central North

Pacific, call rates peak during fall and winter (Moore *et al.* 1998, 2006; Watkins *et al.* 2000a,b).

Sightings of fin whales have been made in Hawaiian waters during fall and winter (Edwards *et al.* 2015), but fin whales are generally considered uncommon at that time (DoN 2005). During spring and summer, their occurrence in Hawaii is considered rare (DoN 2005; see Edwards *et al.* 2015). There were five sightings of fin whales during summer–fall surveys in 2002, with sightings during every month except August (Barlow *et al.* 2004). Most sightings were made to the northwest of the Main Hawaiian Islands; one sighting was made during October southeast of Oahu (Barlow *et al.* 2004). Two sightings were made in the Northwestern Hawaiian Islands during summer–fall 2010 (Carretta *et al.* 2017; Bradford *et al.* 2017). Two additional sightings in the EEZ were made by observers on Hawaii-based longline fishing vessels, including one near proposed seismic Line 3 north of Maui (Carretta *et al.* 2017). Fin whale vocalizations have also been detected in Hawaiian waters, mainly during winter (Oleson *et al.* 2014, 2016).

In the western Pacific, fin whales are seen off northern Japan, the Kuril Islands, and Kamchatka during the summer (Miyashita 2006; Matsuoka *et al.* 2015). During Japanese sightings surveys in the western North Pacific from 1994–2014, the fin whale was sighted more frequently than the blue, humpback, or right whale (Matsuoka *et al.* 2015). During May–June, main distribution areas occurred from 35–40° N and moved north of 40° N during July and August; high densities were reported north of 45° N (Matsuoka *et al.* 2015). During these surveys, fin whales were seen in the proposed Emperor Seamounts survey area from May through September, with most sightings during August (Matsuoka *et al.* 2015). Summer sightings in the survey area during 1958–2000 were also reported by Mizroch *et al.* (2009) and during July–September 2005 (Miyashita 2006). Edwards *et al.* (2015) reported fin whale sightings within or near the Emperor Seamounts survey area from spring through fall.

Thus, fin whales could be encountered in the Emperor Seamounts survey area from spring through fall, and could occur in the Hawaiian survey area during summer in limited numbers.

Blue Whale

The blue whale has a cosmopolitan distribution and tends to be pelagic, only coming nearshore to feed and possibly to breed (Jefferson *et al.* 2015). Blue whale migration is less well defined than for some other rorquals, and their movements tend to be more closely linked to areas of high primary productivity, and hence prey, to meet their high energetic demands (Branch *et al.* 2007). Generally, blue whales are seasonal migrants between high latitudes in the summer, where they feed, and low latitudes in the winter, where they mate and give birth (Lockyer and Brown 1981). Some individuals may stay in low or high latitudes throughout the year (Reilly and Thayer 1990; Watkins *et al.* 2000b).

In the North Pacific, blue whale calls are detected year-round (Stafford *et al.* 2001, 2009; Moore *et al.* 2002, 2006; Monnahan *et al.* 2014). Stafford *et al.* (2009) reported that sea-surface temperature is a good predictor variable for blue whale call detections in the North Pacific. Although it has been suggested that there are at least five subpopulations in the North Pacific (Reeves *et al.* 1998), analysis of calls monitored from the U.S. Navy Sound Surveillance System (SOSUS) and other offshore hydrophones (*e.g.*, Stafford *et al.* 1999, 2001, 2007; Watkins *et al.* 2000a; Stafford 2003) suggests that there are two separate populations: one in the eastern and one in the central North Pacific (Carretta *et al.* 2017). The Eastern North Pacific Stock includes whales that feed primarily off California from June–November and winter off Central America (Calambokidis *et al.* 1990; Mate *et al.* 1999). The Central North Pacific Stock feeds off

Kamchatka, south of the Aleutians and in the Gulf of Alaska during summer (Stafford 2003; Watkins *et al.* 2000b), and migrates to the western and central Pacific (including Hawaii) to breed in winter (Stafford *et al.* 2001; Carretta *et al.* 2017). The status of these two populations could differ substantially, as little is known about the population size in the western North Pacific (Branch *et al.* 2016).

Blue whales are considered rare in Hawaii (DoN 2005). However, call types from both stocks have been recorded near Hawaii during August–April, although eastern calls were more prevalent; western calls were mainly detected during December–March, whereas eastern calls peaked during August and September and were rarely heard during October–March (Stafford *et al.* 2001). No sightings were made in the Hawaiian Islands EEZ during surveys in July–December 2002 (Barlow *et al.* 2004; Barlow 2006). One sighting was made in the Northwestern Hawaiian Islands during August–October 2010 (Bradford *et al.* 2013). Three additional sightings in the EEZ were made by observers on Hawaii-based longline fishing vessels during 1994–2009, including one in offshore waters north of Maui (Carretta *et al.* 2017).

In the western North Pacific, blue whale calls have been detected throughout the year, but are more prevalent from July–December (Stafford *et al.* 2001). Numerous blue whale sightings have also been made in the western North Pacific during Japanese surveys during 1994–2014 (Miyashita 2006; Matsuoka *et al.* 2015). A northward migration pattern was evident, with the main distribution occurring from 35–40° N during May and June, and north of 40° N during July and August (Matsuoka *et al.* 2015). High densities were reported north of 45° N (Matsuoka *et al.* 2015). Blue whales were seen in the proposed Emperor Seamounts survey area during August and September and adjacent to the area during May and July (Matsuoka *et al.* 2015).

Thus, blue whales could be encountered in the Emperor Seamounts and Hawaii survey areas at any time of the year, but are more likely to occur in the Emperor Seamounts area during summer, and in the Hawaii survey area during winter.

Sperm Whale

The sperm whale is the largest of the toothed whales, with an extensive worldwide distribution from the edge of the polar pack ice to the Equator (Whitehead 2009). Sperm whale distribution is linked to its social structure: mixed groups of adult females and juveniles of both sexes generally occur in tropical and subtropical waters at latitudes less than ~40° (Whitehead 2009). After leaving their female relatives, males gradually move to higher latitudes with the largest males occurring at the highest latitudes and only returning to tropical and subtropical regions to breed. Sperm whales generally are distributed over large areas that have high secondary productivity and steep underwater topography, in waters at least 1000 m deep (Jaquet and Whitehead 1996). They are often found far from shore, but can be found closer to oceanic islands that rise steeply from deep ocean waters (Whitehead 2009).

Sperm whale vocalizations have been recorded throughout the Central and Western Pacific Ocean (Merkens *et al.* 2016). Sperm whales are widely distributed in Hawaiian waters throughout the year (Mobley *et al.* 2000) and are considered a separate stock from the Oregon/Washington/California stock in U.S. waters (Carretta *et al.* 2017). Higher densities occur in deep, offshore waters (Forney *et al.* 2015). During summer–fall surveys of the Hawaiian Islands EEZ, 43 sightings were made in 2002 (Barlow 2006) and 41 were made in 2010 (Bradford *et al.* 2013). Sightings were widely distributed across the EEZ during both surveys; numerous sightings occurred in and near the proposed survey area (Barlow *et al.* 2004; Barlow 2006; Bradford *et al.* 2017). All sightings during surveys of the Main Hawaiian Islands in 2000–2012 were made in water >1000 m in depth, with most sightings in areas >3000 m deep (Baird *et* *al.* 2013). Sightings were made during surveys of the Island of Hawaii during all seasons, including near proposed seismic Line 1; no sightings were made off Oahu (Baird *et al.* 2013). Sperm whales were also detected acoustically off the west coast of the Hawaii Island year-round (Klinck *et al.* 2012; Giorli *et al.* 2016).

Sperm whales have been regularly seen in the western North Pacific during Japanese surveys during summer (Miyashita 2006; Hakamada *et al.* 2009), and sightings were also made in offshore waters east of Japan and on the Shatsky Rise during a summer survey in 2010 (Holst and Beland 2010). During winter, few sperm whales are observed off the east coast of Japan (Kato and Miyashita 1998). Sperm whales have been sighted in and near the Emperor Seamounts survey area from May through August, with the greatest numbers occurring there during June–August (Miyashita 2006; Hakamada *et al.* 2009).

Thus, sperm whales could be encountered in the Emperor Seamounts and Hawaii survey areas at any time of the year.

Pygmy and Dwarf Sperm Whales

The pygmy and dwarf sperm whales are distributed widely throughout tropical and temperate seas, but their precise distributions are unknown because much of what we know of the species comes from strandings (McAlpine 2009). It has 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 or ETP (Wade and Gerrodette 1993). *Kogia* spp. are difficult to sight at sea, because of their dive behavior and perhaps because of their avoidance reactions to ships and behavior changes in relation to survey aircraft (Würsig *et al.* 1998). Although there are few useful estimates of abundance for pygmy or dwarf sperm whales anywhere in their range, they are thought to be fairly common in some areas.

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; Jefferson *et al.* 2015). However, 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). On the other hand, McAlpine (2009) and Barros *et al.* (1998) suggested that dwarf sperm whales could be more pelagic and dive deeper than pygmy sperm whales.

Vocalizations of *Kogia* spp. have been recorded in the North Pacific Ocean (Merkens *et al.* 2016). An insular resident population of dwarf sperm whales occurs within ~20 km from the Main Hawaiian Islands throughout the year (Baird *et al.* 2013; Oleson *et al.* 2013). During small-boat surveys in 2000–2012, dwarf sperm whales were sighted in all water depth categories up to 5000 m deep, but the highest sighting rates were in water 500–1,000 m deep (Baird *et al.* 2013). Of a total of 74 sightings during those surveys, most sightings were made off the Island of Hawaii, including near proposed seismic Line 1 (Baird *et al.* 2013). The area off the west coast of the Island of Hawaii is considered a BIA for dwarf sperm whales (Baird *et al.* 2015). Only one sighting was made off Oahu (Baird *et al.* 2013).

Only five sightings of pygmy sperm whales were made during the surveys, including several off the west coast of the Island of Hawaii; the majority of sightings were made in water >3,000 m deep (Baird *et al.* 2013). The dwarf sperm whale was one of the most abundant species during a summer–fall survey of the Hawaiian EEZ in 2002 (Barlow 2006); during that survey, two sightings of pygmy sperm whales, five sightings of dwarf sperm whales, and one sighting of an unidentified *Kogia* sp. were made. All sightings were made in the western portion of the EEZ

(Barlow *et al.* 2004; Barlow 2006). During summer–fall surveys of the Hawaiian EEZ in 2010, one dwarf sperm whale and one unidentified *Kogia* sp. were sighted (Bradford *et al.* 2017); no sightings were made in or near the proposed survey area (Carretta *et al.* 2017).

Although *Kogia* spp. have been seen during Japanese sighting surveys in the western North Pacific in August–September (Kato *et al.* 2005), to the best of our knowledge, there are no direct data available for the Emperor Seamounts survey area with respect to *Kogia* spp. It is possible that *Kogia* spp could occur at both survey locations is limited numbers.

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 likely the most abundant of all beaked whales (Heyning and Mead 2009). Cuvier's beaked whale is found in deep water over and near the continental slope (Jefferson *et al.* 2015).

Cuvier's beaked whale has been sighted during surveys in Hawaii (Barlow 2006; Baird *et al.* 2013; Bradford *et al.* 2017). Resighting and telemetry data suggest that a resident insular population of Cuvier's beaked whale may exist in Hawaii, distinct from offshore, pelagic whales (*e.g.* McSweeney *et al.* 2007; Baird *et al.* 2013; Oleson *et al.* 2013). During small-boat surveys around the Hawaiian Islands in 2000–2012, sightings were made in water depths of 500–4,000 m off the west coast of the Island of Hawaii during all seasons (Baird *et al.* 2013). The waters around the Island of Hawaii are considered a BIA for Cuvier's beaked whale (Baird *et al.* 2015); proposed seismic Line 1 would traverse this area.

During summer–fall surveys of the Hawaiian Islands EEZ, three sightings of Cuvier's beaked whale were made in the western portion of the EEZ in 2002 (Barlow 2006) and 23 were made in the EEZ in 2010 (Bradford *et al.* 2013). It was one of the most abundant cetacean species sighted in 2002 (Barlow 2006). In 2010, most sightings were made in nearshore waters of the Northwestern Hawaiian Islands, but one was made on the west coast of the Island of Hawaii, and another was made far offshore and to the southwest of Kauai (Carretta *et al.* 2017). Cuvier's beaked whales were also reported near proposed seismic line 1 during November 2009 (Klinck *et al.* 2012). They have also been detected acoustically at hydrophones deployed near the Main Hawaiian Islands during spring and fall (Baumann-Pickering *et al.* 2014, 2016), including off the west coast of the Island of Hawaii (Klinck *et al.* 2012). Probable acoustic detections were also made at Cross Seamount, south of the Main Hawaiian Islands, at 18.72° N, 158.25° W (Johnston 2008).

Cuvier's beaked whale has been seen during Japanese sighting surveys in August–September in the western North Pacific (Kato *et al.* 2005). It has also been detected acoustically in the Aleutian Islands (Baumann-Pickering *et al.* 2014). There is very little information on this species for the Emperor Seamounts survey area, but what is known of its distribution and habitat preferences suggests that it could occur there. Therefore, Cuvier's beaked whales could occur at both survey locations.

Longman's Beaked Whale

Longman's beaked whale, also known Indo-Pacific beaked whale, used to be one of the least known cetacean species, but it is now one of the more frequently sighted beaked whales (Pitman 2009a). Longman's beaked whale occurs in tropical waters throughout the Indo-Pacific, with records from 30° S to 40° N (Pitman 2009a). Longman's beaked whale is most often sighted in waters with temperatures ≥26°C and depth >2,000 m, and sightings have also been reported along the continental slope (Anderson *et al.* 2006; Pitman 2009a).

During small-boat surveys around the Hawaiian Islands in 2000–2012, a single sighting of Longman's beaked whale was made off the west coast of the Island of Hawaii during summer (Baird *et al.* 2013). During summer–fall surveys of the Hawaiian Islands EEZ, one sighting was made in 2002 and three were made in 2010; one sighting was made in offshore waters southwest of Ohau, and another was made at the edge of the EEZ southwest of the Island of Hawaii (Barlow *et al.* 2004; Barlow 2006; Bradford *et al.* 2013). Acoustic detections have been made at the Palmyra Atoll and the Pearl and Hermes Reef (Baumann-Pickering *et al.* 2014).

Longman's beaked whale has been seen during Japanese sighting surveys in August–September in the western North Pacific (Kato *et al.* 2005). However, what is known about its distribution and habitat preferences suggests that it does not occur in the Emperor Seamounts survey area.

Blainville's Beaked Whale

Blainville's beaked whale is found in tropical and warm temperate waters of all oceans (Pitman 2009b). It has the widest distribution throughout the world of all mesoplodont species and appears to be common (Pitman 2009b). It is commonly sighted in some areas of Hawaii (Jefferson *et al.* 2015).

McSweeney *et al.* (2007), Schorr *et al.* (2009), Baird *et al.* (2013), and Oleson *et al.* (2013) have suggested the existence of separate insular and offshore Blainville's beaked whales in Hawaiian waters. During small-boat surveys around the Hawaiian Islands in 2000–2012, sightings were made in shelf as well as deep water, with the highest sighting rates in water 3500–4000 m deep, followed by water 500–1000 m deep (Baird *et al.* 2013). Sightings were made during all seasons off the island of Hawaii, as well as off Oahu (Baird *et al.* 2013). The area off the west coast of Hawaii Island is considered a BIA for Blainville's beaked whale (Baird *et al.*

2015); proposed seismic Line 1 would traverse this BIA. During summer–fall shipboard surveys of the Hawaiian Islands EEZ, three sightings were made in 2002 and two were made in 2010, all in the western portion of the EEZ (Barlow *et al.* 2004; Barlow 2006; Bradford *et al.* 2013). In addition, there were four sightings of unidentified *Mesoplodon* there in 2002 (Barlow *et al.* 2004; Barlow 2006) and 10 in 2010 (Bradford *et al.* 2013).

Blainville's beaked whales have also been detected acoustically at hydrophones deployed near the Main Hawaiian Islands throughout the year (Baumann-Pickering *et al.* 2014, 2016; Henderson *et al.* 2016; Manzano-Roth *et al.* 2016), including off the west coast of the Island of Hawaii, near proposed seismic Line 1, during October–November 2009 (Klinck *et al.* 2012). Probable acoustic detections were also made at Cross Seamount, south of the Main Hawaiian Islands, at 18.72° N, 158.25° W (Johnston 2008). Blainville's beaked whale is expected to be absent from the Emperor Seamounts survey area.

Stejneger's Beaked Whale

Stejneger's beaked whale occurs in subarctic and cool temperate waters of the North Pacific (Mead 1989). Most records are from Alaskan waters, and the Aleutian Islands appear to be its center of distribution (Mead 1989). In the western Pacific Ocean, Stejneger's beaked whale has been seen during Japanese sighting surveys during August–September (Kato *et al.* 2005). Seasonal peaks in strandings along the western coast of Japan suggest that this species may migrate north in the summer from the Sea of Japan (Mead 1989). They have also been detected acoustically in the Aleutian Islands during summer, fall, and winter (Baumann-Pickering *et al.* 2014).

Given its distributional range (see Jefferson *et al.* 2015), Stejneger's beaked whale could occur in the Emperor Seamounts survey area. It does not occur in the Hawaiian survey area.

Ginkgo-toothed Beaked Whale

Ginkgo-toothed beaked whale is only known from stranding and capture records (Mead 1989; Jefferson *et al.* 2015). It is hypothesized to occupy tropical and warm temperate waters of the Indian and Pacific oceans (Pitman 2009b). Its distributional range in the North Pacific extends from Japan to the Galapagos Islands, and there are also records for the South Pacific as far south as Australia and New Zealand (Jefferson *et al.* 2015). Although its distributional range is thought to be south of Hawaii (Jefferson *et al.* 2015), vocalizations likely from this species have been detected acoustically at hydrophones deployed near the Main Hawaiian Islands and just to the south at Cross Seamount (18.72° N, 158.25° W), as well as at the Wake Atoll and Mariana Islands (Baumann-Pickering *et al.* 2014, 2016). However, no sightings have been made in Hawaiian waters (Barlow 2006; Baird *et al.* 2013; Bradford *et al.* 2017).

The ginkgo-toothed beaked whale could occur in the southern parts of the Hawaiian survey area, but it is not expected to occur in the Emperor Seamounts survey area.

Deraniyagala's Beaked Whale

Deraniyagala's beaked whale is a newly recognized species of whale that recently has been described for the tropical Indo-Pacific, where it is thought to occur between ~15° N and ~10° S (Dalebout *et al.* 2014). Strandings have been reported for the Maldives, Sri Lanka, the Seychelles, Kiribati, and Palmyra Atoll (Dalebout *et al.* 2014), and acoustic detections have been made at Palmyra Atoll and Kingman Reef in the Line Islands (Baumann-Pickering *et al.* 2014). It is closely related to ginkgo-toothed beaked whale, but DNA and morphological data have shown that the two are separate species (Dalebout *et al.* 2014).

Although possible, Deraniyagala's beaked whale is unlikely to occur in the Hawaiian survey area, and its range does not include the Emperor Seamounts survey area.

Hubb's Beaked Whale

Hubb's beaked whale occurs in temperate waters of the North Pacific (Mead 1989). Most of the stranding records are from California (Willis and Baird 1998). Its distribution appears to be correlated with the deep subarctic current (Mead *et al.* 1982). Its range is believed to be continuous across the North Pacific (Macleod *et al.* 2006), although this has yet to be substantiated because very few direct at-sea observations exist.

Hubb's beaked whale was seen during Japanese sighting surveys in the western North Pacific during August–September (Kato *et al.* 2005). However, there is very little information on this species for the Emperor Seamounts survey area, but what is known of its distribution suggests it would occur in limited numbers. The Hubb's beaked whale is unlikely to occur in the Hawaiian survey area.

Baird's Beaked Whale

Baird's beaked whale has a fairly extensive range across the North Pacific north of 30˚N, and strandings have occurred as far north as the Pribilof Islands (Rice 1986). Two forms of Baird's beaked whales have been recognized – the common slate-gray form and a smaller, rare black form (Morin *et al.* 2017). The gray form is seen off Japan, in the Aleutians, and on the west coast of North America, whereas the black from has been reported for northern Japan and the Aleutians (Morin *et al.* 2017). Recent genetic studies suggest that the black form could be a separate species (Morin *et al.* 2017).

Baird's beaked whale is currently divided into three distinct stocks: Sea of Japan, Okhotsk Sea, and Bering Sea/eastern North Pacific (Balcomb 1989; Reyes 1991). The whales occur year-round in the Okhotsk Sea and Sea of Japan (Kasuya 2009). Baird's beaked whales sometimes are seen close to shore, but their primary habitat is over or near the continental slope and oceanic seamounts in waters 1,000–3,000 m deep (Jefferson *et al.* 1993; Kasuya and Ohsumi 1984; Kasuya 2009).

Off Japan's Pacific coast, Baird's beaked whales start to appear in May, numbers increase over the summer, and decrease toward October (Kasuya 2009). During this time, they are nearly absent in offshore waters (Kasuya 2009). Kato *et al.* (2005) also reported the presence of Baird's beaked whales in the western North Pacific in August–September. They have also been detected acoustically in the Aleutian Islands (Baumann-Pickering *et al.* 2014).

Baird's beaked whale could be encountered at the Emperor Seamounts survey area, but its distribution does not include Hawaiian waters.

Rough-toothed Dolphin

The rough-toothed dolphin is distributed worldwide in tropical to warm temperate oceanic waters (Miyazaki and Perrin 1994; Jefferson 2009). In the Pacific, it occurs from central Japan and northern Australia to Baja California, Mexico, and southern Peru (Jefferson 2009). It generally occurs in deep, oceanic waters, but can be found in shallower coastal waters in some regions (Jefferson *et al.* 2015).

The rough-toothed dolphin is expected to be one of the most abundant cetaceans in the Hawaiian survey area, based on previous surveys in the area (Barlow *et al.* 2004; Barlow 2006; Baird *et al.* 2013; Bradford *et al.* 2017). Higher densities are expected to occur in deeper waters around the Hawaiian Islands than in far offshore waters of the Hawaiian EEZ (Forney *et al.* 2015). During small-boat surveys around the Hawaiian Islands in 2000–2012, it was sighted in water as deep as 5,000 m, with the highest sighting rates in water >3500 m deep, throughout the year (Baird *et al.* 2013). Sightings were made off the Island of Hawaii as well as Oahu (Baird *et al.* 2013). The area west of the Island of Hawaii is considered BIA (Baird *et al.* 2015); proposed seismic Line 1 would traverse this area. During summer–fall surveys of the Hawaiian Islands EEZ, rough-toothed dolphins were observed throughout the EEZ, including near the proposed survey area to the north and south of the Main Hawaiian Islands; in total, there were 18 sightings in 2002 and 24 sightings in 2010 (Barlow 2006; Barlow *et al.* 2004; Bradford *et al.* 2017). Acoustic detections have also been made in Hawaiian waters (Rankin *et al.* 2015).

In the western North Pacific Ocean, rough-toothed dolphins have been seen during Japanese sighting surveys during August–September (Kato *et al.* 2005). However, there is very little information on this species for the Emperor Seamounts survey area, but what is known of its distribution suggests that it is unlikely to occur there.

Common Bottlenose Dolphin

The bottlenose dolphin occurs in tropical, subtropical, and temperate waters throughout the World (Wells and Scott 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).

The bottlenose dolphin is expected to be one of the most abundant cetaceans in the Hawaiian survey area, based on previous surveys in the region (Barlow 2006; Baird *et al.* 2013; Bradford *et al.* 2017). Higher densities are expected to occur around the Hawaiian Islands than in far offshore waters of the Hawaiian EEZ (Forney *et al.* 2015). Photo-identification studies have shown that there are distinct resident populations at the four island groups in Hawaii (Kauai & Niihau, Oahu, the 4-island region, and the Island of Hawaii); the 1,000-m isobath serves as the boundary between these resident insular stocks and the Hawaii pelagic stock (Martien *et al.* 2012). Note that the Kauai/Niihau stock range does not occur near the proposed tracklines and will not be discussed further. Additionally, 98.5 percent of the Hawaii survey will take in deep (>1,000 m) water. The areas where the insular stocks are found are also considered BIAs (Baird *et al.* 2015). Proposed seismic Lines 1 and 2 would traverse the BIAS to the west of Oahu and west of the Island of Hawaii.

During small-boat surveys around the Hawaiian Islands in 2000–2012, the bottlenose dolphin was sighted in water as deep as 4,500 m, but the highest sighting rates occurred in water <500 m deep (Baird *et al.* 2013). Sightings were made during all seasons off the Island of Hawaii, including near proposed seismic Line 1, and off Oahu (Baird *et al.* 2013). Common bottlenose dolphins were also observed during summer–fall surveys of the Hawaiian EEZ, mostly in nearshore waters but also in offshore waters, including in and near the proposed survey area among the Main Hawaiian Islands, and to the north and south of the islands (see map in Carretta *et al.* 2017). Fifteen sightings were made in 2002 (Barlow 2006), and 19 sightings were made in 2010 (Bradford *et al.* 2017).

In the western North Pacific Ocean, common bottlenose dolphins have been sighted off the east coast of Japan during summer surveys in 1983–1991 (Miyashita 1993a). Although only part of the proposed Emperor Seamounts survey area was surveyed during the month of August, no sightings were made within or near the survey area (Miyashita 1993a). Offshore sightings to the south of the proposed survey area were made during September (Miyashita 1993a), and there is also a record just to the southwest of the survey area during summer (Kanaji *et al.* 2017). The distributional range of the common bottlenose dolphin does not appear to extend north to the Emperor Seamounts survey area; thus, it is not expected to be encountered during the survey.

Short-beaked Common Dolphin

The common dolphin is found in tropical and warm temperate oceans around the World

(Perrin 2009a). It ranges as far south as 40° S in the Pacific Ocean, is common in coastal waters 200–300 m deep, and is also associated with prominent underwater topography, such as seamounts (Evans 1994). There are two species of common dolphins: the short-beaked common dolphin (*D. delphis*) and the long-beaked common dolphin (*D. capensis*). The short-beaked common dolphin is mainly found in offshore waters, and the long-beaked common dolphin is more prominent in coastal areas.

During Japanese sighting surveys in the western North Pacific in August–September, both long- and short-beaked common dolphins have been seen (Kato *et al.* 2005). Kanaji *et al.* (2017) reported one record to the southwest of the proposed survey area during summer. There are also bycatch records of short-beaked common dolphins near the Emperor Seamounts survey area during summer and winter (Hobbs and Jones 1993). Based on information regarding the distribution and habitat preferences, only the short-beaked common dolphin could occur in the region.

Both the the short-beaked and long-beaked common dolphin are not expected to occur in the Hawaiian survey area as no sightings have been made of either species during surveys of the Hawaii Islands (Barlow 2006; Baird *et al.* 2013; Bradford *et al.* 2017).

Pantropical Spotted Dolphin

The pantropical spotted dolphin is one of the most abundant cetaceans and is distributed worldwide in tropical and some subtropical waters (Perrin 2009b), between ~40° N and 40° S (Jefferson *et al.* 2015). It is found primarily in deeper waters, but can also be found in coastal, shelf, and slope waters (Perrin 2009b). There are two forms of pantropical spotted dolphin: coastal and offshore. The offshore form inhabits tropical, equatorial, and southern subtropical water masses; the pelagic individuals around the Hawaiian Islands belong to a stock distinct from those in the ETP (Dizon *et al.* 1991; Perrin 2009b). Spotted dolphins are commonly seen together with spinner dolphins in mixed-species groups, *e.g.*, in the ETP (Au and Perryman 1985), off Hawaii (Psarakos *et al.* 2003), and in the Marquesas Archipelago (Gannier 2002).

The pantropical spotted dolphin is expected to be one of the most abundant cetaceans in the proposed Hawaiian survey area based on previous surveys in the region (Baird *et al.* 2013; Barlow 2006; Bradford *et al.* 2017). Higher densities are expected to occur around the Main Hawaiian Islands than elsewhere in the Hawaiian EEZ (Forney *et al.* 2015). Sightings rates peak in depths from 1,500 to 3,500 m (Baird *et al.* 2013). The Main Hawaiian Islands insular spotted dolphin stock consists of two separate stocks at Oahu and 4-Islands (which extend 20 km seaward), and one stock off the Island of Hawaii, up to 65 km from shore (Carretta *et al.* 2017). Spotted dolphins outside of these insular stocks are part of the Hawaii pelagic stock (Carretta *et al.* 2017).

During small-boat surveys around the Hawaiian Islands in 2000–2012, the pantropical spotted dolphin was sighted in all water depth categories, with the lowest sighting rate in water <500 m (Baird *et al.* 2013). It was observed during all seasons, including off of Hawaii Island and Oahu (Baird *et al.* 2013). It was also seen during summer–fall surveys of the Hawaiian Islands EEZ including in the proposed survey area, with sightings to the north, south, and around the Main Hawaiian Islands (see map in Carretta *et al.* 2017); 14 sightings were made in 2002 (Barlow 2006), and 12 sightings were made in 2010 (Bradford *et al.* 2017). The areas off southwest Oahu, south of Lanai, and west of the Island of Hawaii are considered BIAs (Baird *et al.* 2015); proposed seismic Line 1 traverses the BIA west of the Island of Hawaii. One sighting was made in July 2010 in the northwestern portion of the Hawaiian EEZ during the Shatsky Rise cruise (Holst and Beland 2010).

In the western Pacific, pantropical spotted dolphins occur from Japan south to Australia; they have been hunted in drive fisheries off Japan for decades (Kasuya 2007). A sighting of three individuals was made in offshore waters east of Japan in August 2010 during the Shatksy Rise cruise (Holst and Beland 2010). Pantropical spotted dolphins were also sighted off the east coast of Japan during summer surveys in 1983–1991, with the highest densities in offshore waters between 30ºN and 37ºN (Miyashita 1993a). Although only part of the proposed Emperor Seamounts survey area was surveyed during the month of August, no sightings were made within or near the survey area; offshore sightings to the south of the proposed survey area were made during August and September (Miyashita 1993a). The distributional range of the pantropical spotted dolphin does not appear to extend north to the Emperor Seamounts survey area; thus, it is not expected to be encountered during the survey.

Spinner Dolphin

The spinner dolphin is pantropical in distribution, including oceanic tropical and sub-tropical waters between 40ºN and 40ºS (Jefferson *et al.* 2015). It is generally considered a pelagic species (Perrin 2009b), but can also be found in coastal waters and around oceanic islands (Rice 1998). In Hawaii, spinner dolphins belong to the offshore stock (*S.l. longirostris*; Gray's spinner) that is separate from animals in the ETP (Dizon *et al.* 1991).

The spinner dolphin is expected to be one of the most abundant cetaceans in the Hawaiian survey area, based on previous surveys in the region (Barlow 2006; Baird *et al.* 2013; Bradford *et al.* 2017). Higher densities are expected to occur around in offshore waters south of the Hawaiian Islands (Forney *et al.* 2015). There are six separate stocks managed within the Hawaiian EEZ – the Hawaii Island, Oahu/4-islands, Kauai/Niihau, Pearl & Hermes Reef, Midway Atoll/Kure, and Hawaiian pelagic stocks (Carretta *et al.* 2017); individuals from three of these stocks (Hawaii pelagic, Hawaii Island, Oahu/4-Islands) are expected to overlap with the proposed survey area. The boundaries of these stocks are out to 10 n.mi. from shore; these regions are also considered BIAs (Baird *et al.* 2015). Proposed seismic Line 1 traverses the BIA west of the Island of Hawaii.

During small-boat surveys around the Hawaiian Islands in 2000–2012, it was sighted in water as deep as 3,000 m, with the highest sighting rates in water <500 m deep (Baird *et al.* 2013). It was seen during all months, including off the west coast of the Island of Hawaii and off Oahu (Baird *et al.* 2013). Spinner dolphins were also sighted in the proposed survey area during summer–fall surveys of the Hawaiian Islands EEZ, including south of Ohau (see map in Carretta *et al.* 2017); eight sightings were made in 2002 (Barlow 2006) and four were made in 2010 (Bradford *et al.* 2013).

Kato *et al.* (2005) noted that spinner dolphins were seen during Japanese sighting surveys in the western North Pacific in August–September. To the best of our knowledge, there are no data on the occurrence of spinner dolphins near the Emperor Seamounts survey area. However, the survey area is located to the north of the known range of the spinner dolphins. Therefore, they are not anticipated to occur in the Emperor Seamounts area.

Striped Dolphin

The striped dolphin has a cosmopolitan distribution in tropical to warm temperate waters from ~50° N to 40° S (Perrin *et al.* 1994a; Jefferson *et al.* 2015). It is typically found in waters outside the continental shelf and is often associated with convergence zones and areas of upwelling (Archer 2009). It occurs primarily in pelagic waters, but has been observed approaching shore where there is deep water close to the coast (Jefferson *et al.* 2015).

The striped dolphin is expected to be one of the most abundant cetaceans in the proposed

Hawaiian survey area, based on previous surveys in the region (Barlow 2006; Baird *et al.* 2013; Bradford *et al.* 2017). Higher densities are expected to occur around in offshore waters of the Hawaiian EEZ (Forney *et al.* 2015). During small-boat surveys around the Hawaiian Islands in 2000–2012, sightings were made in water depths of 1,000–5,000 m, with the highest sighting rates in water deeper than 3000 m (Baird *et al.* 2013). Sightings were made during all seasons, including near proposed seismic Line 1 off the Island of Hawaii (Baird *et al.* 2013). It was also sighted within the proposed survey area during summer–fall shipboard surveys of the Hawaii Islands EEZ, including north and south of the Main Hawaiian Islands (see map in Carretta *et al.* 2017); 15 sightings were made in 2002 (Barlow 2006) and 25 sightings were made in 2010 (Bradford *et al.* 2013).

In the western North Pacific, the striped dolphin was one of the most common dolphin species seen during Japanese summer sighting surveys (Miyashita 1993a). During these surveys, densities were highest in offshore areas between 35ºN and 40ºN, and in coastal waters of southeastern Japan (Miyashita 1993a). Although only part of the proposed Emperor Seamounts survey area was surveyed during the month of August, no sightings were made within the survey area; sightings near the proposed survey area, south of 41ºN, were made during August (Miyashita 1993a). Kanaji *et al.* (2017) reported on another record during summer to the southwest of the survey area. One winter bycatch record was reported just to the south of the survey area for October 1990 to May 1991 (Hobbs and Jones 1993).

Based on its distributional range and habitat preferences, the striped dolphin could be encountered in both the Hawaii and Emperor Seamounts survey areas.

Fraser's Dolphin (Lagenodelphis hosei)

Fraser's dolphin is a tropical oceanic species distributed between 30° N and 30° S that generally inhabits deeper, offshore water (Dolar 2009). It occurs rarely in temperate regions and then only in relation to temporary oceanographic anomalies such as El Niño events (Perrin *et al.* 1994b). In the eastern tropical pacific, it was sighted at least 15 km from shore in waters 1,500–2,500 m deep (Dolar 2009).

Fraser's dolphin is one of the most abundant cetaceans in the offshore waters of the Hawaiian Islands EEZ (Barlow 2006; Bradford *et al.* 2017). Summer–fall shipboard surveys of the EEZ resulted in two sightings of Fraser's dolphin in 2002 and four in 2010, all in the western portion of the EEZ (Barlow 2006; Bradford *et al.* 2013; Carretta *et al.* 2017). During small-boat surveys around the Hawaiian Islands in 2000–2012, only two sightings were made off the west coast of the Island of Hawaii, one during winter and one during spring in water deeper than 1000 m.

Fraser's dolphin was seen during Japanese sighting surveys in the western North Pacific during August–September (Kato *et al.* 2005). However, its range does not extend as far north as the Emperor Seamounts survey area. Thus, Fraser's dolphin is not expected to occur in the Emperor Seamounts survey area, but it could be encountered in deep water of the Hawaii survey area.

Pacific White-sided Dolphin

The Pacific white-sided dolphin is found throughout the temperate North Pacific, in a relatively narrow distribution between 38° N and 47° N (Brownell *et al.* 1999). It is common both on the high seas and along the continental margins (Leatherwood *et al.* 1984; Dahlheim and Towell 1994; Ferrero and Walker 1996). Pacific white-sided dolphins often associate with other species, including cetaceans (especially Risso's and northern right whale dolphins; Green *et al.* 1993), pinnipeds, and seabirds.

Pacific white-sided dolphins were seen throughout the North Pacific during surveys conducted during 1983–1990 (Buckland *et al.* 1993; Miyashita 1993b). Sightings were made in the western Pacific during the summer (Buckland *et al.* 1993; Miyashita 1993b), as well as during spring and fall (Buckland *et al.* 1993). Pacific white-sided dolphins were observed in the southern portion of the Emperor Seamounts survey area, south of 45° S, as well as at higher latitudes just to the east (Buckland *et al.* 1993; Miyashita 1993b). Bycatch in the squid driftnet fishery has also been reported for the Emperor Seamounts survey area (Hobbs and Jones 1993; Yatsu *et al.* 1993). Thus, Pacific white-sided dolphins could be encountered in the Emperor Seamounts survey area, but they are not known to occur as far south as Hawaii.

Northern Right Whale Dolphin

The northern right whale dolphin is found in cool temperate and sub-arctic waters of the North Pacific, ranging from 34–55° N (Lipsky 2009). It occurs from the Kuril Islands south to Japan and eastward to the Gulf of Alaska and southern California (Rice 1998). The northern right whale dolphin is one of the most common marine mammal species in the North Pacific, occurring primarily on the outer continental shelf, slope waters, and oceanic regions, where water depths are >100 m (see Green *et al.* 1993; Barlow 2003; Carretta *et al.* 2017). The northern right whale dolphin does, however, come closer to shore where there is deep water, such as over submarine canyons (Jefferson *et al.* 2015).

Northern right whale dolphins were seen throughout the North Pacific during surveys conducted during 1983–1990, with sightings made in the western Pacific primarily during the summer (Buckland *et al.* 1993; Miyashita 1993b). Northern right whale dolphins were observed in the southern portion of the Emperor Seamounts survey area, south of 45° S (Buckland *et al.* 1993; Miyashita 1993b). Bycatch records for the Emperor Seamounts survey area have also been reported (Hobbs and Jones 1993; Yatsu *et al.* 1993). One sighting was made just to the east of the survey area, at a more northerly latitude (Miyashita 1993b). Thus, northern right whale dolphins could be encountered in the Emperor Seamounts survey area, but their distribution does not range as far south as the Hawaiian Islands.

Risso's Dolphin

Risso's dolphin is primarily a tropical and mid-temperate species distributed worldwide (Kruse *et al.* 1999). It occurs between 60ºN and 60ºS, where surface water temperatures are at least 10ºC (Kruse *et al.* 1999). Water temperature appears to be an important factor affecting its distribution (Kruse *et al.* 1999). Although it occurs from coastal to deep water, it shows a strong preference for mid-temperate waters of the continental shelf and slope (Jefferson *et al.* 2014).

During small-boat surveys around the Hawaiian Islands in 2000–2012, sighting rates were highest in water >3,000 m deep (Baird *et al.* 2013). Sightings were made during all seasons off the west coast of the Island of Hawaii, including near proposed seismic Line 1; no sightings were made off Oahu (Baird *et al.* 2013). During summer–fall surveys of the Hawaiian Islands EEZ, seven sightings were made in 2002 (Barlow 2006) and 10 were made in 2010 (Bradford *et al.* 2017); several sightings occurred within the proposed survey area south of the Main Hawaiian Islands (see map in Carretta *et al.* 2017).

Risso's dolphins were regularly seen during Japanese summer sighting surveys in the western North Pacific (Miyashita 1993a), and one individual was seen in the offshore waters east of Japan on 18 August 2010 during the Shatksy Rise cruise (Holst and Beland 2010). Occurrence in the western North Pacific appears to be patchy, but high densities were observed in coastal waters, between 148ºE–157ºE, and east of 162ºE (Miyashita 1993a). Although only part of the proposed Emperor Seamounts survey area was surveyed during the month of August, no sightings were made within the survey area; however, sightings were made south of 41ºN (Miyashita 1993a). As its regular northern range extends to the southernmost portion of the Emperor Seamounts survey area, and one record has been reported outside of its range in the Aleutian Islands (Jefferson *et al.* 2014). Therefore, the Risso's dolphin is expected to occur in the Emperor Seamounts survey area.

Melon-headed Whale

The melon-headed whale is an oceanic species found worldwide in tropical and subtropical waters from ~40° N to 35° S (Jefferson *et al.* 2015). It is commonly seen in mixed groups with other cetaceans (Jefferson and Barros 1997; Huggins *et al.* 2005). It occurs most often in deep offshore waters and occasionally in nearshore areas where deep oceanic waters occur near the coast (Perryman 2009). In the North Pacific, it is distributed south of central Japan and southern California, as well as across the Pacific, including Hawaii.

Photo-identification and telemetry studies have revealed that there are two distinct populations of melon-headed whales in Hawaiian waters—the Hawaiian Islands stock and the Kohala resident stock associated with the west coast of the Island of Hawaii (Aschettino *et al.* 2012; Oleson *et al.* 2013; Carretta *et al.* 2017). Individuals in the smaller Kohala resident stock have a limited range restricted to shallower waters of the Kohala shelf and west side of Hawaii Island. During small-boat surveys around the Hawaiian Islands in 2000–2012, sightings were made during all seasons in all water depths up to 5,000 m, including sightings off the west coasts of the Island of Hawaii and Oahu (Baird *et al.* 2013). There are numerous records near the proposed seismic transect off the west coast of the Hawaiian Island (Carretta *et al.* 2017); this area is considered a BIA (Baird *et al.* 2015). During summer–fall surveys of the Hawaiian Islands EEZ in 2002 and 2010, there was a single sighting each year; neither was located near the proposed survey area (Barlow *et al.* 2004; Bradford *et al.* 2017). Satellite telemetry data revealed distant pelagic movements, associated with feeding, nearly to the edge of the Hawaiian Islands EEZ (Oleson *et al.* 2013).

Melon-headed whales have been seen during Japanese sighting surveys in the western North Pacific in August–September (Kato *et al.* 2005). However, their distributional range does not extend to the Emperor Seamounts survey area. Thus, melon-headed whale is expected to occur in the proposed Hawaiian survey area, but not in the Emperor Seamounts survey area.

Pygmy Killer Whale

The pygmy killer whale has a worldwide distribution in tropical and subtropical waters (Donahue and Perryman 2009), generally not ranging south of 35° S (Jefferson *et al.* 2015). In warmer water, it is usually seen close to the coast (Wade and Gerrodette 1993), but it is also found in deep waters. In the North Pacific, it occurs from Japan and Baja, California, southward and across the Pacific Ocean, including Hawaii.

A small resident population inhabits the waters around the Main Hawaiian Islands (Oleson *et al.* 2013), where it generally occurs within ~20 km from shore (Baird *et al.* 2011). During small-boat surveys around the Hawaiian Islands in 2000–2012, sightings were made during all seasons in water up to 3000 m deep, off the west coasts of Oahu and the Island of Hawaii (Baird *et al.* 2013), including near proposed seismic Lines 1 and 2. The waters off the west and southeast coasts of the Island of Hawaii are considered a BIA (Baird *et al.* 2015). Pygmy killer whales were also recorded during summer–fall surveys of the Hawaiian Islands EEZ: three sightings in 2002 (Barlow *et al.* 2004; Barlow 2006) and five in 2010 (Bradford *et al.* 2017), including some within the study area to the north and south of the Main Hawaiian Islands (Carretta *et al.* 2017).

Kato *et al.* (2005) reported the occurrence of this species during Japanese sighting surveys in the western North Pacific in August–September. However, its distributional range indicates that the pygmy killer whale is unlikely to occur in the Emperor Seamounts survey area.

False Killer Whale

The false killer whale is found worldwide in tropical and temperate waters, generally between 50ºN and 50ºS (Odell and McClune 1999). It is widely distributed, but generally uncommon throughout its range (Baird 2009). It is gregarious and forms strong social bonds, as is evident from its propensity to strand en masse (Baird 2009). The false killer whale generally inhabits deep, offshore waters, but sometimes is found over the continental shelf and occasionally moves into very shallow water (Jefferson *et al.* 2008; Baird 2009). In the North Pacific, it occurs from Japan and southern California, southward and across the Pacific, including Hawaii.

Telemetry, photo-identification, and genetic studies have identified three independent populations of false killer whales in Hawaiian waters: Main Hawaiian Islands Insular, Northwestern Hawaiian Islands, and Hawaii pelagic stocks (Chivers *et al.* 2010; Baird *et al.* 2010, 2013; Bradford *et al.* 2014; Carretta *et al.* 2017). The range of the Northwestern Hawaiian Islands stock is not the vicinity of the Hawaii survey tracklines and, therefore, will not be discussed further. The population inhabiting the Main Hawaiian Islands is thought to have declined dramatically since 1989; the reasons for this decline are still uncertain, although interactions with longline fisheries have been suggested (Reeves *et al.* 2009; Bradford and Forney 2014). Higher densities likely occur in the western-most areas of the Hawaiian EEZ (Forney *et al.* 2015).

During 2008–2012, 26 false killer whales were observed hooked or entangled by longline gear within the Hawaiian Islands EEZ or adjacent high-seas waters, and 22 of those were assessed as seriously injured; locations of false killer whale and unidentified blackfish takes observed included the proposed survey area (Bradford and Forney 2014). NMFS published a final rule to implement the False Killer Whale Take Reduction Plan on November 29, 2012 77 FR 71260). The final rule includes gear requirements ("weak" circle hooks and strong branch lines) in the deep-set longline fishery, longline closure areas, training and certification for vessel owners and captains in marine mammal handling and release, captains' supervision of marine mammal handling and release, and posting of placards on longline vessels.

Critical habitat has been proposed for the endangered insular population of the false killer whale in Hawaii (82 FR 51186; November 3, 2017). In general, this includes waters between the 45- and 3,200-m isobaths in the Main Hawaiian Islands (NNMFS 2017c). Note that in the critical habitat proposal, NMFS invited the public to submit comments on whether it is appropriate to include anthropogenic noise as a feature essential to the conservation false killer whales in the final rule. The final rule is expected to be published ~1 July 2018 (NMFS 2017c)..

High-use areas in Hawaii include the north half of the Island of Hawaii, the northern areas of Maui and Molokai, and southwest of Lanai (Baird *et al.* 2012). These areas are considered BIAs (Baird *et al.* 2015), and proposed seismic Line 1 to the west of the Island of Hawaii traverses the BIA. Individuals are found up to 122 km from shore (Baird *et al.* 2012). Satellite-tagged false killer whales were also recorded using the areas off the western Island of Hawaii and west of Oahu during summer 2008 and fall 2009 (Baird *et al.* 2012). During small-boat surveys around the Hawaiian Islands in 2000–2012, the highest sighting rates occurred in water >3,500 m deep (Baird *et al.* 2013). Sightings were made during all seasons, including off the west coast of the Island of Hawaii and Oahu (Baird *et al.* 2013). During summer–fall surveys of the Hawaiian Islands EEZ, two sightings were made in 2002 (Barlow *et al.* 2004; Barlow 2006) and 14 were made in 2010 (Bradford *et al.* 2017), including two within the study area, south of the Main Hawaiian Islands (see map in Carretta *et al.* 2017). False killer whales were also detected acoustically off the west coast of the Hawaiian Island and off Kauai (Baumann-Pickering *et al.* 2015).

False killer whales have been seen during Japanese summer sighting surveys in the western Pacific Ocean (Miyashita 1993a), and a sighting of four individuals was made in offshore waters east of Japan in August 2010 during the Shatksy Rise cruise (Holst and Beland 2010). The distribution in the western Pacific was patchy, with several high-density areas in offshore waters (Miyashita 1993a). Although only part of the proposed Emperor Seamounts survey area was surveyed during the month of August, no sightings were made within the survey area; however, one sighting was made just to the southeast of the survey area (Miyashita 1993a). Jefferson *et al.* (2015) did not show its distributional range to include the Emperor Seamounts region.

False killer whale is expected to occur in the proposed Hawaiian and Emperor Seamounts survey areas.

Killer Whale

The killer whale is cosmopolitan and globally fairly abundant; it has been observed in all oceans of the World (Ford 2009). It is very common in temperate waters and also frequents tropical waters, at least seasonally (Heyning and Dahlheim 1988). High densities of the species occur in high latitudes, especially in areas where prey is abundant. Killer whale movements generally appear to follow the distribution of their prey, which includes marine mammals, fish, and squid.

Killer whales are rare in the Hawaii Islands EEZ. Baird *et al.* (2006) reported 21 sighting records in Hawaiian waters between 1994 and 2004. During small-boat surveys around Hawaii Island in 2000–2012, a single sighting was made during spring in water <2000 m deep off the west coast of Hawaii Island (Baird *et al.* 2013). During summer–fall surveys of the Hawaiian Islands EEZ, two sightings were made in 2002 (Barlow *et al.* 2004; Barlow 2006) and one was made in 2010 (Bradford *et al.* 2017); none was made within the proposed survey area (Barlow *et al.* 2004; Bradford *et al.* 2017; Carretta *et al.* 2017). Numerous additional sightings in and north of the EEZ have been made by observers on longliners, some at the edge of the EEZ north of the Main Hawaiian Islands (Carretta *et al.* 2017).

Very little is known about killer whale abundance and distribution in the western Pacific Ocean outside of Kamchatka. However, they are common along the coast of Russia, Sea of Okhotsk, and Sea of Japan, Sakhalin Island, and Kuril Islands (Forney and Wade 2006). Kato *et al.* (2005) reported sightings of this species during Japanese sighting surveys in the western North Pacific in August–September. However, there is very little information on killer whales for the Emperor Seamounts survey area, but based on information regarding the distribution and habitat preferences, they are likely to occur there (see Forney and Wade 2006).

Killer whales are expected to occur in both the proposed Hawaiian and Emperor survey areas.

Short-finned Pilot Whale

The short-finned pilot whale is found in tropical and warm temperate waters; it is seen as far south as ~40ºS and as far north as 50ºN (Jefferson *et al.* 2015). It is generally nomadic, but may be resident in certain locations, including Hawaii. Pilot whales occur on the shelf break, over the slope, and in areas with prominent topographic features (Olson 2009). Based on genetic data, Van Cise *et al.* (2017) suggested that two types of short-finned pilot whales occur in the Pacific – one in the western and central Pacific, and one in the Eastern Pacific; they hypothesized that prey distribution rather than sea surface temperature determine their latitudinal ranges.

During surveys of the Main Hawaiian Islands during 2000–2012, short-finned pilot whales were the most frequently sighted cetacean (Baird *et al.* 2013). Higher densities are expected to occur around the Hawaiian Islands rather than in far offshore waters of the Hawaiian EEZ (Forney *et al.* 2015). Photo-identification and telemetry studies indicate that there may be insular and pelagic populations of short-finned pilot whales in Hawaii (Mahaffy 2012; Oleson *et al.* 2013). Genetic research is also underway to assist in delimiting population stocks for management (Carretta *et al.* 2017). During small-boat surveys around the Hawaiian Islands in 2000–2012, pilot whales were sighted in water as deep as 5,000 m, with the highest sighting rates in water depths of 500–2,500 m (Baird *et al.* 2013). Sightings were made during all seasons, mainly off the west coasts of the Island of Hawaii and Ohau (Baird *et al.* 2013). The waters off the west coast of the Island of Hawaii are considered a BIA (Baird *et al.* 2015); proposed seismic tLine 1 traverses the BIA. During summer–fall surveys of the Hawaiian Islands EEZ, 25 sightings were made in 2002 (Barlow 2006) and 36 were made in 2010 (Bradford *et al.* 2017), including within the proposed survey area, north, south, and between the Main Hawaiian Islands (see Carretta *et al.* 2017). Short-finned pilot whales were also detected acoustically off the west coast of the Island of Hawaii and off Kauai (Baumann-Pickering *et al.* 2015).

Stock structure of short-finned pilot whales has not been adequately studied in the North Pacific, except in Japanese waters, where two stocks have been identified based on pigmentation patterns and head shape differences of adult males (Kasuya *et al.* 1988). The southern stock of short-finned pilot whales has been observed during Japanese summer sightings surveys

(Miyashita 1993a) and is morphologically similar to pilot whales found in Hawaiian waters (Carretta *et al.* 2017). Distribution of short-finned pilot whales in the western North Pacific appears to be patchy, but high densities were observed in coastal waters of central and southern Japan and in some areas offshore (Miyashita 1993a). A sighting of three individuals was made in offshore waters east of Japan in August 2010 during the Shatksy Rise cruise (Holst and Beland 2010). Although only part of the proposed Emperor Seamounts survey area was surveyed during the month of August, no sightings were made within or near the survey area; offshore sightings to the south of the proposed survey area were made during the month of September (Miyashita 1993a). Although Jefferson *et al.* (2015) did not include the Emperor Seamounts region in its distributional range, Olson (2009) did.

Short-finned pilot whales are expected to occur in both the proposed Hawaiian and Emperor Seamounts survey areas.

Dall's Porpoise

Dall's porpoise is only found in the North Pacific and adjacent seas. It is widely distributed across the North Pacific over the continental shelf and slope waters, and over deep (>2500 m) oceanic waters (Hall 1979), ranging from ~30–62ºN (Jefferson *et al.* 2015). In general, this species is common throughout its range (Buckland *et al.* 1993). It is known to approach vessels to bowride (Jefferson 2009b).

In the western North Pacific, there are two different color morphs which are also considered sub-species: the *truei*-type (*P. d. truei*) and the *dalli*-type (*P. d. dalli*) (Jefferson *et al.* 2015). They can be distinguished from each other by the extent of their white thoracic patches—the *truei*-type has a much broader patch, which extends nearly the length of the body. Both types could be encountered in the proposed Emperor Seamounts survey area.

Dall' porpoise was one of the most common cetaceans in the bycatch of the central and western North Pacific high-seas driftnet fisheries, but that source of mortality is not thought to have substantially depleted their abundance in the region (Hobbs and Jones 1993). Dall's porpoises were seen throughout the North Pacific during surveys conducted during 1987–1990 (Buckland *et al.* 1993), including in the western Pacific during the summer (Buckland *et al.* 1993; Kato *et al.* 2005). The observed range included the entire Emperor Seamounts survey area (Buckland *et al.* 1993). Records of both types within the Emperor Seamounts survey area, in particular for April–July, have also been reported by Kasuya (1982), and bycatch records in the proposed survey area have also been reported (Hobbs and Jones 1993; Yatsu *et al.* 1993). Thus, Dall's porpoise could be encountered in the Emperor Seamounts survey area, but its distribution does not range as far south as the Hawaiian Islands.

Hawaiian Monk Seal

The Hawaiian monk seal only occurs in the Central North Pacific. It is distributed throughout the Hawaiian Island chain, with most of the population occurring in the Northwestern Hawaiian Islands (within the PMNM), and a small but increasing number residing in the Main Hawaiian Islands (Baker *et al.* 2011). Six main breeding subpopulations are located at the Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and French Frigate Shoals (Baker *et al.* 2011). Most births occur from February to August, with a peak in April to June, but births have been reported any time of the year (Gilmartin and Forcada 2009). Hawaiian monk seals show high site fidelity to natal islands (Gilmartin and Forcada 2009; Wilson *et al.* 2017). They mainly occur within 50 km of atolls/islands (Parrish *et al.* 2000; Stewart *et al.* 2006; Wilson *et al.* 2017) and within the 500-m isobath (*e.g.*, Parrish *et al.* 2002; Wilson *et al.* 2017). Secondary occurrence may occur in water as deep as 1000 m, but occurrence beyond the 1000-m isobath is rare (DoN 2005). Nonetheless, tagged monk seals have been tracked in water >1000 m deep (Wilson *et al.* 2017).

Hawaiian monk seals are benthic foragers that feed on marine terraces of atolls and banks; most foraging occurs in water depths <100 m deep but occasionally to depths up to 500 m (Parrish *et al.* 2002; Stewart *et al.* 2006). Stewart *et al.* (2006) used satellite tracking to examine the foraging behavior of monk seals at the six main breeding colonies in the Northwestern Hawaiian Islands. Foraging trips varied by sex and by age and ranged from <1 km up to 322 km from haul-out sites. Wilson *et al.* (2017) reported foraging trips of up to 100 km. Satellite tracking of Hawaiian monk seals revealed that home ranges in Main Hawaiian Islands were much smaller than those in the Northwestern Hawaiian Islands (NMFS 2007, 2014); home ranges for most seals were <2000 km^2 (Wilson *et al.* 2017).

Critical habitat has been designated based on preferred pupping and nursing areas, significant haul-out areas, and marine foraging areas out to a depth of 200 m (NMFS 2017b). In the Main Hawaiian Islands, critical habitat generally includes marine habitat from the seafloor to 10 m above the seafloor, from the 200-m isobath to the shoreline and 5 m inland, with some exceptions for specific areas (NMFS 2017b). For the Island of Hawaii of Hawaii, Maui, and Oahu (islands adjacent to the proposed transects), all marine habitat and inland habitat is included as critical habitat (NMFS 2017b). The seismic transects are located at least 10 km from monk seal critical habitat (Fig. 1).

Hawaiian monk seals have been reported throughout the Main Hawaiian Islands, including the west coast of Oahu, the east coast of Maui, and the north coast of the Island of Hawaii (Baker and Johanos 2004; DoN 2005). Tagged seals showed movements among the Main Hawaiian Islands, and were reported to occur near and crossing proposed seismic Lines 1 and 2 off the west coast of Oahu and the Island of Hawaii (Wilson *et al.* 2017). However, the core area of occurrence around Oahu was reported to be off the south coast, not the west coast (Wilson *et al.* 2017). Thus, monk seals could be encountered during the proposed survey, especially in nearshore portions (<1000 m deep), as well as areas near the islands where water depth is greater than >1000 m.

Northern Fur Seal

The northern fur seal is endemic to the North Pacific Ocean and occurs from southern California to the Bering Sea, Okhotsk Sea, and Honshu Island, Japan (Muto *et al.* 2017). During the breeding season, most of the worldwide population of northern fur seals inhabits the Pribilof Islands in the southern Bering Sea (Lee *et al.* 2014; Muto *et al.* 2017). The rest of the population occurs at rookeries on Bogoslof Island in the Bering Sea, in Russia (Commander Islands, Robben Island, Kuril Islands), on San Miguel Island in southern California (NMFS 1993; Lee *et al.* 2014), and on the Farallon Islands off central California (Muto *et al.* 2017). In the United States, two stocks are recognized—the Eastern Pacific and the California stocks (Muto *et al.* 2017). The Eastern Pacific stock ranges from the Pribilof Islands and Bogoslof Island in the Bering Sea during summer to California during winter (Muto *et al.* 2017).

When not on rookery islands, northern fur seals are primarily pelagic but occasionally haul out on rocky shorelines (Muto *et al.* 2017). During the breeding season, adult males usually come ashore in May–August and may sometimes be present until November; adult females are found ashore from June–November (Carretta *et al.* 2017; Muto *et al.* 2017). After reproduction, northern fur seals spend the next 7–8 months feeding at sea (Roppel 1984). Once weaned, juveniles spend 2–3 years at sea before returning to rookeries. Animals may migrate to the Gulf of Alaska, off Japan, and the west coast of the United States (Muto *et al.* 2017); in particular, adult males from the Pripilof Islands have been shown to migrate to the Kuril Islands in the western Pacific (Loughlin *et al.* 1999). The southern extent of the migration is ~35ºN.

Northern fur seals were seen throughout the North Pacific during surveys conducted during 1987–1990, including in the western Pacific during the summer (Buckland *et al.* 1993). The observed range included the entire Emperor Seamounts survey area (Buckland *et al.* 1993). They have also been reported as bycatch in squid and large-mesh fisheries during summer in the Emperor Seamounts survey area (Hobbs and Jones 1993; Yatsu *et al.* 1993). Tracked adult male fur seals that were tagged on St. Paul Island in the Bering Sea in October 2009, wintered in the Bering Sea or northern North Pacific Ocean, and approached near the eastern-most extent of the Emperor Seamounts survey area; females migrated to the Gulf of Alaska and the California Current (Sterling *et al.* 2014). Tagged pups also approached the eastern portion of the Emperor Seamounts survey area during November (Lea *et al.* 2009). Thus, northern fur seals could be encountered in the Emperor Seamounts survey area; only juveniles would be expected to occur there during the summer. Their distribution does not range as far south as the Hawaiian Islands.

Northern Elephant Seal

Northern elephant seals breed in California and Baja California, primarily on offshore islands (Stewart *et al.* 1994), from December–March (Stewart and Huber 1993). Adult elephant seals engage in two long northward migrations per year, one following the breeding season, and another following the annual molt, with females returning earlier to molt (March–April) than males (July–August) (Stewart and DeLong 1995). Juvenile elephant seals typically leave the rookeries in April or May and head north, traveling an average of 900–1,000 km. Hindell (2009) noted that traveling likely takes place in water depths >200 m.

When not breeding, elephant seals feed at sea far from the rookeries, ranging as far north as 60° N, into the Gulf of Alaska and along the Aleutian Islands (Le Boeuf *et al.* 2000). Some seals that were tracked via satellite-tags for no more than 224 days traveled distances in excess of 10,000 km during that time (Le Beouf *et al.* 2000). Northern elephant seals that were satellite-tagged at a California rookery have been recorded traveling as far west as ~166.5–172.5° E, including the proposed Emperor Seamount survey area (Le Boeuf *et al.* 2000; Robinson *et al.* 2012; Robinson 2016 *in* OBIS 2018; Costa 2017 *in* OBIS 2018). Occurrence in the survey area was documented during August and September; during July and October, northern elephant seals were tracked just to the east of the survey area (Robinson *et al.* 2012). Post-molting seals traveled longer and farther than post-breeding seals (Robinson *et al.* 2012).

Thus, northern elephant seals could be encountered in the Emperor Seamounts survey area during summer and fall. Although there are rare records of northern elephant seals in Hawaiian waters, they are unlikely to occur in the proposed survey area.

Ribbon Seal

Ribbon seals occur in the North Pacific and adjacent Arctic Ocean, ranging from the Okhotsk Sea, to the Aleutian Islands and the Bering, Chukchi, and western Beaufort seas. Ribbon seals inhabit the Bering Sea ice front from late-March to early-May and are abundant in the northern parts of the ice front in the central and western parts of the Bering Sea (Burns 1970; Burns 1981). In May to mid-July, when the ice recedes, some of the seals move farther north (Burns 1970; Burns 1981) to the Chukchi Sea (Kelly 1988c). However, most likely become pelagic and remain in the Bering Sea during the open-water season, and some occur on the Pacific Ocean side of the Aleutian Islands (Boveng *et al.* 2008). Of 10 seals that were tagged along the cost of the Kamchatka Peninsula in 2005, most stayed in the central and eastern Bering Sea, but two were tracked along the south side of the Aleutian Islands; 8 of 26 seals that were tagged in the central Bering Sea in 2007 traveled to the Bering Strait, Chukchi Sea, and Arctic Basin (Boveng *et al.* 2008). Although unlikely ribbon seals could be encountered in the proposed Emperor Seamounts survey area.

Marine Mammal Hearing

Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.*, Richardson *et al.*, 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e*., low-frequency cetaceans). Subsequently, NMFS (2016) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 dB threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. The functional groups and the associated frequencies are indicated below (note that these frequency ranges correspond to the range for the composite group, with the entire range not necessarily reflecting the capabilities of every species within that group):

- Low-frequency cetaceans (mysticetes): generalized hearing is estimated to occur between approximately 7 Hz and 35 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. Forty marine mammal species (36 cetacean and 4 pinniped (1 otariid and 3 phocid) species) have the reasonable potential to co-occur with the proposed survey activities. Please refer to Table 1. Of the cetacean species that may be present, 8 are classified as low-frequency cetaceans (*i.e.*, all mysticete species), 25 are classified as mid-frequency cetaceans (*i.e*., all delphinid and ziphiid species and the sperm whale), and 3 are classified as high-frequency cetaceans (*i.e*., Dall's porpoise and 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 decibel (dB). A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is 1 microPascal (μPa)) and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of 1 m from the source (referenced to 1 μPa) while the received level is the SPL at the listener’s position (referenced to 1 μPa).

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

Sound exposure level (SEL; represented as dB re 1 μPa^2-s) represents the total energy contained within a puls 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 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.

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

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

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

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

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

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

As described above, a Kongsberg EM 122 MBES, a Knudsen Chirp 3260 SBP, and a Teledyne RDI 75 kHz Ocean Surveyor ADCP would be operated continuously during the proposed surveys, but not during transit to and from the survey areas. Due to the lower source level of the Kongsberg EM 122 MBES relative to the *Langseth's* airgun array (242 dB re 1 μPa · m for the MBES versus a minimum of 258 dB re 1 μPa · m (rms) for the 36 airgun array (NSF-USGS, 2011), sounds from the MBES are expected to be effectively subsumed by the sounds from the airgun array. Thus, any marine mammal potentially exposed to sounds from the MBES would already have been exposed to sounds from the airgun array, which are expected to propagate further in the water. Each ping emitted by the MBES consists of eight (in water >1,000 m deep) or four (<1,000 m) successive fan-shaped transmissions, each ensonifying a sector that extends 1° fore–aft. Given the movement and speed of the vessel, the intermittent and narrow downward-directed nature of the sounds emitted by the MBES would result in no more than one or two brief ping exposures of any individual marine mammal, if any exposure were to occur.

Due to the lower source levels of both the Knudsen Chirp 3260 SBP and the Teledyne RDI 75 kHz Ocean Surveyor ADCP relative to the *Langseth's* airgun array (maximum SL of 222 dB re 1 μPa · m for the SBP and maximum SL of 224 dB re 1 μPa · m for the ADCP, versus a minimum of 258 dB re 1 μPa · m for the 36 airgun array (NSF-USGS, 2011), sounds from the SBP and ADCP are expected to be effectively subsumed by sounds from the airgun array. Thus, any marine mammal potentially exposed to sounds from the SBP and/or the ADCP would already have been exposed to sounds from the airgun array, which are expected to propagate further in the water. As such, we conclude that the likelihood of marine mammal take resulting from exposure to sound from the MBES, SBP or ADCP is discountable and therefore we do not consider noise from the MBES, SBP or ADCP further in this analysis.

Acoustic Effects

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

Potential Effects of Underwater Sound – Please refer to the information given previously ("Description of Active Acoustic Sources") regarding sound, characteristics of sound types, and metrics used in this document. 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 airgun arrays.

Richardson *et al.* (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal, but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological 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 of certain non-auditory physical or physiological effects only briefly as we do not expect that use of airgun arrays are reasonably likely to result in such effects (see below for further discussion). Potential effects from impulsive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al.*, 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.*, change in dive profile as a result of an avoidance reaction) caused by exposure to sound include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.*, 2006; Southall *et al.*, 2007; Zimmer and Tyack, 2007; Tal *et al.*, 2015). The survey activities considered here do not involve the use of devices such as explosives or mid-frequency tactical sonar that are associated with these types of effects.

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

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

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

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).

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.*, 2013a, b). 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 6 percent lower during exposure than control periods (Miller *et al.*, 2009). These data raise concerns that seismic surveys may impact foraging behavior in sperm whales, although more data are required to understand whether the differences were due to exposure or natural variation in sperm whale behavior (Miller *et al.*, 2009).

Variations in respiration naturally vary with different behaviors and alterations to breathing rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Various studies have shown that respiration rates may either be unaffected or could increase, depending on the species and signal characteristics, again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure (*e.g.*, Kastelein *et al.*, 2001, 2005, 2006; Gailey *et al.*, 2007; 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 h of the survey, a steady decrease in song received levels and bearings to singers indicated that whales moved away from the acoustic source and out of the study area. This displacement persisted for a time period well beyond the 10-day duration of seismic airgun activity, providing evidence that fin whales may avoid an area for an extended period in the presence of increased noise. The authors hypothesize that fin whale acoustic communication is modified to compensate for increased background noise and that a sensitization process may play a role in the observed temporary displacement.

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

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

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

Behavioral disturbance can also impact marine mammals in more subtle ways. Increased vigilance may result in costs related to diversion of focus and attention (*i.e.*, when a response consists of increased vigilance, it may come at the cost of decreased attention to other critical behaviors such as foraging or resting). These effects have generally not been demonstrated for marine mammals, but studies involving fish and terrestrial animals have shown that increased vigilance may substantially reduce feeding rates (*e.g.*, Beauchamp and Livoreil, 1997; Fritz *et al.*, 2002; Purser and Radford, 2011). In addition, chronic disturbance can cause population declines through reduction of fitness (*e.g.*, decline in body condition) and subsequent reduction in reproductive success, survival, or both (*e.g.*, Harrington and Veitch, 1992; Daan *et al.*, 1996; Bradshaw *et al.*, 1998). However, Ridgway *et al.* (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five-day period did not cause any sleep deprivation or stress effects.

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

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

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

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

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

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

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

Under certain circumstances, 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.

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses. However, in exceptional situations, reverberation occurs for much or all of the interval between pulses (*e.g.*, Simard *et al.* 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (*e.g.*, Gedamke 2011; Guerra *et al.* 2011, 2016; Klinck *et al.* 2012; Guan *et al.* 2015), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree. Guerra *et al.* (2016) reported that ambient noise levels between seismic pulses were elevated as a result of reverberation at ranges of 50 km from the seismic source. Based on measurements in deep water of the Southern Ocean, Gedamke (2011) estimated that the slight elevation of background levels during intervals between pulses reduced blue and fin whale communication space by as much as 36–51 percent when a seismic survey was operating 450–2,800 km away. Based on preliminary modeling, Wittekind *et al.* (2016) reported that airgun sounds could reduce the communication range of blue and fin whales 2000 km from the seismic source. Nieukirk *et al.* (2012) and Blackwell *et al.* (2013) noted the potential for masking effects from seismic surveys on large whales.

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

Ship Noise

Vessel noise from the *Langseth* could affect marine animals in the proposed survey areas. Houghton *et al.* (2015) proposed that vessel speed is the most important predictor of received noise levels, and Putland *et al.* (2017) also reported reduced sound levels with decreased vessel speed. Sounds produced by large vessels generally dominate ambient noise at frequencies from 20 to 300 Hz (Richardson *et al.* 1995). However, some energy is also produced at higher frequencies (Hermannsen *et al.* 2014); low levels of high-frequency sound from vessels has been shown to elicit responses in harbor porpoise (Dyndo *et al.* 2015). Increased levels of ship noise have been shown to affect foraging by porpoise (Teilmann *et al.* 2015; Wisniewska *et al.* 2018); Wisniewska *et al.* (2018) suggest that a decrease in foraging success could have long-term fitness consequences.

Ship noise, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (*e.g.*, Richardson *et al.* 1995; Clark *et al.* 2009; Jensen *et al.* 2009; Gervaise *et al.* 2012; Hatch *et al.* 2012; Rice *et al.* 2014; Dunlop 2015; Erbe *et al.* 2015; Jones *et al.* 2017; Putland *et al.* 2017). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (Branstetter *et al.* 2013, 2016; Finneran and Branstetter 2013; Sills *et al.* 2017). Branstetter *et al.* (2013) reported that time-domain metrics are also important in describing and predicting masking. In order to compensate for increased ambient noise, some cetaceans are known to increase the source levels of their calls in the presence of elevated noise levels from shipping, shift their peak frequencies, or otherwise change their vocal behavior (*e.g.*, Parks *et al.* 2011, 2012, 2016a,b; Castellote *et al.* 2012; Melcón *et al.* 2012; Azzara *et al.* 2013; Tyack and Janik 2013; Luís *et al.* 2014; Sairanen 2014; Papale *et al.* 2015; Bittencourt *et al.* 2016; Dahlheim and Castellote 2016; Gospić and Picciulin 2016; Gridley *et al.* 2016; Heiler *et al.* 2016; Martins *et al.* 2016; O'Brien *et al.* 2016; Tenessen and Parks 2016). Harp seals did not increase their call frequencies in environments with increased low-frequency sounds (Terhune and Bosker 2016). Holt *et al.* (2015) reported that changes in vocal modifications can have increased energetic costs for individual marine mammals. A negative correlation between the presence of some cetacean species and the number of vessels in an area has been demonstrated by several studies (*e.g.*, Campana *et al.* 2015; Culloch *et al.* 2016).

Baleen whales are thought to be more sensitive to sound at these low frequencies than are toothed whales (*e.g.*, MacGillivray *et al.* 2014), possibly causing localized avoidance of the proposed survey area during seismic operations. Reactions of gray and humpback whales to vessels have been studied, and there is limited information available about the reactions of right whales and rorquals (fin, blue, and minke whales). Reactions of humpback whales to boats are variable, ranging from approach to avoidance (Payne 1978; Salden 1993). Baker *et al.* (1982, 1983) and Baker and Herman (1989) found humpbacks often move away when vessels are within several kilometers. Humpbacks seem less likely to react overtly when actively feeding than when resting or engaged in other activities (Krieger and Wing 1984, 1986). Increased levels of ship noise have been shown to affect foraging by humpback whales (Blair *et al.* 2016). Fin whale sightings in the western Mediterranean were negatively correlated with the number of vessels in the area (Campana *et al.* 2015). Minke whales and gray seals have shown slight displacement in response to construction-related vessel traffic (Anderwald *et al.* 2013).

Many odontocetes show considerable tolerance of vessel traffic, although they sometimes react at long distances if confined by ice or shallow water, if previously harassed by vessels, or have had little or no recent exposure to ships (Richardson *et al.* 1995). Dolphins of many species tolerate and sometimes approach vessels (*e.g.,* Anderwald *et al.* 2013). Some dolphin species approach moving vessels to ride the bow or stern waves (Williams *et al.* 1992). Pirotta *et al.* (2015) noted that the physical presence of vessels, not just ship noise, disturbed the foraging activity of bottlenose dolphins. Sightings of striped dolphin, Risso's dolphin, sperm whale, and Cuvier's beaked whale in the western Mediterranean were negatively correlated with the number of vessels in the area (Campana *et al.* 2015).

There are few data on the behavioral reactions of beaked whales to vessel noise, though they seem to avoid approaching vessels (*e.g.*, Würsig *et al.* 1998) or dive for an extended period when approached by a vessel (*e.g.*, Kasuya 1986). Based on a single observation, Aguilar Soto *et al.* (2006) suggest foraging efficiency of Cuvier's beaked whales may be reduced by close approach of vessels.

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

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 *Langseth* travels at a speed of 4.1 kt (7.6 km/h) while towing seismic survey gear (LGL 2018). At this speed, both the possibility of striking a marine mammal and the possibility of a strike resulting in serious injury or mortality are discountable. At average transit speed, the probability of serious injury or mortality resulting from a strike is less than 50 percent. However, the likelihood of a strike actually happening is again discountable. 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). 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 = 0-5.5×10^{-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), and the presence of marine mammal observers, 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 that "(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, 2005a; 2005b, Romero, 2004; Sih *et al.*, 2004).

Use of military tactical sonar has been implicated in a majority of investigated stranding events. 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 surveys to result in marine mammal stranding and have concluded that, based on the best available information, stranding is not expected to occur.

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 $inch^3$ airgun decreased zooplankton abundance when compared with controls, as measured by sonar and net tows, and caused a two- to threefold increase in dead adult and larval zooplankton. Although no adult krill were present, the study found that all larval krill were killed after air gun passage. Impacts were observed out to the maximum 1.2 km range sampled.

In general, impacts to marine mammal prey are expected to be limited due to the relatively small temporal and spatial overlap between the proposed survey and any areas used by marine mammal prey species. The proposed use of airguns as part of an active seismic array survey would occur over a relatively short time period (~32 days) at two locations and would occur over a very small area relative to the area available as marine mammal habitat in the Pacific Ocean near Hawaii and the Emperor Seamounts. We believe any impacts to marine mammals due to adverse affects 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 whether the number of takes is "small" and the negligible impact determination.

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

Authorized takes would primarily be by Level B harassment, as use of seismic airguns has the potential to result in disruption of behavioral patterns for individual marine mammals. There is also some potential for auditory injury (Level A harassment) for mysticetes and high frequency cetaceans (*i.e.*, kogiidae spp.), due to larger predicted auditory injury zones for those functional hearing groups. The proposed mitigation and monitoring measures are expected to minimize the severity of such taking to the extent practicable.

Auditory injury is unlikely to occur for mid-frequency species given very small modeled zones of injury for those species (13.6 m). Moreover, the source level of the array is a theoretical definition assuming a point source and measurement in the far-field of the source (MacGillivray, 2006). As described by Caldwell and Dragoset (2000), an array is not a point source, but one that spans a small area. In the far-field, individual elements in arrays will effectively work as one source because individual pressure peaks will have coalesced into one relatively broad pulse. The array can then be considered a "point source." For distances within the near-field, *i.e.*, approximately 2-3 times the array dimensions, pressure peaks from individual elements do not arrive simultaneously because the observation point is not equidistant from each element. The effect is destructive interference of the outputs of each element, so that peak pressures in the near-field will be significantly lower than the output of the largest individual element. Here, the 230 dB peak isopleth distances would in all cases be expected to be within the near-field of the array where the definition of source level breaks down. Therefore, actual locations within this distance of the array center where the sound level exceeds 230 dB peak SPL would not necessarily exist. In general, Caldwell and Dragoset (2000) suggest that the near-field for airgun arrays is considered to extend out to approximately 250 m.

As described previously, no mortality is anticipated or proposed to be authorized for this activity. Below we describe how the take is estimated.

Described in the most basic way, we estimate take by considering: 1) acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; 2) the area or volume of water that will be ensonified above these levels in a day; 3) the density or occurrence of marine mammals within these ensonified areas; and 4) and the number of days of activities.

Below, we describe these components in more detail and present the exposure estimate and associated numbers of take proposed for authorization.

Acoustic Thresholds

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

Level B Harassment for non-explosive sources – Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (*e.g.*, frequency, predictability, duty cycle), the environment (*e.g.*, bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall *et al.*, 2007, Ellison *et al.* 2012). Based on the best available science and the practical need to use a threshold based on a factor that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS predicts that marine mammals are likely to be behaviorally harassed in a manner we consider to fall under Level B harassment when exposed to underwater anthropogenic noise above received levels of 160 dB re 1 μPa (rms) for non-explosive impulsive (*e.g.*, seismic airguns) sources. L-DEO's proposed activity includes the use of impulsive seismic sources. Therefore, the 160 dB re 1 μPa (rms) criteria is applicable for analysis of level B harassment.

Level A harassment for non-explosive sources - NMFS' Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NMFS, 2016) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). The Technical Guidance identifies the received levels, or thresholds, above which individual marine mammals are predicted to experience changes in their hearing sensitivity for all underwater anthropogenic sound sources, reflects the best available science, and better predicts the potential for auditory injury than does NMFS' historical criteria.

These thresholds were developed by compiling and synthesizing the best available science and soliciting input multiple times from both the public and peer reviewers to inform the final product, and are provided in Table 2 below. The references, analysis, and methodology used in the development of the thresholds are described in NMFS 2016 Technical Guidance. As described above, L-DEO's proposed activity includes the use of intermittent and impulsive seismic sources.

Table 2. Thresholds Identifying the Onset of Permanent Threshold Shift in Marine Mammals

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

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

Note: Peak sound pressure (Lpk) has a reference value of 1 μPa, and cumulative sound exposure level (LE) has a reference value of 1μPa2s. In this Table, thresholds are abbreviated to reflect American National Standards Institute standards (ANSI 2013). However, peak sound pressure is defined by ANSI as incorporating frequency weighting, which is not the intent for this Technical Guidance. Hence, the subscript "flat" is being included to indicate peak sound pressure should be flat weighted or unweighted within the generalized hearing range. The subscript associated with cumulative sound exposure level thresholds indicates the designated marine mammal auditory weighting function (LF, MF, and HF cetaceans, and PW and OW pinnipeds) and that the recommended accumulation period is 24 hours. The cumulative sound exposure level thresholds could be exceeded in a multitude of ways (*i.e.*, varying exposure levels and durations, duty cycle). When possible, it is valuable for action proponents to indicate the conditions under which these acoustic thresholds will be exceeded.

Ensonified Area

Here, we describe operational and environmental parameters of the activity that will feed into estimating the area ensonified above the relevant acoustic thresholds.

The proposed surveys would acquire data with the 36-airgun array with a total discharge of 6,600 in^3 at a maximum tow depth of 12 m. L-DEO model results are used to determine the 160-dBrms radius for the 36-airgun array and 40-in^3 airgun at a 12-m tow depth in deep water (>1000 m) down to a maximum water depth of 2,000 m. Received sound levels were predicted by L-DEO's model (Diebold *et al.*, 2010) which uses ray tracing for the direct wave traveling from the array to the receiver and its associated source ghost (reflection at the air-water interface in the vicinity of the array), in a constant-velocity half-space (infinite homogeneous ocean layer, unbounded by a seafloor). In addition, propagation measurements of pulses from the 36-airgun array at a tow depth of 6 m have been reported in deep water (approximately 1600 m), intermediate water depth on the slope (approximately 600–1100 m), and shallow water (approximately 50 m) in the Gulf of Mexico in 2007–2008 (Tolstoy *et al.* 2009; Diebold *et al.* 2010).

For deep and intermediate-water cases, the field measurements cannot be used readily to derive Level A and Level B isopleths, as at those sites the calibration hydrophone was located at a roughly constant depth of 350–500 m, which may not intersect all the sound pressure level (SPL) isopleths at their widest point from the sea surface down to the maximum relevant water depth for marine mammals of ~2,000 m. At short ranges, where the direct arrivals dominate and the effects of seafloor interactions are minimal, the data recorded at the deep and slope sites are suitable for comparison with modeled levels at the depth of the calibration hydrophone. At longer ranges, the comparison with the model—constructed from the maximum SPL through the entire water column at varying distances from the airgun array—is the most relevant.

In deep and intermediate-water depths, comparisons at short ranges between sound levels for direct arrivals recorded by the calibration hydrophone and model results for the same array tow depth are in good agreement (Fig. 12 and 14 in Appendix H of NSF-USGS, 2011).. Consequently, isopleths falling within this domain can be predicted reliably by the L-DEO model, although they may be imperfectly sampled by measurements recorded at a single depth. At greater distances, the calibration data show that seafloor-reflected and sub-seafloor-refracted arrivals dominate, whereas the direct arrivals become weak and/or incoherent. Aside from local topography effects, the region around the critical distance is where the observed levels rise closest to the model curve. However, the observed sound levels are found to fall almost entirely below the model curve. Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L-DEO model is a robust tool for conservatively estimating isopleths.

For deep water (>1,000 m), L-DEO used the deep-water radii obtained from model results down to a maximum water depth of 2000 m. The radii for intermediate water depths (100–1,000 m) were derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (See Fig. 16 in Appendix H of NSF-USGS, 2011).

Measurements have not been reported for the single 40-in^3 airgun. L-DEO model results are used to determine the 160-dB (rms) radius for the 40-in^3 airgun at a 12 m tow depth in deep water (See LGL 2018, Figure A-2). For intermediate-water depths, a correction factor of 1.5 was applied to the deep-water model results.

L-DEO's modeling methodology is described in greater detail in the IHA application (LGL 2018). The estimated distances to the Level B harassment isopleth for the *Langseth's* 36-airgun array and single 40-in^3 airgun are shown in Table 3.

Table 3: Predicted Radial Distances from R/V Langseth Seismic Source to Isopleths Corresponding to Level B Harassment Threshold

Source and Volume	Tow Depth (m)	Water Depth (m)	Predicted distances (in m) to the 160-dB Received Sound Level
Single Bolt airgun, 40 in^3	12	>1000 m	431[1]
		100–1000 m	647[2]
4 strings, 36 airguns, 6600 in^3	12	>1000 m	6,733[1]
		100–1000 m	10,100[2]

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

Predicted distances to Level A harassment isopleths, which vary based on marine mammal hearing groups, were calculated based on modeling performed by L-DEO using the NUCLEUS software program and the NMFS User Spreadsheet, described below. The updated acoustic thresholds for impulsive sounds (*e.g.*, airguns) contained in the Technical Guidance were presented as dual metric acoustic thresholds using both SEL_{cum} and peak sound pressure metrics (NMFS 2016). As dual metrics, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the two metrics is exceeded (*i.e.*, metric resulting in the largest isopleth). The SEL_{cum} metric considers both level and duration of exposure, as well as auditory weighting functions by marine mammal hearing group. 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 *Langseth* airgun array were derived from calculating the modified farfield signature (Table 4). 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 large 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. L-DEO used the acoustic modeling methodology as used for Level B harassment with a small grid step of 1 m in both the inline and depth directions. The propagation modeling takes into account all airgun interactions at short distances from the source, including interactions between subarrays which are modeled using the NUCLEUS software to estimate the notional signature and MATLAB software to calculate the pressure signal at each mesh point of a grid.

Table 4: Modeled Source Levels Based on Modified Farfield Signature for the R/V Langseth 6,600 in^3 Airgun Array, and single 40 in^3 Airgun.

	Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)
6,600 in^3 airgun array (Peak SPL_{flat})	252.06	252.65	253.24	252.25	252.52
6,600 in^3 airgun array (SEL_{cum})	232.98	232.83	233.08	232.83	232.07
40 in^3 airgun (Peak SPL_{flat})	223.93	N.A.	223.92	223.95	N.A.
40 in^3 airgun (SEL_{cum})	202.99	202.89	204.37	202.89	202.35

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 *Langseth's* airgun array (modeled in 1 hertz (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 and source velocities and shot intervals specific to each of the three planned surveys (Table 1), potential radial distances to auditory injury zones were then calculated for SEL_{cum} thresholds.

Inputs to the User Spreadsheets in the form of estimated SLs are shown in Table 5. User Spreadsheets used by L-DEO to estimate distances to Level A harassment isopleths for the 36-airgun array and single 40 in^3 airgun for the surveys are shown is Tables A-2, A-3, A-5, and A-8 in Appendix A of the IHA application (LGL 2018). Outputs from the User Spreadsheets in the form of estimated distances to Level A harassment isopleths for the surveys are shown in Table 5. As described above, NMFS considers onset of PTS (Level A harassment) to have occurred when either one of the dual metrics (SEL_{cum} and Peak SPL_{flat}) is exceeded (*i.e.*, metric resulting in the largest isopleth).

Table 5. Modeled Radial Distances (m) to Isopleths Corresponding to Level A Harassment Thresholds

	Low frequency cetaceans ($L_{pk,flat}$: 219 dB; $L_{E,LF,24h}$: 183 dB)	Mid frequency cetaceans ($L_{pk,flat}$: 230 dB; $L_{E,MF,24h}$: 185 dB	High frequency cetaceans ($L_{pk,flat}$: 202 dB; $L_{E,HF,24h}$: 155 dB)	Phocid Pinnipeds (Underwater) ($L_{pk,flat}$: 218 dB; $L_{E,HF,24h}$: 185 dB)	Otariid Pinnipeds (Underwater) ($L_{pk,flat}$: 232 dB; $L_{E,HF,24h}$: 203 dB)
6,600 in^3 airgun array (Peak SPL_{flat})	38.9	13.6	268.3	43.7	10.6
6,600 in^3 airgun array (SEL_{cum})	320.2	N.A.	N.A.	N.A.	N.A.
40 in^3 airgun (Peak SPL_{flat})	1.76	N.A.	12.5	1.98	N.A.
40 in^3 airgun (SEL_{cum})	2.38	N.A.	N.A.	N.A.	N.A.

Note that because of some of the assumptions included in the methods used, isopleths produced may be overestimates to some degree, which will ultimately result in some degree of overestimate of Level A harassment. However, these tools offer the best way to predict appropriate isopleths when more sophisticated 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).

In the proposed survey area in the Hawaiian EEZ, densities from Bradford *et al.* (2017) were used, when available. For the pygmy sperm whale, dwarf sperm whale, and spinner dolphin, densities from Barlow *et al.* (2009) were used because densities were not provided by Bradford *et al.* (2017). For the humpback, minke, and killer whales, the calculated take was increased to mean group size, based on Bradford *et al.* (2017). For Hawaiian monk seals, NMFS recommended following the methods used by the U.S. Navy (Navy 2017a) to determine densities. L-DEO followed a similar method, but did not correct for hauled out animals as haul-out sites are not accessible in offshore areas. We determined density by dividing the number of animals expected to occur in the Hawaiian EEZ in water depths >200 m. According to the U.S. Navy (Navy 2017a), 90 percent of the population may be found within the 200-m isobath; therefore 10 percent of the population (127 of 1272 animals; Carretta *et al.* 2017) is expected to occur outside of the 200-m isobath. The area within the Hawaii EEZ but outside of the 200-m isobath was estimated by the U.S. Navy to be 2,461,994 km^2 (Navy 2017a). Thus, we estimated the average density of monk seals at sea where they could be exposed to seismic sounds as 127/2,461,994 km^2 = 0.0000517/ km^2. No haul-out factors were used to adjust this density, as it is not possible that animals would haul out beyond the 200-m isobath. Densities for the Hawaii portion of the survey are shown in Table 7.

There are very few published data on the densities of cetaceans or pinnipeds in the Emperor Seamounts area, so NMFS relied on a range of sources to establish marine mammal densities. As part of the Navy's Final Supplemental Environmental Impact Statement/Supplemental Overseas Environmental Impact Statement for SURTASS LFA Sonar Routine Training, Testing, and Military Operations, the Navy modelled densities for a designated mission area northeast of Japan during the summer season. These values were used for the North Pacific right whale, sei whale, fin whale, sperm whale, Cuvier's beaked whale, Stejneger's beaked whale, and Baird's beaked whale.

For northern right whale dolphin, Dall's porpoise, and northern fur seal, L-DEO used densities from Buckland *et al.* (1993). Forney and Wade (2006) reported a density of 0.3/100 km^2 for killer whales at latitudes 43–48° N where the proposed survey would be conducted. Although Miyashita (1993) published data on the abundance of striped, Pantropical spotted, bottlenose, and Risso's dolphins, and false killer and short-finned pilot whales in the Northwest Pacific Ocean as far north as 41° N, the distributional range of the Pantropical spotted and bottlenose dolphins does not extend as far north as the proposed survey area. For the other species, we used data from 40–41° N, 160–180° E to calculate densities and estimate the numbers of individuals that could be exposed to seismic sounds during the proposed survey. Risso's dolphin, false killer whale, and short-finned pilot whale are expected to be rare in the proposed survey area, and the calculated densities were zero. Thus, we used the mean group size from Bradford *et al.* (2017) for Risso's dolphin and short-finned pilot whale, and the mean group size of false killer whales from Barlow (2006).

The short-beaked common dolphin is expected to be rare in the Emperor Seamounts survey area; thus, there are no density estimates available. L-DEO used the mean group size (rounded up) for the California Current from Barlow (2016). The density of Bryde's whale in the proposed survey area was assumed to be zero, based on information from Hakamada *et al.* (2009, 2017) and Forney *et al.* (2015); its known distribution range does not appear to extend that far north. For this species, L-DEO rounded up the mean group size from Bradford *et al.* (2017). For pygmy and dwarf sperm whales NMFS assumed densities in the Emperor Seamounts would be equivalent to those in the Hawaii survey are and used densities from Bradford *et al.* 2017.

The densities for the remaining species were obtained from calculations using data from the papers presented to the IWC. For blue and humpback whales, L-DEO used a weighted mean density from Matsuoka *et al.* (2009) for the years 1994–2007 and Hakamada and Matsuoka (2015) for the years 2008–2014. L-DEO used Matsuoka *et al.* (2009) instead of Matsuoka *et al.* (2015), as the later document did not contain all of the necessary information to calculate densities. L-DEO used densities for their Block 9N which coincides with the proposed Emperor Seamounts survey area. The density for each survey period was weighted by the number of years in the survey period; that is, 14 years for Matsuoka *et al.* (2009) and 7 years for Hakamada and Matsuoka (2015), to obtain a final density for the 21-year period. For minke whales L-DEO used the estimates of numbers of whales in survey blocks overlapping the Emperor Seamounts survey area from Hakamada *et al.* (2009); densities were estimated by dividing the number of whales in Block 9N by the area of Block 9N. For gray whales, NMFS used a paper by Rugh *et al.* (2005) that looked at abundance of eastern DPS gray whales. The paper provides mean group sizes for their surveys, which ranged from 1 to 2 individuals. For purposes of estimating exposures we will assume that the western DPS group sizes would not vary greatly from the eastern DPS. As such, NMFS assumes that there will be two western DPS gray whales Level B takes, based on mean group size.

Finally, no northern elephant seals have been reported during any of the above surveys although Buckland *et al.* (1993) estimated fur seal abundance during their surveys. Telemetry studies, however, indicate that elephant seals do forage as far west as the proposed Emperor Seamounts survey area. Here, L-DEO assumed a density of 0.00831/1000 km^2, which is 10 percent of that used by LGL Limited (2017) for an area off the west coast of the United States. However, densities of northern elephant seals in the region are expected to be much less than densities of northern fur seals. For species that are unlikely to occur in the survey area, such as ribbon seals, proposed exposures are set at 5 individuals. Densities for Emperor are shown in Table 8.

Take Calculation and Estimation

Here we describe how the information provided above is brought together to produce a quantitative take estimate. In order to estimate the number of marine mammals predicted to be exposed to sound levels that would result in Level A harassment or Level B harassment, radial distances from the airgun array to predicted isopleths corresponding to the Level A harassment and Level B harassment thresholds are calculated, as described above. Those radial distances are then used to calculate the area(s) around the airgun array predicted to be ensonified to sound levels that exceed the Level A harassment and Level B harassment thresholds. The area estimated to be ensonified in a single day of the survey is then calculated (Table 6), based on the areas predicted to be ensonified around the array and the estimated trackline distance traveled per day. This number is then multiplied by the number of survey days. Active seismic operations are planned for 13 days at Emperor Seamounts and 19 days at Hawaii.

Table 6. Areas (km^2) Estimated to be Ensonified to Level A and Level B Harassment Thresholds, Per Day for Hawaii and Emperor Seamounts Surveys

Survey	Criteria	Daily Ensonified Area (km^2)	Total Survey Days	25% Increase	Total Ensonified Area (km^2)	Relevant Isopleth (m)
Hawaii Level B						
Multi-depth line (intermediate water)	160 dB	538.5	12	1.25	8076.9	10,100
Multi-depth line (deep water)	160 dB	2349.8	12	1.25	35246.4	6,733
Multi-depth line (total)	160 dB	2888.2	12	1.25	43323.3	6,733
Deep-water line	160 dB	2566.3	7	1.25	22455.1	6,733
Hawaii Level A[1]						
Hawaii	LF Cetacean	115.6	19	1.25	2745.4	320.2
	MF Cetacean	4.9	19	1.25	116.3	13.6
	HF Cetacean	96.8	19	1.25	2299.3	268.3
	Phocid	15.7	19	1.25	373.8	43.7
Emperor Seamounts Level B						
Emperor Seamounts	160 dB	2566.3	13	1.25	41702.4	6,733
Emperor Seamounts Level A[1]						
Emperor Seamounts	LF Cetacean	115.6	13	1.25	1878.4	320.2
	MF Cetacean	4.9	13	1.25	79.6	13.6
	HF Cetacean	96.8	13	1.25	1573.2	268.3
	Phocid	15.7	13	1.25	255.7	43.7
	Otariid	3.8	13	1.25	62	10.6

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

The product is then multiplied by 1.25 to account for the additional 25 percent contingency. This results in an estimate of the total areas (km^2) expected to be ensonified to the Level A harassment and Level B harassment thresholds. For purposes of Level B take calculations, areas estimated to be ensonified to Level A harassment thresholds are subtracted from total areas estimated to be ensonified to Level B harassment thresholds in order to avoid double counting the animals taken (*i.e.*, if an animal is taken by Level A harassment, it is not also counted as taken by Level B harassment). The marine mammals predicted to occur within these respective areas, based on estimated densities, are assumed to be incidentally taken.

Estimated exposures for the Hawaii survey and the Emperor Seamounts survey are shown respectively in Table 7 and Table 8.

Table 7. Densities, Estimated Level A and Level B Exposures, and Percentage of Stock or Population Exposed During Hawaii Survey.

Species	Stock	Density (#/1000 km^2)	Total Exposures	Level A	Level B	Percentage of stock/population	Takes Proposed for Authorization	
							Level A	Level B
Mysticetes								
Humpback Whale	Central North Pacific	--	2[4]	--	2	<0.01	0	2
	Western North Pacific	--		--		0.2		
Minke whale	Hawaii	0[3]	1[4]	0	0	<0.01	0	1
Bryde's whale	Hawaii	0.72[1]	49	2	47	2.8	2	47
Sei whale	Hawaii	0.16[1]	11	0	11	6.2	0	11
Fin whale	Hawaii	0.06[1]	4	0	4	2.7	0	4
Blue whale	Central north Pacific	0.05[1]	5	0	5	3.9	0	5
Odontocetes								
Sperm whale	Hawaii	1.86[1]	122	0	122	2.7	0	122
Pygmy sperm whale	Hawaii	2.91[2]	198	7	191	2.8	7	191
Dwarf sperm whale	Hawaii	7.14[2]	486	16	470	2.8	16	470
Cuvier's beaked whale	Hawaii pelagic	0.30[1]	20	0	20	2.7	0	20
Longman's beaked whale	Hawaii	3.11[1]	205	0	205	2.7	0	205
Blainville's beaked whale	Hawaii pelagic	0.86[1]	57	0	57	2.7	0	57
Ginkgo-toothed beaked whale	N/A	0.63[6]	41	0	41	0.16	0	41
Deraniygala's beaked whale	N/A	0.63[6]	41	0	41	0.16	0	41
Hubb's beaked whale	N/A	0.63[6]	41	0	41	0.16	0	41
Rough-toothed dolphin	Hawaii	29.63[1]	1,952	3	1,949	2.7	0	1,952
Common bottlenose dolphin	HI Pelagic	8.99[1]	592	1	591	2.7[7]	0	592
	Oahu					0.4		
	4 islands					1.5		
	HI Islands					2.3		
Pantropical spotted dolphin	HI Pelagic	23.32[1]	1,534	3	1531	1.3[8]	0	1,354
	Oahu					N.A.		

	4 island					N.A.		
	HI Islands					N.A.		
Spinner dolphin	HI Pelagic	6.99[2]	461	1	460	N.A.	0	461
	HI Island					10.9[9]		
	Oahu/4 island					19.4		
Striped dolphin	HI Pelagic	5.36[1]	354	1	353	0.6	0	354
Fraser's dolphin	Hawaii	21.0[1]	1,383	2	1381	2.7	0	1,383
Risso's dolphin	Hawaii	4.74[1]	313	1	312	2.7	0	313
Melon-headed whale	HI Islands	3.54[1]	233	0	233	2.4[10]	0	233
	Kohala resident					5.2		
Pygmy killer whale	Hawaii	4.35[1]	287	1	286	2.7	0	287
False killer whale	MHI Insular	0.0.09[5]	6	0	6	3.5	0	6
	HI Pelagic	0.06[5]	4	0	4	0.26	0	4
Killer whale	Hawaiian Islands	0.06[1]	5[4]	0	4	2.7	0	5
Short-finned pilot whale	Hawaii	7.97[1]	525	1	524	2.7	0	525
Pinnipeds								
Hawaiian monk seal	Hawaii	0.051[3]	3	0	3	0.15	0	3

1- Bradford *et al.* 2017.
2 – Barlow *et al.* 2009.
3 – U.S. Department of the Navy. (2017a). U.S. Navy Marine Species Density Database Phase III for the Hawaii-Southern California Training and Testing Study Area. NAVFAC Pacific Technical Report. Naval Facilities Engineering Command Pacific, Pearl Harbor, HI. 274 pp. Navy, 2017.
4 - Requested take authorization (Level B only) increased to mean group size from Bradford *et al.*, 2017
5 – Bradford *et al.* 2015
6 - From Bradford *et al.* (2017) for 'Unidentified *Mesoplodon*' proportioned equally among *Mesoplodon* spp., except M. *densirostris*
7 – Assumes 98.5 percent of proposed takes are from Hawaii pelagic stock (583) with remaining 9 animals split evenly among Oahu, 4 Islands, and Hawaiian Islands stock.
8- Assumes 50 percent of proposed takes are from Hawaii pelagic stock (767) since most sightings occur in waters between 1,500 -5,000 m. The remainder are split evenly (256) between Hawaiian Islands, 4 islands, and Oahu stocks. Populations of insular stocks are unknown.
9 – Assumes 70 percent of proposed takes from Hawaii pelagic stock (323) since most of the survey tracklines will occur outside of boundary ranges of Hawaii Island and Oahu/4 island stocks. Assumes remaining takes (138) are split evenly between Hawaii Island (69) and Oahu/4 island (69) stocks
10 – Assumes 90 percent of takes from Hawaiian Islands stock (210) and 10 percent from Kohala resident stock which has a small range.

Table 8. Densities, Estimated Level A and Level B Exposures, Percentage of Stock or Population Exposed, and Number of Takes Proposed for Authorization During Emperor Seamounts Survey

Species	Stock	Estimated Density (#/1000 km²)	Total Exposures	Level A Takes	Level B Takes	% of Pop. (Total Takes)	Takes Proposed for Authorization	
							Level A	Level B
Mysticetes								
Gray whale	N/A	N.A.	2[2]	0	2	1.43	0	2
North Pacific right whale	N/A/	0.01[1]	2[10]	0	0	0.44	0	2
Humpback whale	Central North Pacific	0.41[1]	16	1	15	0.16[11]	1	16
	Western North Pacific DPS		2	0	2	0.18[11]	0	2
Minke whale	N/A	2.48	108	5	103	0.49	5	108
Bryde's whale	N/A	N.A.	2[3]	N.A.	N.A.	<0.01	0	2
Sei whale	N/A	0.29[1]	13	1	12	0.05	1	12
Fin whale	N/A	0.20[1]	9	0	8	0.06	0	8
Blue whale	Central north Pacific	0.13	5	0	5	3.7	0	5
Odontocetes								
Sperm whale	N/A	2.20[1]	92	0	92	0.31	0	92
Pygmy sperm whale	N/A	2.91[4]	126	5	121	1.76	5	121
Dwarf sperm whale	N/A	7.14[4]	309	11	298	1.76	11	298
Cuvier's beaked whale	N/A	5.40[1]	225	0	225	1.13	0	225
Stejner's beaked whale	Alaska	0.5[1]	21	0	21	0.08	0	21
Baird's beaked whale	N/A	2.9[1]	121	0	121	1.19	0	121
Short-beaked common dolphin	N/A	180[5]	N.A.	N.A.	N.A.	<0.01	0	180
Striped dolphin	N/A	9.21[6]	385	1	384	0.04	0	385
Pacific white-sided dolphin	N/A	68.81[7]	2,875	5	2,870	0.29	0	2,875
Northern	N/A	3.37[7]	141	0	141	0.05	0	141

right whale dolphin								
Risso's dolphin	N/A	27[3]	1,128	2	1,126	1.02	0	1,128
False killer whale	N/A	10[5]	418	1	417	2.51	0	418
Killer whale	N/A	3.00[8]	125	0	125	1.47	0	125
Short-finned pilot whale	N/A	41[3]	1,713	3	1,710	3.2	0	1,713
Dall's porpoise	N/A	35.46	1,535	56	1,479	0.13	56	1,479
Pinnipeds								
Northern fur seal	N/A	3.56[7]	149	0	148	0.01	0	148
Northern elephant seal	N/A	8.31	349	2	347	0.16	2	347
Ribbon seal	Alaska	N.A.	5[9]	0	5	<0.01	0	5

1 – Navy 2017b. Final Supplemental Environmental Impact Statement/Supplemental Overseas Environmental Impact Statement.
2- Mean group size based on Rugh *et al.* (2005).
3-Mean group size from Bradford *et al.* (2017).
4 – Bradford *et al.* (2017).
5- Mean group size from Barlow (2016).
6 - Miyashita (1993).
7 - Buckland *et al.* (1993).
8 - Forney and Wade (2006).
9 – Estimated exposures increased to 5 for pinnipeds.
10 – Mean group size from Matsuoka *et al.* (2009).
11 – Based on population size, take is split proportionally between central north Pacific (91.2 percent of total take) and western north Pacific DPS stocks (9.8 percent of total take).

Estimated exposures are tabulated in Table 7 and Table 8. The sum will be the total number of takes proposed for authorization. Table 7 and Table 8 contain the numbers of animals proposed for authorized take.

It should be noted that the proposed take numbers shown in Tables 7 and 8 are expected to be conservative for several reasons. First, in the calculations of estimated take, 25 percent has been added in the form of operational survey days to account for the possibility of additional seismic operations associated with airgun testing and repeat coverage of any areas where initial data quality is sub-standard, and in recognition of the uncertainties in the density estimates used to estimate take as described above. Additionally, marine mammals would be expected to move away from a loud sound source that represents an aversive stimulus, such as an airgun array, potentially reducing the number of Level A takes. However, the extent to which marine mammals would move away from the sound source is difficult to quantify and is, therefore, not accounted for in the take estimates.

Note that for some marine mammal species, we propose to authorize a different number of incidental takes than the number of incidental takes requested by L-DEO (see Table 5 and Table 6 in the IHA application for requested take numbers).

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,.

L-DEO 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, L-DEO has proposed to implement mitigation measures for marine mammals. Mitigation measures that would be adopted during the proposed surveys include (1) Vessel-based visual mitigation monitoring; (2) Vessel-based passive acoustic monitoring; (3) Establishment of an exclusion zone; (4) Power down procedures; (5) Shutdown procedures; (6) Ramp-up procedures; and (7) Vessel strike avoidance measures.

Vessel-Based Visual Mitigation Monitoring

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

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

At least one of the visual and two of the acoustic PSOs aboard the vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, during a deep penetration (*i.e.*, “high energy”) seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. One visual PSO with such experience shall be designated as the lead for the entire protected species observation team. The lead PSO shall serve as primary point of contact for the vessel operator and ensure all PSO requirements per the IHA are met. To the maximum extent practicable, the experienced PSOs should be scheduled to be on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

During survey operations (*e.g.*, any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two visual PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.*, from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during nighttime ramp-ups of the airgun array. Visual monitoring of the exclusion and buffer zones must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset. Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

PSOs shall establish and monitor the exclusion and buffer zones. These zones shall be based upon the radial distance from the edges of the acoustic source (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source (*i.e.*, anytime airguns are active, including ramp-up), occurrences of marine mammals within the buffer zone (but outside the exclusion zone) shall be communicated to the operator to prepare for the potential shutdown or powerdown of the acoustic source.

During use of the airgun (*i.e.*, anytime the acoustic source is active, including ramp-up), occurrences of marine mammals within the buffer zone (but outside the exclusion zone) should be communicated to the operator to prepare for the potential shutdown or powerdown of the acoustic source. Visual PSOs will immediately communicate all observations to the on duty acoustic PSO(s), including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination. Any observations of marine mammals by crew members shall be relayed to the PSO team. During good conditions (*e.g.*, daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable. Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO.

Passive Acoustic Monitoring

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

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

The *R/V Langseth* will use a towed PAM system, which must be monitored by at a minimum one on duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source. Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (acoustic and visual but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO.

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

- Sea state is less than or equal to BSS 4;
- No marine mammals (excluding delphinids) detected solely by PAM in the applicable exclusion zone in the previous two hours;

- NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and
- Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

Establishment of an Exclusion Zone and Buffer Zone

An exclusion zone (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 500 m radius for the 36 airgun array. The 500 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 or enters this zone, the acoustic source would be shut down..

The 500 m EZ is intended to be precautionary in the sense that it would be expected to contain sound exceeding the injury criteria for all cetacean hearing groups, (based on the dual criteria of SELcum and peak SPL), while also providing a consistent, reasonably observable zone within which PSOs would typically be able to conduct effective observational effort. Additionally, a 500 m EZ is expected to minimize the likelihood that marine mammals will be exposed to levels likely to result in more severe behavioral responses. Although significantly greater distances may be observed from an elevated platform under good conditions, we believe that 500 m is likely regularly attainable for PSOs using the naked eye during typical conditions.

Pre-clearance and Ramp-up

Ramp-up (sometimes referred to as "soft start") means the gradual and systematic increase of emitted sound levels from an airgun array. Ramp-up begins by first activating a single airgun of the smallest volume, followed by doubling the number of active elements in stages until the full complement of an array's airguns are active. Each stage should be approximately the same duration, and the total duration should not be less than approximately 20 minutes. The intent of pre-clearance observation (30 minutes) is to ensure no protected species are observed within the buffer zone prior to the beginning of ramp-up. During pre-clearance is the only time observations of protected species in the buffer zone would prevent operations (*i.e.*, the beginning of ramp-up). The intent of ramp-up is to warn protected species of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity. A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. All operators must adhere to the following pre-clearance and ramp-up requirements:

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

or the buffer zone during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zones or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and 30 minutes for all other species).

- Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Duration shall not be less than 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed.

- PSOs must monitor the exclusion and buffer zones during ramp-up, and ramp-up must cease and the source must be shut down upon observation of a marine mammal within the applicable exclusion zone. Once ramp-up has begun, observations of marine mammals within the buffer zone do not require shutdown or powerdown, but such observation shall be communicated to the operator to prepare for the potential shutdown or powerdown.

- Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances.

- If the acoustic source is shut down for brief periods (*i.e.*, less than 30 minutes) for reasons other than that described for shutdown and powerdown (*e.g.*, mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual or acoustic detections of marine mammals have occurred within the applicable exclusion zone. For any longer shutdown, pre-clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.*, BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-clearance watch of 30 min is not required.

- Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance of 30 min.

Shutdown and Powerdown

The shutdown of an airgun array requires the immediate de-activation of all individual airgun elements of the array while a powerdown requires immediate de-activation of all individual airgun elements of the array except the single 40-in^3 airgun. Any PSO on duty will have the authority to delay the start of survey operations or to call for shutdown or powerdown of the acoustic source if a marine mammal is detected within the applicable exclusion zone. The operator must also establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown and powerdown commands are conveyed swiftly while allowing PSOs to maintain watch. When both visual and acoustic PSOs are on duty, all detections will be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs. When the airgun array is active (*i.e.*, anytime one or more airguns is active, including during ramp-up and powerdown) and (1) a marine mammal appears within or enters the applicable exclusion zone and/or (2) a marine mammal (other than delphinids, see below) is detected acoustically and localized within the applicable exclusion zone, the acoustic source will be shut down. When shutdown is called for by a PSO, the acoustic source will be immediately deactivated and any dispute resolved only following deactivation. Additionally, shutdown will occur whenever PAM alone (without visual sighting), confirms presence of marine mammal(s) in the EZ. If the acoustic PSO cannot confirm presence within the EZ, visual PSOs will be notified but shutdown is not required.

Following a shutdown, airgun activity would not resume until the marine mammal has cleared the 500 m EZ. The animal would be considered to have cleared the 500 m EZ if it is visually observed to have departed the 500 m EZ, or it has not been seen within the 500 m EZ for 15 min in the case of small odontocetes and pinnipeds, or 30 min in the case of mysticetes and large odontocetes, including sperm, pygmy sperm, dwarf sperm, and beaked whales.

The shutdown requirement can be waived for small dolphins in which case the acoustic source shall be powered down to the single 40-in^3 airgun if an individual is visually detected within the exclusion zone. As defined here, the small delphinoid group is intended to encompass those members of the Family Delphinidae most likely to voluntarily approach the source vessel for purposes of interacting with the vessel and/or airgun array (*e.g.*, bow riding). This exception to the shutdown requirement would apply solely to specific genera of small dolphins — *Tursiops, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Stenella and Steno* — The acoustic source shall be powered down to 40-in^3 airgun if an individual belonging to these genera is visually detected within the 500 m exclusion zone.

b. Powerdown conditions shall be maintained until delphinids for which shutdown is waived are no longer observed within the 500 m exclusion zone, following which full-power operations may be resumed without ramp-up. Visual PSOs may elect to waive the powerdown requirement if delphinids for which shutdown is waived to be voluntarily approaching the vessel for the purpose of interacting with the vessel or towed gear, and may use best professional judgment in making this decision.

We include this small delphinoid exception because power-down/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 above, 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).

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 Langseth to revisit the missed track line to reacquire data, resulting in an overall increase in the total sound energy input to the marine environment and an increase in the total duration over which the survey is active in a given area. Although other mid-frequency hearing specialists (*e.g.*, large delphinoids) are no more likely to incur auditory injury than are small delphinoids, they are much less likely to approach vessels. Therefore, retaining a power-down / 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 power-down / shutdown requirement for large delphinoids in that it simplifies somewhat the total range of decision-making for PSOs and may preclude any potential for physiological effects other than to the auditory system as well as some more severe behavioral reactions for any such animals in close proximity to the source vessel.

Powerdown conditions shall be maintained until the marine mammal(s) of the above listed genera are no longer observed within the exclusion zone, following which full-power operations may be resumed without ramp-up. Additionally, visual PSOs may elect to waive the powerdown requirement if the small dolphin(s) appear to be voluntarily approaching the vessel for the purpose of interacting with the vessel or towed gear, and may use best professional judgment in making this decision. Visual PSOs shall use best professional judgment in making the decision to call for a shutdown if there is uncertainty regarding identification (*i.e.*, whether the observed marine mammal(s) belongs to one of the delphinid genera for which shutdown is waived or one of the species with a larger exclusion zone). If PSOs observe any behaviors in a small delphinid for which shutdown is waived that indicate an adverse reaction, then powerdown will be initiated immediately.

Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable exclusion zone (*i.e.*, animal is not required to fully exit the buffer zone where applicable) or following 15 minutes for small odontocetes and 30 minutes for all other species with no further observation of the marine mammal(s).

Vessel Strike Avoidance

These measures apply to all vessels associated with the planned survey activity; however, we note that 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. These measures include the following:

1. Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A single marine mammal at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should be exercised when an animal is observed. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (specific distances detailed below), to ensure the potential for strike is minimized. 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 and broadly to identify a marine mammal to broad taxonomic group (*i.e.*, as a large whale or other marine mammal).

2. Vessel speeds must be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of any marine mammal are observed near a vessel.

3. All vessels must maintain a minimum separation distance of 100 m from large whales (*i.e.*, sperm whales and all baleen whales.

4. All vessels must attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel.

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

gear.

We have carefully evaluated the suite of mitigation measures described here and considered a range of other measures in the context of ensuring that we prescribe the means of effecting the least practicable adverse impact on the affected marine mammal species and stocks and their habitat. Based on our evaluation of the proposed measures, NMFS has preliminarily determined that the 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 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).
- Mitigation and monitoring effectiveness.

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, at least five visual PSOs would be based aboard the *Langseth*. Monitoring shall be conducted in accordance with the following requirements:

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

- The operator will work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals. (c)

PSOs must have the following requirements and qualifications:

- PSOs shall be independent, dedicated, trained visual and acoustic PSOs and must be employed by a third-party observer provider.
- PSOs shall have no tasks other than to conduct observational effort (visual or acoustic), collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards),
- PSOs shall have successfully completed an approved PSO training course appropriate for their designated task (visual or acoustic). Acoustic PSOs are required to complete specialized training for operating PAM systems and are encouraged to have familiarity with the vessel with which they will be working.
- PSOs can act as acoustic or visual observers (but not at the same time) as long as they demonstrate that their training and experience are sufficient to perform the task at hand.
- NMFS must review and approve PSO resumes accompanied by a relevant training course information packet that includes the name and qualifications (*i.e.*, experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material as well as a document stating successful completion of the course.
- NMFS shall have one week to approve PSOs from the time that the necessary information is submitted, after which PSOs meeting the minimum requirements shall automatically be considered approved.

- PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.
- PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics.
- The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Requests shall be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

For data collection purposes, PSOs shall use standardized data collection 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. If required mitigation was not implemented, PSOs should record a description of the circumstances. At a minimum, the following information must be recorded:

- Vessel names (source vessel and other vessels associated with survey) and call signs;
- PSO names and affiliations;
- Dates of departures and returns to port with port name;
- Date and participants of PSO briefings;
- Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;
- Vessel location (latitude/longitude) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
- Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;
- Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
- Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (*e.g.*, vessel traffic, equipment malfunctions); and
- 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-clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.).

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

- Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
- PSO who sighted the animal;
- Time of sighting;
- Vessel location at time of sighting;
- Water depth;
- Direction of vessel's travel (compass direction);
- Direction of animal's travel relative to the vessel;
- Pace of the animal;
- Estimated distance to the animal and its heading relative to vessel at initial sighting;
- Identification of the animal (*e.g.*, genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;
- Estimated number of animals (high/low/best);
- Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
- Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
- Detailed behavior observations (*e.g.*, number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);

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

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

- An acoustic encounter identification number, and whether the detection was linked with a visual sighting;
- Date and time when first and last heard;
- Types and nature of sounds heard (*e.g.*, clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal);
- Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

A report would be submitted to NMFS within 90 days after the end of the cruise. 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. The 90-day report 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.

L-DEO will be required to shall submit a draft comprehensive report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of protected species 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 protected species sightings (dates, times, locations, activities, associated survey activities). The draft report shall also include geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording any change in airgun status (*e.g.*, when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa). GIS files shall be provided in ESRI shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the information submitted in interim monthly reports as well as additional data collected as described above and the 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 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 on the draft report.

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).

To avoid repetition, our analysis applies to all species listed in Table 7 and 8, given that NMFS expects the anticipated effects of the proposed seismic survey to be similar in nature. Where there are meaningful differences between species or stocks, or groups of species, in anticipated individual responses to activities, impact of expected take on the population due to differences in population status, or impacts on habitat, NMFS has identified species-specific factors to inform the analysis.

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

We propose to authorize a limited number of instances of Level A harassment of 18 species and Level B harassment of 39 marine mammal species. However, we believe that any PTS incurred in marine mammals as a result of the proposed activity would be in the form of only a small degree of PTS, not total deafness, and would be unlikely to affect the fitness of any individuals, because of the constant movement of both the *Langseth* and of the marine mammals in the project areas, as well as the fact that the vessel is not expected to remain in any one area in which individual marine mammals would be expected to concentrate for an extended period of time (*i.e.*, since the duration of exposure to loud sounds will be relatively short). Also, as described above, we expect that marine mammals would be likely to move away from a sound source that represents an aversive stimulus, especially at levels that would be expected to result in PTS, given sufficient notice of the *Langseth's* approach due to the vessel's relatively low speed when conducting seismic surveys. We expect that the majority of takes would be in the form of short-term Level B behavioral harassment in the form of temporary avoidance of the area or decreased foraging (if such activity were occurring), reactions that are considered to be of low severity and with no lasting biological consequences (*e.g.*, Southall *et al.*, 2007).

Potential impacts to marine mammal habitat were discussed previously in this document (see *Potential Effects of the Specified Activity on Marine Mammals and their Habitat*). Marine mammal habitat may be impacted by elevated sound levels, but these impacts would be temporary. Feeding behavior is not likely to be significantly impacted, as marine mammals appear to be less likely to exhibit behavioral reactions or avoidance responses while engaged in feeding activities (Richardson *et al.*, 1995). Prey species are mobile and are broadly distributed throughout the project areas; 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 relatively short duration (~32 days) and temporary nature of the disturbance, the availability of similar habitat and resources in the surrounding area, 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.

The activity is expected to impact a small percentage of all marine mammal stocks that would be affected by L-DEO's proposed survey (less than 20 percent of all species). Additionally, the acoustic "footprint" of the proposed survey would be small relative to the ranges of the 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 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 power downs and/or shutdowns of the airgun array. Based on previous monitoring reports for substantially similar activities that have been previously authorized by NMFS, we expect that the proposed mitigation will be effective in preventing at least some extent of potential PTS in marine mammals that may otherwise occur in the absence of the proposed mitigation.

The ESA-listed marine mammal species under our jurisdiction that are likely to be taken by the proposed surveys include the endangered sei, fin, blue, sperm, gray, North Pacific Right, Western North Pacific DPS humpback, and Main Hawaiian Islands Insular DPS false killer whale as well as the Hawaiian monk seal. We propose to authorize very small numbers of takes for these species relative to their population sizes. 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 the proposed survey are not listed as threatened or endangered under the ESA. With the exception of the northern fur seal, none of the non-listed marine mammals for which we propose to authorize take are considered "depleted" or "strategic" by NMFS under the MMPA.

The tracklines of the Hawaii survey either traverse or are proximal to BIAs for 11 species that NMFS has proposed to authorize for take. Ten of the BIAs pertain to small and resident cetacean populations while a breeding BIA has been delineated for humpback whales. However, this designation is only applicable to humpback whales in the December through March timeframe (Baird *et al.*, 2015). Since the Hawaii survey is proposed for August, there will be no effects on humpback whales. For cetacean species with small and resident BIAs in the Hawaii survey area, that designation is applicable year-round. There are 19 days of seismic operations proposed for the Hawaii survey. Only a portion of those days would maintain seismic operations along Tracklines 1 and 2. No physical impacts to BIA habitat are anticipated from seismic activities. While SPLs of sufficient strength have been known to cause injury to fish and fish mortality, the most likely impact to prey species from survey activities would be temporary avoidance of the affected 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 expected. Given the short operational seismic time near or traversing BIAs, as well as the ability of cetaceans and prey species to move away from acoustic sources, NMFS expects that there would be, at worst, minimal impacts to animals and habitat within the designated BIAs.

NMFS concludes that exposures to marine mammal species and stocks due to L-DEO’s proposed survey would result in only short-term (temporary and short in duration) effects to individuals exposed. Animals 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 marine mammal species or stocks through effects on annual rates of recruitment or survival:

- No mortality is anticipated or authorized;
- The proposed activity is temporary and of relatively short duration (~32 days);
- 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 number of instances of PTS that may occur are expected to be very small in number. Instances of PTS that are incurred in marine mammals would be of a low level, due to constant movement of the vessel and of the marine mammals in the area, and the nature of the survey design (not concentrated in areas of high marine mammal concentration);

- The availability of alternate areas of similar habitat value for marine mammals to temporarily vacate the survey area during the proposed survey to avoid exposure to sounds from the activity;
- The 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;
- The proposed mitigation measures, including visual and acoustic monitoring, power-downs, 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; 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. Tables 7 and 8 provide numbers of take by Level A harassment and Level B harassment proposed for authorization. These are the numbers we use for purposes of the small numbers analysis.

The numbers of marine mammals that we propose for authorized take would be considered small relative to the relevant populations (19.4 percent for all species) for the species for which abundance estimates are available.

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.

Unmitigable Adverse Impact Analysis and Determination

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

Endangered Species Act (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.

The NMFS Permits and Conservation Division is proposing to authorize the incidental take of marine mammals which are listed under the ESA (the North Pacific right, sei, fin, blue, sperm whales, Western North Pacific DPS humpback whale, gray whale, the Hawaiian Islands Insular DPS false killer whale, and the Hawaiian monk seal. We have requested initiation of Section 7 consultation with the Interagency Cooperation Division for the issuance of this IHA. NMFS will conclude the ESA section 7 consultation prior to reaching a determination regarding the proposed issuance of the authorization.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to L-DEO for conducting seismic surveys in the Pacific Ocean near Hawaii in summer/early fall of 2018 and in the Emperor Seamounts area in spring/early summer 2019, 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 incidental harassment authorization (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 L-DEO's IHA application and using an array aboard the R/V *Langseth* with characteristics specified in the IHA application, in the Pacific Ocean near the Main Hawaiian Islands and the Emperor Seamounts.

3. General Conditions

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

(b) L-DEO shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and shall ensure that relevant vessel personnel and the protected species monitoring team participate in a joint onboard briefing (hereafter PSO briefing) led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, protected species monitoring protocols, operational procedures, and IHA requirements are clearly understood. This PSO briefing must be repeated when relevant new personnel join the survey operations.

(c) The species authorized for taking are listed in Table 7 and 8. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 7 and 8. Any taking exceeding the authorized amounts listed in Table 7 and 8 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) 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.

(e) During use of the airgun(s), if marine mammal species other than those listed in Table 7 and 8 are detected by PSOs, the airgun array must be shut down.

4. Mitigation Requirements

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

(a) L-DEO must use at least five dedicated, trained, NMFS-approved Protected Species Observers (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 of the visual and two of the acoustic PSOs aboard the vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience.

(c) Visual Observation

(i) During survey operations (*e.g.*, any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two visual PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.*, from 30 minutes prior to sunrise through 30 minutes following and 30 minutes prior to and during nighttime ramp-ups of the airgun array.

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

(iii) PSOs shall establish and monitor the exclusion and buffer zones. These zones shall be based upon the radial distance from the edges of the acoustic source (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source (*i.e.*, anytime airguns are active, including ramp-up), occurrences of marine mammals within the buffer zone (but outside the exclusion zone) shall be communicated to the operator to prepare for the potential shutdown or powerdown of the acoustic source.

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

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

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

(d) Acoustic Monitoring

(i) The source vessel must use a towed PAM system, which must be monitored by at a minimum one on duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.

(ii) Acoustic PSOs shall immediately communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

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

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

a. Sea state is less than or equal to BSS 4;

b. With the exception of delphinids, no marine mammals detected solely by PAM in the applicable exclusion zone in the previous two hours;

c. NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and

d. Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

(e) Exclusion zone and buffer zone

(i) PSO shall establish and monitor a 500 m exclusion zone and 1,000 m buffer zone. The exclusion zone encompasses the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0–500 meters). The buffer zone encompasses the area at and below the sea surface from the edge of the 0–500 meter exclusion zone, out to a radius of 1000 meters from the edges of the airgun array (500–1,000 meters).

(f) Pre-clearance and Ramp-up

(i) A ramp-up procedure shall be required at all times as part of the activation of the acoustic source.

(v) Ramp-up may not be initiated if any marine mammal is within the exclusion or buffer zone. If a marine mammal is observed within the exclusion zone or the buffer zone during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zone or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and pinnipeds and 30 minutes for all other species).

(vi) Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Duration shall not be less than 20 minutes.

(vii) PSOs must monitor the exclusion and buffer zones during ramp-up, and ramp-up must cease and the source must be shut down upon observation of a marine mammal within the exclusion zone. Once ramp-up has begun, observations of marine mammals within the buffer zone do not require shutdown or powerdown, but such observation shall be communicated to the operator to prepare for the potential shutdown or powerdown.

(viii) Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up.

(ix) If the acoustic source is shut down for brief periods (*i.e.*, less than 30 minutes) for reasons other than that described for shutdown and powerdown (*e.g.*, mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual or acoustic detections of marine mammals have occurred within the applicable exclusion zone. For any longer shutdown, pre-clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.*, BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-clearance watch of 30 min is not required.

(x) Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance of 30 min.

(g) Shutdown and Powerdown

(i) Any PSO on duty shall have the authority to delay the start of survey operations or to call for shutdown or powerdown of the acoustic source if a marine mammal is detected within the applicable exclusion zone.

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

(iii) When both visual and acoustic PSOs are on duty, all detections shall be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs.

(iv) When the airgun array is active (*i.e.*, anytime one or more airguns is active, including during ramp-up and powerdown) and (1) a marine mammal (excluding delphinids) appears within or enters the exclusion zone and/or (2) a marine mammal is detected acoustically and localized within the exclusion zone, the acoustic source shall be shut down. When shutdown is called for by a PSO, the airgun array shall be immediately deactivated. Any questions regarding a PSO shutdown shall be resolved after deactivation.

(v) Shutdown shall occur whenever PAM alone (without visual sighting), confirms presence of marine mammal(s) (other than delphinids) in the 500 m exclusion zone. If the acoustic PSO cannot confirm presence within exclusion zone, visual PSOs shall be notified but shutdown is not required.

(v) The shutdown requirement shall be waived for small dolphins of the following genera: *Tursiops, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Stenella and Steno*.

a. The acoustic source shall be powered down to 40-in^3 airgun if an individual belonging to these genera is visually detected within the 500 m exclusion zone.

b. Powerdown conditions shall be maintained until delphinids for which shutdown is waived are no longer observed within the 500 m exclusion zone, following which full-power operations may be resumed without ramp-up. Visual PSOs may elect to waive the powerdown requirement if delphinids for which shutdown is waived to be voluntarily approaching the vessel for the purpose of interacting with the vessel or towed gear, and may use best professional judgment in making this decision.

d. If PSOs observe any behaviors in delphinids for which shutdown is waived that indicate an adverse reaction, then powerdown shall be initiated.

(vi) Visual PSOs shall use best professional judgment in making the decision to call for a shutdown if there is uncertainty regarding identification (*i.e.*, whether the observed marine mammal(s) belongs to one of the delphinid genera for which shutdown is waived).

(vii) Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable exclusion zone (*i.e.*, animal is not required to fully exit the buffer zone where applicable) or following a 30-minute clearance period with no further observation of the marine mammal(s).

(g) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (specific distances detailed below), to ensure the potential for strike is minimized.

(i) Vessel speeds must be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of any marine mammal are observed near a vessel.

a. Vessels must maintain a minimum separation distance of 100 m from large whales (*i.e.*, sperm whales and all baleen whales.

b. Vessels must attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel.

c. When marine mammals are sighted while a vessel is underway, the vessel should take action as necessary to avoid violating the relevant separation distance. If marine mammals are sighted within the relevant separation distance, the vessel should reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This recommendation does not apply to any vessel towing gear.

5. Monitoring Requirements.

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

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

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

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

(ii). At least one night-vision device suited for the marine environment for use during nighttime pre-clearance and ramp-up that features automatic brightness and gain control, bright light protection, infrared illumination, and/or optics suited for low-light situations (*e.g.,* Exelis PVS-7 night vision goggles; Night Optics D-300 night vision monocular; FLIR M324XP thermal imaging camera or equivalents).

(iii) Reticle binoculars (*e.g.*, 7 x 50) of appropriate quality (*i.e.*, Fujinon or equivalent) (at least one per PSO, plus backups)

(iv) Global Positioning Units (GPS) (at least one per PSO, plus backups)

(v) Digital single-lens reflex cameras of appropriate quality that capture photographs and video (*i.e.*, Canon or equivalent) (at least one per PSO, plus backups)

(vi) Compasses (at least one per PSO, plus backups)

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

(viii) Any other tools necessary to adequately perform necessary PSO tasks.

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

(i) PSOs shall be independent, dedicated, trained visual and acoustic PSOs and must be employed by a third-party observer provider,

(ii) PSOs shall have no tasks other than to conduct observational effort (visual or acoustic), collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards), and

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

(iv) PSOs can act as acoustic or visual observers (but not at the same time) as long as they demonstrate that their training and experience are sufficient to perform the task at hand.

(v) NMFS must review and approve PSO resumes accompanied by a relevant training course information packet that includes the name and qualifications (*i.e.*, experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material as well as a document stating successful completion of the course.

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

(vii) One visual PSO with experience as shown in 4(b) shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. To the maximum extent practicable, the lead PSO shall devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

(viii) PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

(ix). PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics.

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

(d) Data Collection

(i) PSOs shall use standardized data collection 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. If required mitigation was not implemented, PSOs should record a description of the circumstances.

(ii) At a minimum, the following information must be recorded:

a. Vessel names (source vessel and other vessels associated with survey) and call signs;

b. PSO names and affiliations;

c. Dates of departures and returns to port with port name;

d. Date and participants of PSO briefings (as discussed in General Requirements. 2.)

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

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

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

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

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

j 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-clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.); and

(iii). Upon visual observation of any protected species, the following information shall 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) and 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/breaths, 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 (CPA) and/or closest distance from any element 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) and time and location of the action.

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

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

b. Date and time when first and last heard;

c. Types and nature of sounds heard (*e.g.*, clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal);

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

6. Reporting

(a) L-DEO shall submit a draft comprehensive report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of protected species 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 protected species sightings (dates, times, locations, activities, associated survey activities). The draft report shall also include geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording any change in airgun status (*e.g.*, when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa). GIS files shall be provided in ESRI shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the information submitted in interim monthly reports as well as additional data collected as described above in Data Collection and the 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 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 on the draft report.

(b) Reporting injured or dead protected species:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not permitted by this IHA, such as serious injury or mortality, L-DEO shall immediately cease the specified activities and immediately report the incident to the NMFS Office of Protected Resources and the NMFS Pacific Islands Regional Stranding Coordinator. The report must include the following information:

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

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

c. Description of the incident;

d. Status of all sound source use in the 24 hours preceding the incident;

e. Water depth;

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

g. Description of all marine mammal observations in the 24 hours preceding the incident;

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

i. Fate of the animal(s); and

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

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

(ii) In the event that L-DEO 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), L-DEO shall immediately report the incident to the NMFS Office of Protected Resources and the NMFS Pacific Islands Regional Stranding Coordinator. 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 L-DEO to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iii) In the event that L-DEO 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), L-DEO shall report the incident to the NMFS Office of Protected Resources and the Pacific Islands Regional Stranding Coordinator within 24 hours of the discovery. L-DEO 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 L-DEO's proposed surveys. We also request comment on the potential for renewal of this proposed IHA as described in the paragraph below. Please include with your comments any supporting data or literature citations to help inform our final decision on the request for MMPA authorization.

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

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

- The request for renewal must include the following:

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

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

- Upon review of the request for renewal, the status of the affected species or stocks, and any other pertinent information, NMFS determines that there are no more than minor changes in the activities, the mitigation and monitoring measures remain the same and appropriate, and the original findings remain valid.

Dated: June 21, 2018.

Elaine T. Saiz,

Acting Deputy Director,

Office of Protected Resources,

National Marine Fisheries Service.

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