DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XG736

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Marine Geophysical Survey in the Gulf of Alaska

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

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

SUMMARY: NMFS 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 Gulf of Alaska. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an incidental harassment authorization (IHA) to incidentally take marine mammals during the specified activities. NMFS is also requesting comments on a possible one-year renewal that could be issued under certain circumstances and if all requirements are met, as described in *Request for Public Comments* at the end of this notice. NMFS will consider public comments prior to making any final decision on the issuance of the requested MMPA authorizations and agency responses will be summarized in the final notice of our decision.

DATES: Comments and information must be received no later than May 9, 2019.

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.redding@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/permit/incidental-take-authorizations-under-marine-mammal-protection-act* 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: Gray Redding, Office of Protected Resources, NMFS, (301) 427–8401. Electronic copies of the application and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities.* In case of problems accessing these documents, please call the contact listed above.

SUPPLEMENTARY INFORMATION:

Background

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

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

The definitions of all applicable MMPA statutory terms cited above are included in the relevant sections below.

National Environmental Policy Act

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

Accordingly, NMFS plans to adopt the National Science Foundation's (NSF) 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. NMFS is a cooperating agency on NSF's EA. NSF's EA will be made available for public comment at *https://www.nsf.gov/geo/oce/envcomp/* on approximately April 1, 2019. 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 November 20, 2018, NMFS received a request from L–DEO for an IHA to take marine mammals incidental to conducting seismic geophysical surveys in the Gulf of Alaska along the Alaska Peninsula subduction zone. On December 19, 2018, NMFS received a revised copy of the application, and that application was deemed adequate and complete on February 11, 2019. L–DEO's request is for take of a small number of 21 marine mammal species by Level B harassment and Level A harassment. Underwater sound associated with airgun use may result in the behavioral harassment or auditory injury of marine mammals in the ensonified areas. Neither L–DEO nor NMFS expects serious injury or mortality to result from this activity and, therefore, an IHA is appropriate.

NMFS previously issued an IHA to L–DEO for similar work (76 FR 38621; July 1, 2011). L–DEO complied with all the requirements (*e.g.,* mitigation, monitoring, and reporting) of the previous IHA and information regarding their monitoring results may be found in the ''Description of Marine Mammals in the Area of Specified Activities.''

Description of Proposed Activity

Overview

The specified activity consists of a high energy geophysical seismic survey conducted in a portion of the Gulf of

Alaska. Researchers from Lamont-Doherty Earth Observatory (L–DEO), Cornell University, Colgate University, University of Washington, University of California Santa Cruz, University of Colorado Boulder, University of New Mexico, Washington University in St. Louis, and the United States Geological Survey (USGS), with funding from NSF, propose to conduct the seismic survey from the Research Vessel (R/V) *Marcus G. Langseth* (*Langseth*) in the Gulf of Alaska during 2019. The NSF-owned *Langseth* is operated by Columbia University's L–DEO under an existing Cooperative Agreement. The proposed seismic survey would likely occur off the Alaska Peninsula and the eastern Aleutian islands during late spring 2019 and would use a 36-airgun towed array with a total discharge volume of ~6600 in^3. The survey would take place within the U.S. Exclusive Economic Zone (EEZ), in water ~15 to ~6,184 m deep.

The main goal of L–DEO's proposed seismic program is to conduct a 2D survey along the Alaska Peninsula subduction zone using airguns. The addition of active sources (airguns) to the existing seismic monitoring equipment in place would directly contribute to the overall project goals of imaging the architecture for the subduction zone and understanding the structures controlling how and where the planet's largest earthquakes occur.

Dates and Duration

The survey is expected to consist of up to 18 days of seismic operations and ~1 day of transit. The *Langseth* would leave from and return to port in Kodiak, likely during late spring (end of May/early June) 2019. Tentative sail dates are 1–19 June 2019.

Timing of the proposed survey will take advantage of the Alaska Amphibious Community Seismic Experiment (AACSE), which has deployed 75 ocean bottom seismometers (OBSs) offshore of the Alaska Peninsula. The survey needs to be conducted while the AACSE OBSs are on the sea floor (before 6 August 2019). The most value-added time window is mid-May through mid-June, when an on-shore seismic array, consisting of 400–450 onshore seismometers will also be deployed on Kodiak Island and which could record an unprecedented ship-to-shore dataset.

Specific Geographic Region

The proposed survey would occur within the area of ~52–58° N, ~150–162° W, within the EEZ of Alaska in water depths ranging from ~15 to ~6184 m. Representative survey tracklines are shown in Figure 1. As described further in this document, however, 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, within the constraints of any federal authorizations issued for the activity, tracklines may shift from those shown in the application and could occur anywhere within the coordinates noted above and illustrated by the box in the inset map on Figure 1 of the IHA application.

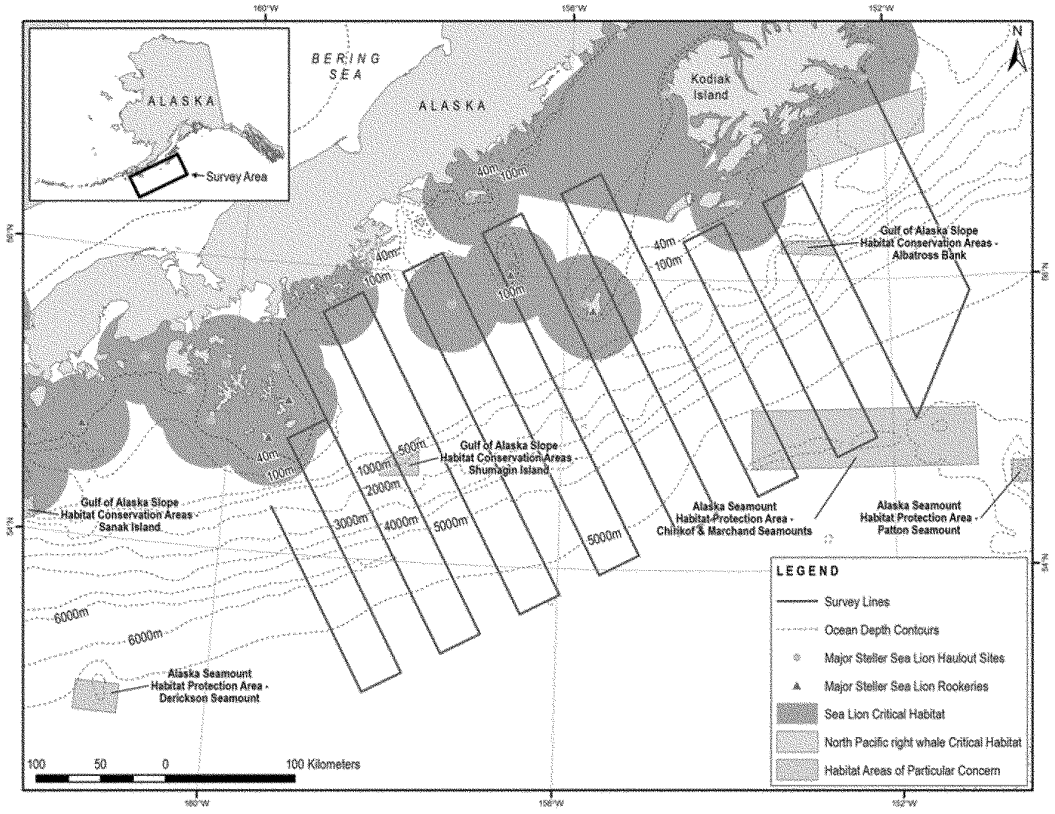

Figure 1. Map of the proposed 2019 seismic survey off the Alaskan Peninsula showing representative survey lines.

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 previously deployed OBSs and onshore seismometers (See Figure 2 in IHA Application), as well as a single hydrophone streamer 5 kilometers (km) in length; no hydrophone streamer would be towed during the survey. As the airgun arrays are towed along the survey lines, the seismometers would receive and store the returning acoustic signals internally for later analysis and the hydrophone streamer would transfer the data to the on-board processing system.

For this proposed survey, a total of ~4400 km of transect lines would be surveyed in the Gulf of Alaska (GOA). There could be additional seismic operations associated with turns, airgun testing, and repeat coverage of any areas where initial data quality is sub-standard. To account for unanticipated delays, 25 percent has been added in the form of operational days, which is equivalent to adding 25 percent to the proposed line km to be surveyed. During the survey, approximately 13 percent of the line km would take place in shallow water (<100 meter (m)), 27 percent would occur in intermediate water depths (100–1000 m), and the rest (60 percent) would occur in deep water (>1000 m).

In addition to the operations of the airgun array, the ocean floor would be mapped with a Kongsberg EM 122 multibeam echosounder (MBES) and a Knudsen Chirp 3260 sub-bottom profiler (SBP). A Teledyne RDI 75 kilohertz (kHz) Ocean Surveyor Acoustic Doppler Current Profiler (ADCP) would be used to measure water current velocities. These sources would be operated from the *Langseth* continuously during the seismic survey, 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 survey, 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 be 399.3 m for the entire survey.

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

Description of Marine Mammals in the Area of Specified Activities

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

Table 1 lists all species with expected potential for occurrence in the Gulf of Alaska and summarizes information related to the population or stock, including regulatory status under the MMPA and ESA and potential biological removal (PBR), where known. For taxonomy, we follow Committee on Taxonomy (2017). PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (as described in NMFS's SARs). While no mortality is anticipated or authorized here, PBR and annual serious injury and mortality from anthropogenic sources are included here as gross indicators of the status of the species and other threats.

Sixteen species of cetaceans and five species of pinnipeds could occur in the proposed Gulf of Alaska survey area. Cetacean species include seven species of mysticetes (baleen whales) and nine species of odontocetes (dolphins and small and large toothed whales).

Ferguson *et al.* (2015) described Biological Important Areas (BIAs) for cetaceans in the Gulf of Alaska. BIAs were delineated for four baleen whale species and one toothed whale species including fin, gray, North Pacific right, and humpback whales, and belugas in U.S. waters of the Gulf of Alaska. BIAs are described in the following sections for each marine mammal species, except for beluga whale BIAs, as these do not co-occur within L–DEO's proposed survey area and the species is not expected to be present there. BIAs are delineated for feeding, migratory corridors, and small and resident populations. Supporting evidence for these BIAs came from aerial-, land-, and vessel-based surveys; satellite tagging data; passive acoustic monitoring; traditional ecological knowledge; photo- and genetic-identification data; whaling data, including catch and sighting locations and stomach contents; prey studies; and observations from fishermen.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study or survey area. NMFS's stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, stock abundance estimates are not available, and survey abundance estimates are used. This survey area may or may not align completely with a stock's geographic range as defined in the SARs. For some species, this geographic area may extend beyond U.S. waters. All managed stocks in this region are assessed in NMFS's U.S. Alaska and U.S. Pacific SARs (*e.g.,* Muto *et al.* 2018, Carretta *et al.* 2018). All values presented in Table 1 are the most recent available at the time of publication and are available in the 2017 SARs (Muto *et al.* 2018, Carretta *et al.* 2018) and draft 2018 SARs (available online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/draft-marine-mammal-stock-assessment-reports*).

TABLE 1—MARINE MAMMALS THAT COULD OCCUR IN THE PROJECT AREA DURING THE SPECIFIED ACTIVITY

Common name	Scientific name	Stock	ESA/ MMPA status; strategic (Y/N) [1]	Stock abundance (CV, N_{min}, most recent abundance survey) [2]	PBR	Annual M/SI [3]
Order Cetartiodactyla—Cetacea—Superfamily Mysticeti (baleen whales)						
Family Eschrichtiidae:						
Gray whale	*Eschrichtius robustus*	Eastern North Pacific	-, -, N	26,960 (0.05, 25,849, 2016)	801	138
		Western North Pacific	E, D, Y	175 (0.05, 167, 2016)	0.07	UNK
Family Balaenidae:						
North Pacific right whale	*Eubalaena japonica*	Eastern North Pacific	E, D, Y	31 (0.226, 26, 2015)	0.05 b	0
Family Balaenopteridae (rorquals):						
Blue whale	*Balaenoptera musculus*	Eastern North Pacific	E, D, Y	1,647 (0.07, 1,551, 2011)	2.3	≥0.2
		Central North Pacific	E, D, Y	133 (1.09, 63, 2010)	0.1	0
Fin whale * [4]	*Balaenoptera physalus*	Northeast Pacific	E, D, Y	3,168 [4]	5.1	0.6
Sei whale	*Balaenoptera borealis*	Eastern North Pacific	E, D, Y	519 (0.4, 374, 2014)	0.75	0
Minke whale * [5]	*Balaenoptera acutorostrata*	Alaska	-, -, N	1,233 [5]	UND	0
Humpback whale	*Megaptera novaeangliae*	Central North Pacific	-, -, Y	10,103 (0.3, 7,890, 2006)	83	25
		Western North Pacific	E, D, Y	1,107 (0.3, 865, 2006)	3	3.2
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)						
Family Physeteridae:						
Sperm whale *	*Physeter macrocephalus*	North Pacific	E, D, Y	N/A (see SAR, N/A, 2015)	see SAR	4.4
Family Ziphiidae (beaked whales):						
Cuvier's beaked whale	*Ziphius cavirostris*	Alaska	-, -, N	N/A (see SAR, N/A, see SAR).	UND	0
Baird's beaked whale	*Berardius bairdii*	Alaska	-, -, N	N/A (see SAR, N/A, see SAR).	UND	0
Stejneger's beaked whale.	*Mesoplodon stejnegeri*	Alaska	-, -, N	N/A (see SAR, N/A, see SAR).	UND	0
Family Delphinidae:						
Killer whale	*Orcinus orca*	Eastern North Pacific Alaska Resident.	-, -, N	2,347 c (N/A, 2347, 2012)	24	1
		Gulf of Alaska, Aleutian Islands, and Bering Sea Transient.	-, -, N	587 c (N/A, 587, 2012)	5.87	1
		AT1 Transient	-, D, Y	7 c (N/A, 7, 2017)	0.01	0
		Offshore	-, -, N	240 (0.49, 162, 2014)	1.6	0
Risso's dolphin	*Grampus griseus*	CA/WA/OR	-, -, N	6,336 (0.32, 4,817, 2014)	46	≥3.7
Pacific white-sided dolphin.	*Lagenorhynchus obliquidens*	North Pacific	-, -, N	26,880 (N/A, N/A, 1990)	UND	0
Family Phocoenidae (porpoises):						
Harbor porpoise	*Phocoena phocoena*	GOA	-, -, Y	31,046 (0.214, N/A, 1998)	UND	72
		Southeast Alaska	-, -, Y	see SAR (see SAR, see SAR, 2012).	8.9	34
Dall's porpoise	*Phocoenoides dalli*	Alaska	-, -, N	83,400 (0.097, N/A, 1991)	UND	38
Order Carnivora—Superfamily Pinnipedia						
Family Otariidae (eared seals and sea lions):						
Steller sea lion	*Eumetopias jubatus*	Eastern U.S.	T, D, Y	41,638 a (see SAR, 41,638, 2015).	2,498	108
		Western U.S.	E, D, Y	54,267 a (see SAR, 54,267, 2017).	326	252
California sea lion	*Zalophus californianus*	U.S.	-, -, N	296,750 (N/A, 153,337, 2011).	9,200	389
Northern fur seal	*Callorhinus ursinus*	Eastern Pacific	-, D, Y	620,660 (0.2, 525,333, 2016).	11,295	457
Family Phocidae (earless seals):						
Northern elephant seal	*Mirounga angustirostris*	California Breeding	-, -, N	179,000 (N/A, 81,368, 2010)	4,882	8.8
Harbor seal	*Phoca vitulina*	South Kodiak	-, -, N	19,199 (see SAR, 17,479, 2011).	314	128
		Cook Inlet/Shelikof Strait	-, -, N	27,386 (see SAR, 25,651, 2011).	770	234
		Prince William Sound?	-, -, N	29,889 (see SAR, 27,936, 2011).	838	279

* Stocks marked with an asterisk are addressed in further detail in text below.

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

[2] NMFS marine mammal stock assessment reports online at: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessments.* CV is coefficient of variation; N_{min} is the minimum estimate of stock abundance. In some cases, CV is not applicable (N/A).

[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).

[4] Uncorrected estimate from Rone *et al.* (2017) based on a series of line-transect surveys off of Kodiak Island. The maximum estimate from the three surveys was selected. Based on the limited footprint of the surveys that lead to this estimate, the true abundance of the stock is expected to be much higher.

[5] Uncorrected estimate from Zerbini *et al.,* (2006) based on a partial line-transect survey of the Gulf of Alaska.
Note—Italicized species or stocks are not expected to be taken or proposed for authorization.

All species that could potentially occur in the proposed survey areas are included in Table 1. With the exception of AT1 transient killer whales, these species or stocks temporally and spatially co-occur with the activity to the degree that take is reasonably likely to occur. However, the spatial occurrence of the AT1 transient is such that take is not expected to occur, and they are not discussed further beyond the explanation provided here.

AT1 transient killer whales are a small, genetically distinct population of transient ecotype killer whales found in the Gulf of Alaska (Matkin *et al.* 1999). The population has declined from a size of 22 whales in 1984, to just 7 today, and it is believed this decline was associated with the Exxon Valdez Oil Spill in 1989 (Matkin *et al.* 2008). AT1 transients have only ever been seen in Prince William Sound and in the Kenai Fjords region (Muto *et al.* 2018; Matkin *et al.* 2008). Therefore, while the stock is present in the Gulf of Alaska, and deserved consideration, the limited range of the stock and the fact that this range does not overlap with L–DEO's proposed survey means take is not likely to occur for the AT1 stock of transient killer whales.

No comprehensive abundance estimate is available for the Alaska stock of minke whales. The best available estimate for the area comes from line-transect surveys conducted in shelf and nearshore waters (within 30–45 nautical miles of land) in 2001–2003 between the Kenai Peninsula (150° W) and Amchitka Pass (178° W). Minke whale abundance was estimated to be 1,233 (CV = 0.34) for this area (not been corrected for animals missed on the trackline) (Zerbini *et al.* 2006). The majority of the sightings were in the Aleutian Islands, rather than in the Gulf of Alaska, and in water shallower than 200 m. This estimate cannot be used as an estimate of the entire Alaska stock of minke whales because only a portion of the stock's range was surveyed. Similarly, although a comprehensive abundance estimate is not available for the northeast Pacific stock of fin whales, there are provisional estimates representing relevant portions of the range. Zerbini *et al.* (2006) produced an estimate of 1,652 (95 percent CI: 1,142–2,389) fin whales for the area described above. Additionally, a series of line-transect surveys off of Kodiak Island and the in the northern Gulf of Alaska conducted in 2009, 2013, and 2015, generated a maximum estimate of 3,168 (CV = 0.26) (also not been corrected for animals missed on the trackline) (Rone *et al.* 2017).

Kato and Miyashita (1998) reported 102,112 sperm whales (CV = 0.155) in the western North Pacific, however, with the caveat that their estimate is likely positively biased. From surveys in the Gulf of Alaska in 2009 and 2015, Rone *et al.* (2017) estimated 129 (CV = 0.44) and 345 sperm whales (CV = 0.43) in each year, respectively. The overall number of sperm whales occurring in Alaska waters is unknown (Muto *et al.* 2018).

For the three species of beaked whale expected to occur in the area (Baird's, Cuvier's, and Stejneger's), there are no reliable estimates of abundance.

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 21 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.

In addition, the northern sea otter (*Enhydra lutris*) and Pacific walrus (*Odobenus rosmarus divergens*) may be found in the Gulf of Alaska. However, northern sea otter and Pacific walrus are managed by the U.S. Fish and Wildlife Service and are not considered further in this document.

Mysticetes

North Pacific Right Whale (*Eubalaena japonica*)

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). This species is divided into western and eastern North Pacific stocks. The eastern North Pacific stock that occurs in U.S. waters numbers only ~31 individuals (Wade *et al.* 2011b), and critical habitat has been designated in the eastern Bering Sea and in the GOA, 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; Banfield 1974; Gilmore 1978; Reeves *et al.* 1978; Herman *et al.* 1980; Omura 1986).

Since the 1960s, North Pacific right whale sightings have been relatively rare (*e.g.,* Clapham *et al.* 2004; Shelden *et al.* 2005). In the eastern North Pacific, south of 50 °N, only 29 reliable sightings were recorded from 1900 to 1994 (Scarff 1986, 1991; Carretta *et al.* 1994). Starting in 1996, right whales have been sighted regularly in the southeast Bering Sea, including calves in some years (Goddard and Rugh 1998; LeDuc *et al.* 2001; Moore *et al.* 2000, 2002b; Wade *et al.* 2006; Zerbini *et al.* 2009); they have also been detected acoustically when sonobuoys were deployed (McDonald and Moore 2002; Munger *et al.* 2003, 2005, 2008; Berchok *et al.* 2009). Right whales are known to occur in the southeast Bering Sea from May to December (*e.g.,* Tynan *et al.* 2001; Hildebrand and Munger 2005; Munger *et al.* 2005, 2008). Call frequencies tended to be higher in July–October than from May–June or November–December (Munger *et al.* 2008). Right whales seem to pass through the middle-shelf areas, without remaining there longer than a few days (Munger *et al.* 2008).

Shelden *et al.* (2005) reported that the slope and abyssal plain in the western GOA were important areas for right whales until the late 1960s, but sightings and acoustic detections in this region in recent decades are rare. In March 1979, a group of four right whales was seen in Yakutat Bay (Waite *et al.* 2003), but there were no further reports of right whale sightings in the GOA until July 1998, when a single whale was seen southeast of Kodiak Island (Waite *et al.* 2003). Three sightings and one acoustic detection of right whales were made in Barnabas Trough south of Kodiak Island during NOAA surveys in 2004 to 2006 in areas with high densities of zooplankton (Wade *et al.* 2011a). Those authors also report a fourth opportunistic sighting by a commercial fisher during that time in the same area. One right whale was sighted in the Aleutian Islands south of Unimak Pass in September 2004 (Wade *et al.* 2011b). A BIA for feeding for North Pacific right whales was designated east of the Kodiak Archipelago, encompassing the GOA critical habitat and extending south of 56° N and north of 58° N and beyond the shelf edge (Ferguson *et al.* 2015). Feeding primarily occurs in this BIA between June and September (Ferguson *et al.* 2015)

Right whale acoustic detections were made south of the Alaska Peninsula and to the east of Kodiak Island in 2000 during August and September (see

Waite *et al.* 2003; Mellinger *et al.* 2004b), but no acoustic detections were made from April to August 2003 (Munger *et al.* 2008) or in April 2009 (Rone *et al.* 2010). Three right whales were acoustically detected in the Barnabas Trench area during a towed-PAM survey of the U.S. Navy training area east of Kodiak in the summer of 2013 but none were observed visually (Rone *et al.* 2014). Right whales were not consistently detected acoustically from (2011–2015) with the fixed PAM monitoring in this region (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013; Rice *et al.* 2015), but there were detections on two days in June and August 2013 (Debich *et al.* 2014). No right whales were visually observed during the three years of surveys (2009, 2013, and 2015) in this military area east of Kodiak (Rone *et al.* 2017). There was one sighting of a single North Pacific right whale during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011). There was another sighting of a lone North Pacific right whale during a marine mammal cruise, approximately 130 miles east of Kodiak Island in July 2012 (Matsuoka *et al.* 2013). Thus, it is possible that a right whale could be seen during the proposed survey.

Gray Whale (*Eschrichtius robustus*)

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 distinction population segments (DPSs) could occur in the proposed survey area in the eastern North Pacific.

Gray whale populations were severely reduced by whaling, but the eastern North Pacific population is considered to have recovered. Punt and Wade (2012) estimated the eastern North Pacific population to be at 85 percent of its carrying capacity in 2009. 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; Rice 1998; Jefferson *et al.* 2015). Most of the eastern Pacific population makes a round-trip annual migration of more than 18,000 km. From late May to early October, the majority of the population concentrates in the northern and western Bering Sea and in the Chukchi Sea. However, some individuals spend the summer months scattered along the coasts of southeast Alaska, B.C., Washington, Oregon, and northern California (Rice and Wolman 1971; Nerini 1984; Darling *et al.* 1998; Dunham and Duffus 2001, 2002; Calambokidis *et al.* 2002). Gray whales are found primarily in shallow water; most follow the coast during migration, staying close to the shoreline except when crossing major bays, straits, and inlets (Braham 1984).

It is difficult to determine precisely when the southbound migration begins; whales near Barrow were moving predominantly south in August (Maher 1960; Braham 1984). Gray whales leave the Bering Sea through Unimak Pass from late October through January (Braham 1984). From October to January, the main part of the population moves down the west coast of North America. Rugh *et al.* (2001) analyzed data collected from two sites in California to estimate the timing of the gray whale southward migration. They estimated that the median date for the migration past various sites was 1 December in the central Bering Sea (a nominal starting point), 12 December at Unimak Pass, 18 December at Kodiak Island, and 5 January for Washington.

By January and February, most of the whales are concentrated in the lagoons along the Pacific coast of the Baja Peninsula, Mexico. From late February to June, the population migrates northward to arctic and subarctic seas (Rice and Wolman 1971). The peak of northward migration in the GOA occurs in mid-April (Braham 1984). Most gray whales follow the coast during migration and stay within 2 km of the shoreline, except when crossing major bays, straits, and inlets from southeast Alaska to the eastern Bering Sea (Braham 1984). Gray whales use the nearshore areas of the Alaska Peninsula during the spring and fall migrations, and are often found within the bays and lagoons, primarily north of the peninsula, during the summer (Brueggeman *et al.* 1989 in Waite *et al.* 1999). However, gray whales are known to move further offshore between the entrance to Prince William Sound (PWS) and Kodiak Island and between Kodiak Island and the southern part of the Alaska Peninsula (Consiglieri *et al.* 1982). During May–October, primary occurrence extends seaward 28 km from the shoreline. This is the main migratory corridor for gray whales.

In the summer, gray whales are seen in the southeast Bering Sea (Moore *et al.* 2002b) and in the GOA, including around Kodiak Island (*e.g.,* Wade *et al.* 2003; Calambokidis *et al.* 2004; Calambokidis 2007; Moore *et al.* 2007). In fact, gray whales have been seen feeding off southeast Kodiak Island, in particular near Ugak Bay, year-round (Moore *et al.* 2007). Moore *et al.* (2007) noted monthly sighting rates that exceeded 100 sightings/h in January, June, September, and November, and >20 sightings/h in most other months. One feeding aggregation in July consisted of 350–400 animals, clustered in groups of 10–20 animals, from the mouth of Ugak Bay to 100 km ESE of Ugak Island (Moore *et al.* 2007). Wade *et al.* (2003) reported a group size of 5.6 in the western GOA. A biologically important area (BIA) for feeding for gray whales has been identified in the waters east of the Kodiak Archipelago, with the greatest densities of gray whales occurring from June through August (Ferguson *et al.* 2015). Additionally, a gray whale migratory corridor BIA has been established extending from Unimak Pass in the western GOA to the Canadian border in the eastern GOA (Ferguson *et al.* 2015), including much of the landward side of the survey area. Gray whales occur in this area in high densities during November through January (southbound) and March through May (northbound).

Rone *et al.* (2017) sighted gray whales off Ugak Island, Kodiak, in all three years (2009, 2013, and 2015) of surveys in the military training area east of Kodiak. Gray whales were detected acoustically throughout the summer and fall at fixed hydrophones on the shelf off Kenai Peninsula and near Kodiak Island in this military training area in a 2014–2015 study (Rice *et al.* 2015), but they were not detected at deeper slope or seamount sites and they were detected only once in prior years of study from 2011 to 2013 (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013). Gray whales were neither observed visually nor detected acoustically during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011). Gray whales could be encountered during the proposed seismic survey in the GOA.

Humpback Whale (*Megaptera novaeangliae*)

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). These breeding areas are recognized as the Mexico, Central America, Hawaii, and Western Pacific DPSs (NMFS 2016b). Hawaii is the primary wintering area for whales from summer feeding areas in the Gulf of Alaska (Calambokidis *et al.* 2008). Individuals from the Hawaii, Western Pacific, and Mexico DPSs could occur in the proposed survey area to feed. The Hawaii DPS is not listed and the Mexico DPS is listed as threatened under the ESA. Additionally, the Western North Pacific stock, analogous to the western Pacific DPS, is listed as endangered under the ESA.

There is potential for mixing of the western and eastern North Pacific humpback populations on their summer feeding grounds, and several sources suggest that this occurs to a limited extent (Muto *et al.* 2018). NMFS is currently reviewing the global humpback whale stock structure in light of the recent revision to their ESA listing and identification of 14 DPSs (81 FR 62259; 8 September 2016). Currently, two stocks of humpback whales are recognized as occurring in Alaskan waters. The Central North Pacific Stock occurs from southeast Alaska to the Alaska Peninsula and the Western North Pacific Stock occurs from the Aleutians to the Bering Sea and Russia. These two stocks overlap on feeding grounds in the eastern Bering Sea and the western Gulf of Alaska (Muto *et al.* 2018), encompassing the entire proposed survey area. BIAs for humpback whale feeding have been designated surrounding Kodiak Island and the Shumagin Islands (Ferguson *et al.* 2015). The highest densities of humpback whales occur during July through September around Kodiak Island and during July through August in the Shumagin Islands.

Humpback whales are commonly sighted within the proposed survey area. Waite (2003) reported that 117 humpbacks were seen in 41 groups during their surveys in the western GOA in 2003, with aggregations seen off northeast Kodiak Island. During summer surveys from the Kenai Fjords to the central Aleutian Islands in 2001–2003, humpbacks were most abundant near Kodiak Island, the Shumagin Islands, and north of Unimak Pass (Zerbini *et al.* 2006). Sightings of humpbacks around the Kodiak Islands were made most frequently in the fall, and aggregations were seen off Shuyak and Sitkalidak islands (Wynne and Witteveen 2005), as well as in Marmot and Chiniak bays (Baraff *et al.* 2005). Waite *et al.* (1999) noted another aggregation area north of Unalaska Island. Offshore sightings of humpbacks have also been made south of the Alaska Peninsula, including ~280 km south of the Shumagin Islands (*e.g.,* Forney and Brownell 1996; Waite *et al.* 1999). Humpback whales were sighted a total of 220 times (637 animals) during the three years of surveys (2009, 2013, and 2015) in and near the U.S. Navy training area east of Kodiak (Rone *et al.* 2017). Humpback whales were also frequently detected acoustically during all years (2011–2015) of fixed-PAM studies in this area, with peak detections during late fall through early winter and detections at all shelf, slope, and seamount sites (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013; Rice *et al.* 2015). Humpback whales were the most frequently sighted cetacean during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey, comprising 50 percent of all cetacean sightings (RPS 2011). There were 92 sightings of this species, representing 288 animals during the 37 days of monitoring. The average group size was three and the maximum group size was 37. This species is likely to be common in the proposed survey area.

Calambokidis *et al.* (2008) reported an abundance estimate of 3,000–5,000 for the GOA. Rone *et al.* (2017) calculated an abundance estimate of 2,215 (uncorrected for missed animals) from a June–July 2013 survey in the U.S. Navy training area east of Kodiak Island, with the bulk of this estimate (2,927) found in the inshore stratum. NMFS provides best estimates of 1,107 for the Western North Pacific Stock and 10,103 for the Central North Pacific Stock (Muto *et al.* 2018). Within the Central North Pacific stock, the Hawaii DPS is estimated to contain 11,398 animals where the Mexico DPS is estimated to contain 3,264 animals (81 FR 62259; effective October 11, 2016).

Minke Whale (*Balaenoptera acutorostrata*)

The 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 180°N, and the remainder of the Pacific (Donovan 1991). NMFS recognizes a single stock in Alaskan waters and a second California/Oregon/Washington Stock (Muto *et al.* 2016).

The minke whale tends to be solitary or in groups of 2–3 but can occur in much larger aggregations around prey resources (Jefferson *et al.* 2008). Predominantly solitary animals were seen during surveys in Alaska (Wade *et al.* 2003; Waite 2003; Zerbini *et al.* 2006). The small size, inconspicuous blows, and brief surfacing times of minke whales mean that they are easily overlooked in heavy sea states, although they are known to approach vessels in some circumstances (Stewart and Leatherwood 1985). Little is known about the diving behavior of minke whales, but they are not known to make prolonged deep dives (Leatherwood and Reeves 1983).

Minke whales are relatively common in the Bering and Chukchi seas and in the inshore waters of the GOA (Mizroch 1992), but they are not considered abundant in any other part of the eastern Pacific (Brueggeman *et al.* 1990). Waite (2003) sighted four minke whales in three groups during surveys in the western GOA in 2003, south of the Kenai Peninsula and south of PWS. Moore *et al.* (2002b) reported a minke whale sighting south of the Sanak Islands. Baraff *et al.* (2005) reported a single sighting near Kodiak Island in July 2002. During surveys in the western GOA and eastern Aleutians, minke whales occurred primarily in the Aleutians; a few sightings were made

south of the Alaska Peninsula and near Kodiak Island (Zerbini *et al.* 2006). Rone *et al.* (2017) reported two sightings totaling three minke whales in 2009, three sightings totaling six minke whales in 2013, and no sightings of minke whales in 2015 in the U.S. Navy training area east of Kodiak. Minke whales were not detected acoustically during any year (2011–2015) of the fixed-PAM studies in the Department of the Navy (DoN) area east of Kodiak (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013; Rice *et al.* 2015). There was one sighting of a single minke whale during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Sei Whale (*Balaenoptera borealis*)

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). On feeding grounds, sei whales associate with oceanic frontal systems (Horwood 1987) such as the cold eastern currents in the North Pacific (Perry *et al.* 1999). Sei whales are frequently seen in groups of 2–5 (Jefferson *et al.* 2008), although larger groups sometimes form on feeding grounds (Gambell 1985a).

In the U.S. Pacific, an Eastern North Pacific and a Hawaii stock are recognized (Carretta *et al.* 2017). During summer in the North Pacific, the sei whale can be found from the Bering Sea to the northern GOA and south to California, and in the western Pacific from Japan to Korea. Its winter distribution is concentrated at about 20° N, and sightings have been made between southern Baja California and the Islas Revilla Gigedo (Rice 1998). No breeding grounds have been identified for sei whales; however, calving is thought to occur from September to March.

Moore *et al.* (2002b) made four sightings of six sei whales during summer surveys in the eastern Bering Sea, and one sighting south of the Alaska Peninsula between Kodiak and the Shumagin Islands. No sei whales were seen during surveys of the GOA by Wade *et al.* (2003), Waite (2003), or Zerbini *et al.* (2006). Rone *et al.* (2017) reported no sei whale sightings in 2009 or 2013 and a single sei whale sighting of one animal in 2015 in the U.S. Navy training area east of Kodiak. There was one sighting of two sei whales during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011). During a 2012 survey in summer and early fall, Matsuoka *et al.* (2013) reported 87 sei whale sightings of 1,647 individuals, however the majority of these sightings were far south of the action area. Sei whale sightings are likely to be uncommon in the proposed survey area.

Fin Whale (*Balaenoptera physalus*)

The fin whale is widely distributed in all the World's oceans (Gambell 1985b), 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 1985b). In the United States, 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 the GOA (*e.g.,* Moore *et al.* 2006; Stafford *et al.* 2007, 2009; Edwards *et al.* 2015). Near the Alaska Peninsula in the western GOA, the number of calls received peaked in May–August, with few calls during the rest of the year (Moore *et al.* 1998). In the central North Pacific, the GOA, and the Aleutian Islands, call rates peak during fall and winter (Moore *et al.* 1998, 2006; Watkins *et al.* 2000a,b; Stafford *et al.* 2009).

Rice and Wolman (1982) encountered 19 fin whales during surveys in the GOA, including 10 aggregated near Middleton Island on 1 July 1980. During surveys from the Kenai Peninsula to the central Aleutian Islands, fin whales were most abundant near the Semidi Islands and Kodiak Island (Zerbini *et al.* 2006). Numerous sightings of fin whales were also seen between the Semidi Islands and Kodiak Island during surveys by Waite (2003). Fin whale sightings around Kodiak Island were most numerous along the western part of the island in Uyak Bay and Kupreanof Straits, and in Marmot Bay (Wynne and Witteveen 2005; Baraff *et al.* 2005). Fin whales were sighted around Kodiak Island year-round, but most sightings were made in the spring and summer (Wynne and Witteveeen 2005). A BIA for fin whale feeding has been designated southward from the Kenai Peninsula inshore of the Kodiak Archipelago and along the Alaska Peninsula to include the Semidi Islands (Ferguson *et al.* 2015), overlapping with a proportion of the proposed survey area. Densities of fin whales are highest in this area during June through August.

Rone *et al.* (2017) reported 24 fin whale sightings (64 animals) in 2009, two hundred fin whale sightings (392 animals) in 2013, and 48 fin whale sightings (69 animals) in 2015 in the U.S. Navy training area east of Kodiak. That study also provided an abundance estimate of 3168 for this area. The density and abundance estimates were not corrected for missed animals. Fin whales were also frequently detected acoustically throughout the year during all years (2011–2015) of fixed-PAM studies in this area and detections occurred at all shelf, slope, and seamount sites (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013; Rice *et al.* 2015). Fin whales were the second most frequently sighted cetacean during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey, comprising

15.2 percent of all cetacean sightings (RPS 2011). There were 28 sightings of this species, representing 79 animals during the 37 days of monitoring. The average group size was three and the maximum group size was 10. Fin whales are likely to be common in the proposed survey area.

Blue Whale (*Balaenoptera musculus*)

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).

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).

In the North Pacific, blue whale calls are detected year-round (Stafford *et al.* 2001, 2009; Moore *et al.* 2002a, 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. In the GOA, no detections of blue whales had been made since the late 1960s (NOAA 2004b; Calambokidis *et al.* 2009) until blue whale calls were recorded in the area during 1999–2002 (Stafford 2003; Stafford and Moore 2005; Moore *et al.* 2006; Stafford *et al.* 2007). Call types from both northeastern and northwestern Pacific blue whales were recorded from July through December in the GOA, suggesting that two stocks used the area at that time (Stafford 2003; Stafford *et al.* 2007). Call rates peaked from August through November (Moore *et al.* 2006). More recent acoustic studies using fixed PAM have confirmed the presence of blue whales from both the Central and Northeast Pacific stocks in the Gulf of Alaska concurrently (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013; Rice *et al.* 2015). Blue whale calls were recorded in all months; at all shelf, slope, and seamount sites; and during all years (2011–2015) of those studies.

In July 2004, three blue whales were sighted in the GOA. The first blue whale was seen on 14 July ~185 km southeast of PWS. Two more blue whales were seen ~275 km southeast of PWS (NOAA 2004b; Calambokidis *et al.* 2009). These whales were thought to be part of the California feeding population (Calambokidis *et al.* 2009). Western blue whales are more likely to occur in the western portion of the GOA, southwest of Kodiak, where their calls have been detected (see Stafford 2003). Two blue whale sightings were also made in the Aleutians in August 2004 (Calambokidis *et al.* 2009). No blue whales were seen during surveys of the western GOA by Zerbini *et al.* (2006).

Rone *et al.* (2017) reported no blue whale sightings in 2009, five blue whale sightings (seven animals) in 2013, and 13 blue whale sightings (13 animals) in 2015 in the U.S. Navy training area east of Kodiak. Blue whales were not observed during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Odontocetes

Sperm Whale (*Physeter macrocephalus*)

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).

Most of the information regarding sperm whale distribution in the GOA (especially the eastern GOA) and southeast Alaska has come from observations from fishermen and reports from fisheries observers aboard commercial fishing vessels (*e.g.,* Dahlheim 1988). Fishery observers have identified interactions (*e.g.,* depredation) between longline vessels and sperm whales in the GOA and southeast Alaska since at least the mid-1970s (*e.g.,* Hill *et al.* 1999; Straley *et al.* 2005; Sigler *et al.* 2008), with most interactions occurring in the West Yakutat and East Yakutat/Southeast regions (Perez 2006; Hanselman *et al.* 2008). Sigler *et al.* (2008) noted high depredation rates in West Yakutat, East Yakutat/Southeast region, as well as the central GOA. Hill *et al.* (1999) found that most interactions in the GOA occurred to the east of Kodiak Island, even though there was substantial longline effort in waters to the west of Kodiak. Mellinger *et al.* (2004a) also noted that sperm whales occurred less often west of Kodiak Island.

Sperm whales are commonly sighted during surveys in the Aleutians and the central and western GOA (*e.g.,* Forney and Brownell 1996; Moore 2001; Waite 2003; Wade *et al.* 2003; Zerbini *et al.* 2004; Barlow and Henry 2005; Ireland *et al.* 2005; Straley *et al.* 2005). Waite (2003) and Wade *et al.* (2003) noted an average group size of 1.2 in the western GOA. In contrast, there are fewer reports on the occurrence of sperm whales in the eastern GOA (*e.g.,* Rice and Wolman 1982; Mellinger *et al.* 2004a; MacLean and Koski 2005; Rone *et al.* 2010). Rone *et al.* (2017) reported no sperm whale sightings in 2009, 19 sperm whale sightings (22 animals) in 2013, and 27 sperm whale sightings (45 animals) in 2015 in the U.S. Navy training area east of Kodiak. Additionally, there were 241 acoustic encounters with sperm whales during the 2013 towed-hydrophone survey in that study (Rone *et al.* 2014). Sperm whales were also frequently detected acoustically throughout the year during all years (2011–2015) of fixed-PAM studies in this area and detections occurred at all shelf, slope, and seamount sites, but they were less common at the shelf site near Kenai Peninsula and most common on the

slope (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013; Rice *et al.* 2015).

Rone *et al.* (2017) provided an abundance estimate (uncorrected for missed animals) for the area of 129 sperm whales, most of which were found in slope waters. Sperm whales were not observed during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Cuvier's Beaked Whale (*Ziphius cavirostris*)

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 ranges north to the GOA, including southeast Alaska, the Aleutian Islands, and the Commander Islands (Rice 1986, 1998). Most reported sightings have been in the Aleutian Islands (*e.g.,* Leatherwood *et al.* 1983; Forney and Brownell 1996; Brueggeman *et al.* 1987). Waite (2003) reported a single sighting of four Cuvier's beaked whales at the shelf break east of Kodiak Island during the summer of 2003 and one stranded on Kodiak Island in January 1987 (Foster and Hare 1990). There was one sighting of a single Cuvier's beaked whale during a 2013 survey in the U.S. Navy training area east of Kodiak, but none during the 2009 and 2015 surveys in that region (Rone *et al.* 2017). There were also five sightings (eight animals) of unidentified beaked whales during the 2013 survey and none during the other years. Additionally, there were 34 acoustic encounters with Cuvier's beaked whales during the 2013 towed-hydrophone survey in that study (Rone *et al.* 2014). Cuvier's beaked whales were detected occasionally at deep-water sites (900–1,000 m) during the 2011–2015 fixed-PAM studies in the U.S. Navy training area. They were infrequently detected on the slope site but more commonly detected at Pratt and Quinn seamounts. Detections occurred May to July 2014 at Pratt Seamount and October 2014 to March 2015 at Quinn Seamount in one of those studies (Rice *et al.* 2015). Beaked whales were not observed during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Stejneger's Beaked Whale (*Mesoplodon stejnegeri*)

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; Wade *et al.* 2003). There have been no confirmed sightings of Stejneger's beaked whale in the GOA since 1986 (Wade *et al.* 2003). However, they have been detected acoustically in the Aleutian Islands during summer, fall, and winter (Baumann-Pickering *et al.* 2014) and were detected year-round at deep-water sites during the 2011–2015 fixed-PAM studies in the U.S. Navy training area east of Kodiak (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013; Rice *et al.* 2015). In contrast to Cuvier's beaked whales, which were more prevalent at seamounts, Stejneger's beaked whales were detected most frequently at the slope site, with peak detections in September and October (Debich *et al.* 2013; Rice *et al.* 2015). There were no sightings of Stejneger's beaked whales during three years of surveys (2009, 2013, 2015) in this area (Rone *et al.* 2017). However, there were five sightings (eight animals) of unidentified beaked whales during the 2013 survey. Additionally, there were six acoustic encounters with Stejneger's beaked whales during the 2013 towed-hydrophone survey in that study (Rone *et al.* 2014). Beaked whales were not observed during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Baird's Beaked Whale (*Berardius bairdii*)

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). 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).

Baird's beaked whale is migratory, arriving in the Bering Sea in the spring, and remaining there throughout the summer; the winter distribution is unknown (Kasuya 2002). There are numerous sighting records from the central GOA to the Aleutian Islands and the southern Bering Sea (Leatherwood *et al.* 1983; Kasuya and Ohsumi 1984; Forney and Brownell 1996; Brueggeman *et al.* 1987; Moore *et al.* 2002b; Waite 2003; Wade *et al.* 2003). There were seven sightings of Baird's beaked whales (58 animals) during a 2013 survey in the U.S. Navy training area east of Kodiak (Rone *et al.* 2017). Additionally, there were nine acoustic encounters with Baird's beaked whales during the 2013 towed-hydrophone survey in that study (Rone *et al.* 2014). There were also five sightings (eight animals) of unidentified beaked whales during that survey. No beaked whales were observed in 2009 or 2015 surveys in the same area (Rone *et al.* 2017). Baird's beaked whales were detected acoustically during fixed-PAM studies in this area during the 2011–2012 and 2012–2013 studies but not in 2014–2015 (Baumann-Pickering *et al.* 2012; Debich *et al.* 2013; Rice *et al.* 2015). They were detected regularly at the slope site from November through and January and at the Pratt Seamount site during most months. Beaked whales were not observed during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Pacific White-Sided Dolphin (*Lagenorhynchus obliquidens*)

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). During winter, this species is most abundant in California slope and offshore areas; as northern marine waters begin to warm in the spring, it appears to move north to slope and

offshore waters off Oregon/Washington (Green *et al.* 1992, 1993; Forney 1994; Forney *et al.* 1995; Buchanan *et al.* 2001; Barlow 2003). During the summer, Pacific white-sided dolphins occur north into the GOA and west to Amchitka in the Aleutian Islands, but rarely in the southern Bering Sea (Allen and Angliss 2010). Moore *et al.* (2002b) documented a single sighting of eight Pacific white-sided dolphins in the southeast Bering Sea along the Alaska Peninsula. Sightings in the GOA and Aleutian Islands have been documented in the summer by Waite (2003) and Wade *et al.* (2003), and in the spring to the southeast of Kodiak Island by Rone *et al.* (2010). Dahlheim and Towell (1994) reported sightings for southeast Alaska. There was one sighting of 60 Pacific white-sided dolphins in 2009, no sightings in 2013, and 10 sightings of Pacific white-sided dolphins (986 animals) in 2015 during surveys in the U.S. Navy training area east of Kodiak (Rone *et al.* 2017). Pacific white-sided dolphins were not observed during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011), but there was one sighting of two unidentified small odontocetes.

Risso's Dolphin (*Grampus griseus*)

Risso's dolphin is primarily a tropical and mid-temperate species distributed worldwide (Kruse *et al.* 1999). It occurs between 60° N and 60° S, where surface water temperatures are at least 10° C (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).

Throughout the region from California to Washington, the distribution and abundance of Risso's dolphins are highly variable, presumably in response to changing oceanographic conditions on both annual and seasonal time scales (Forney and Barlow 1998; Buchanan *et al.* 2001; Becker 2007). Water temperature appears to be an important factor affecting their distribution (Kruse *et al.* 1999; see also Becker 2007). Like the Pacific white-sided dolphin, Risso's dolphin is believed to make seasonal north-south movements related to water temperature, spending colder winter months off California and moving north to waters off Oregon/Washington during the spring and summer as northern waters begin to warm (Green *et al.* 1992, 1993; Buchanan *et al.* 2001; Barlow 2003; Becker 2007). Risso's dolphins are uncommon to rare in the GOA. Risso's dolphins have been sighted near Chirikof Island (southwest of Kodiak Island) and offshore in the GOA (Consiglieri *et al.* 1980; Braham 1983). They were detected acoustically once, in January 2013, near Pratt Seamount during fixed-PAM studies from 2011–2015 in the U.S. Navy training area (Debich *et al.* 2013). The DoN (2014) considers this species to be only an occasional visitor to their GOA training area. Risso's dolphins were not observed during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011). There was one sighting of two unidentified small odontocetes.

Killer Whale (*Orcinus orca*)

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.

Of eight killer whale stocks currently recognized in the Pacific U.S., six occur in Alaskan waters: (1) The Eastern North Pacific Alaska Resident Stock, from southeast Alaska to the Aleutians and Bering Sea, (2) the Eastern North Pacific Northern Resident Stock, from B.C. through parts of southeast Alaska, (3) the Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock, from PWS through to the Aleutians and Bering Sea, (4) the AT1 Transient Stock, from PWS through the Kenai Fjords, (5) the West Coast Transient Stock, from California through southeast Alaska, and (6) the Offshore Stock, from California through Alaska. The AT1 Transient Stock is considered depleted under the MMPA and therefore a strategic stock. Movements of resident groups between different geographic areas have also been documented (Leatherwood *et al.* 1990; Dahlheim *et al.* 1997; Matkin *et al.* 1997, 1999 in Allen and Angliss 2010). In the proposed study area, individuals from one resident stock (Eastern North Pacific Alaska Resident Stock), the North Pacific Offshore Stock, and one transient stock (Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock), could be encountered during the survey. AT1 transients have only ever been seen in Prince William Sound and in the Kenai Fjords region (Muto et al., 2018; Matkin et al 2008). Therefore, while the stock is present in the Gulf of Alaska, the limited range of the stock and the fact that this range does not overlap with L–DEO's proposed survey means take is not likely to occur for the AT1 stock of transient killer whales.

During surveys of the western GOA and Aleutian Islands, transient killer whale densities were higher south of the Alaska Peninsula between the Shumagin Islands and the eastern Aleutians than in other areas (Wade *et al.* 2003; Zerbini *et al.* 2007). They were not seen between the Shumagin Islands and the eastern side of Kodiak Island during surveys in 2001–2003, but they were sighted there during earlier surveys (*e.g.,* Dahlheim 1997 in Zerbini *et al.* 2007). Resident killer whales were most abundant near Kodiak Island, around Umnak and Unalaska Islands in the eastern Aleutians, and in Seguam Pass in the central Aleutians (Wade *et al.* 2003; Zerbini *et al.* 2007). No residents were seen between 156° W and 164° W, south of the Alaska Peninsula (Zerbini *et al.* 2007).

Little is known about offshore killer whales in the GOA, but they could be encountered during the proposed survey. During summer surveys of the western GOA and Aleutian Islands in 2001–2003, two sightings of offshore killer whales were made, one northeast of Unalaska Island and another one south of Kodiak Island near the Trinity Islands (Wade *et al.* 2003; Zerbini *et al.* 2007). As the groups sighted were large, it suggests the number of offshore killer whales in the area is relatively high (Zerbini *et al.* 2007). Dahlheim *et al.* (2008b) encountered groups of 20–60 killer whales in western Alaska; offshore killer whales encountered near Kodiak Island and the eastern Aleutians were also sighted in southeast Alaska and California. A group of at least 54 offshore killer whales was sighted in July 2003 during a survey in the eastern Aleutian Islands (Matkin *et al.* 2007).

Rone *et al.* (2017) reported six killer whale sightings (119 animals) in 2009, 21 killer whale sightings (138 animals) in 2013, and 10 killer whale sightings (73 animals) in 2015 in the U.S. Navy training area east of Kodiak. Additionally, there were 32 acoustic encounters with killer whales and three acoustic encounters with offshore killer whales (based on known differences in their acoustic signals) during the 2013 towed-hydrophone survey in that study (Rone *et al.* 2014). Killer whales were detected acoustically sporadiacally throughout the year at shelf, slope, and seamount sites in the U.S. Navy training area (Baumann-Pickering *et al.* 2012;

Debich *et al.* 2013). Rone *et al.* (2017) an abundance estimate (uncorrected for missed animals) for the area of 899 killer whales, most of which were found in slope waters. There was one sighting of a single killer whale during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Dall's Porpoise (*Phocoenoides dalli*)

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 (>2,500 m) oceanic waters (Hall 1979), ranging from ~30–62° N (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 2009).

Dall's porpoise occurs throughout Alaska; the only apparent gaps in distribution in Alaskan waters south of the Bering Strait are for upper Cook Inlet and the Bering Sea shelf. Using a population estimate based on vessel surveys during 1987–1991, and correcting for the tendency of this species to approach vessels, which Turnock and Quinn (1991) suggested resulted in inflated abundance estimates perhaps by as much as five times, a population estimate of 83,400 was calculated for the Alaska stock of Dall's porpoise. Because this estimate is more than eight years old, NMFS considers it to be unreliable and reported that there are no reliable abundance estimates available for the Alaska Stock of this species when it was last reviewed (Muto *et al.* 2016).

Numerous studies have documented the occurrence of Dall's porpoise in the Aleutian Islands and western GOA (Forney and Brownell 1996; Moore 2001; Wade *et al.* 2003; Waite 2003; Baraff *et al.* 2005; Ireland *et al.* 2005) as well as in the Bering Sea (Moore *et al.* 2002b). Dall's porpoise was one of the most frequently sighted species during summer seismic surveys in the central and eastern GOA and southeast Alaska (MacLean and Koski 2005; Hauser and Holst 2009). Rone *et al.* (2017) reported 10 Dall's porpoise sightings (59 animals) in 2009, 337 Dall's porpoise sightings (907 animals) in 2013, and 98 Dall's porpoise sightings (391 animals) in 2015 in the U.S. Navy training area east of Kodiak. Additionally, there were three acoustic encounters with Dall's porpoise during the 2013 towed-hydrophone survey in that study (Rone *et al.* 2014). Rone *et al.* (2017) provided an abundance estimate for the area of 15,423 Dall's porpoises. This estimate was uncorrected for missed animals and did not account for their propensity to approach vessels. Dall's porpoise was the second most frequently sighted cetacean during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey, comprising 14.1 percent of all cetacean sightings (RPS 2011). There were 26 sightings of this species, representing 227 animals during the 37 days of monitoring. The average group size was nine and the largest group size was 35.

Harbor Porpoise (*Phocoena phocoena*)

The harbor porpoise inhabits temperate, subarctic, and arctic waters. It is typically found in shallow water (<100 m) nearshore but is occasionally sighted in deeper offshore water (Jefferson *et al.* 2015); abundance declines linearly as depth increases (Barlow 1988). In the eastern North Pacific, its range extends from Point Barrow, Alaska, to Point Conception, California.

In Alaska, there are three separate stocks of harbor porpoise: Southeast Alaska, GOA, and Bering Sea. The Southeast Alaska Stock occurs from northern B.C. to Cape Suckling, and the GOA Stock ranges from Cape Suckling to Unimak Pass. The population estimates for the Southeast Alaska, GOA, and Bering Sea stocks are 11,146, 31,046, and 48,215, respectively (Muto *et al.* 2016). The Southeast Alaska stock is

Harbor porpoise are seen regularly in the western GOA and Aleutian Islands (*e.g.,* Wade *et al.* 2003; Waite 2003; Baraff *et al.* 2005; Ireland *et al.* 2005) and Bering Sea (Moore *et al.* 2002b). Harbor porpoises are also sighted in the eastern and central GOA and southeast Alaska (Dahlheim *et al.* 2000, 2008a; MacLean and Koski 2005; Rone *et al.* 2010). There were 30 sightings (89 animals) of harbor porpoise in 2009, eight sightings (11 animals) of harbor porposie in 2013, and a single sighting of one harbor porpoise in 2015 during surveys in the U.S. Navy training area east of Kodiak (Rone *et al.* 2017). Harbor porpoise were not observed during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011), but there was one sighting of two unidentified small odontocetes.

Pinnipeds

Northern Fur Seal (*Callorhinus ursinus*)

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.* 2018). 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.* 2018). 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.* 2018). In the United States, two stocks are recognized—the Eastern Pacific and the California stocks (Muto *et al.* 2018). 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.* 2018).

When not on rookery islands, northern fur seals are primarily pelagic but occasionally haul out on rocky shorelines (Muto *et al.* 2018). 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.* 2018). 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 GOA, off Japan, and the west coast of the United States (Muto *et al.* 2018). Pups travel through Aleutian passes and spend the first two years at sea before returning to their islands of origin.

In November, adult females and pups leave the Pribilof Islands and migrate into the North Pacific Ocean to areas including offshore Oregon and Washington (Ream *et al.* 2005). Males usually migrate only as far south as the GOA (Kajimura 1984). Ream *et al.* (2005) showed that migrating females moved over the continental shelf as they migrated southeasterly. Instead of following depth contours, their travel corresponded with movements of the Alaska Gyre and the North Pacific Current (Ream *et al.* 2005). Their foraging areas were associated with eddies, the subarctic-subtropical transition region, and coastal mixing (Ream *et al.* 2005; Alford *et al.* 2005). Some juveniles and non-pregnant females may remain in the GOA throughout the summer (Calkins 1986).

Robson *et al.* (2004) reported that female fur seals from St. Paul and St. George islands traveled in different directions. They also observed habitat separation among breeding sites on the same island (Robson *et al.* 2004). Lactating females from the same breeding site share a foraging area,

whereas females from different sites tend to forage in different areas (Robson *et al.* 2004). Females from both islands traveled for similar durations and maximum distances (Robson *et al.* 2004).

Northern fur seals were seen throughout the North Pacific during surveys conducted during 1987–1990 (Buckland *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; females migrated to the GOA and the California Current (Sterling *et al.* 2014).

A total of 42 northern fur seals was seen during 3767 km of shipboard surveys in the northwestern GOA during June–July 1987 (Brueggeman *et al.* 1988). Leatherwood *et al.* (1983) reported 14 sightings of 34 northern fur seals away from the breeding islands in the southeast Bering Sea during aerial surveys in 1982, mostly during July and August. No fur seals were seen during summer surveys in the GOA in 2004 and 2008 (MacLean and Koski 2005; Hauser and Holst 2009) or during spring surveys in 2009 (Rone *et al.* 2010). None of the 42 female northern fur seals tagged on St Paul Island between August–October 2007 and 2008 traveled south of the Aleutian Islands (Kuhn *et al.* 2010). Rone *et al.* (2014) reported 78 northern fur seal sightings (83 animals) in 2013 in the U.S. Navy training area east of Kodiak. They also provided an abundance estimate (uncorrected for missed animals) for the area of 1770 northern fur seals. There were seven sightings, representing 7 northern fur seals, during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Steller Sea Lion (*Eumetopias jubatus*)

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 are two stocks, or DPSs, of Steller sea lions—the Western and Eastern DPSs, which are divided at 144° W longitude (NMFS 2016c). The Western DPS is listed as endangered and includes animals that occur in Japan and Russia (NMFS 2016c; Muto *et al.* 2017); the Eastern DPS was delisted from threatened in 2013 (NMFS 2013a). Critical habitat has been designated 20 nmi around all major haulouts and rookeries, as well as three large foraging areas (NMFS 2017b). The critical habitat of both stocks is currently under review in light of the delisting of the Eastern DPS (Muto *et al.* 2018). Critical habitat as well as ''no approach'' zones occur within the proposed study area. ''No approach'' zones are restricted areas wherein no vessel may approach within 3 nmi (5.6 km) of listed rookeries (50 CFR 223.202). Only individuals from the Western DPS are expected to occur in the proposed survey area. The Eastern DPS is estimated at 41,638 (Muto *et al.* 2017) and appears to have increased at an annual rate of 4.76 percent between 1989 and 2015 (Muto *et al.* 2018).

Rookeries of Steller sea lions from the Western DPS are located on the Aleutian Islands and along the Gulf of Alaska, as well as the east coast of Kamchatka, Commander Islands, and Kuril Islands (Burkanov and Loughlin 2005; Fritz *et al.* 2016; Muto *et al.* 2017). Breeding adults occupy rookeries from late-May to early-July (NMFS 2008). Non-breeding adults use haulouts or occupy sites at the periphery of rookeries during the breeding season (NMFS 2008). Pupping occurs from mid-May to mid July (Pitcher and Calkins 1981) and peaks in June (Pitcher *et al.* 2002). Territorial males fast and remain on land during the breeding season (NMFS 2008). Females with pups generally stay within 30 km of the rookeries in shallow (30–120 m) water when feeding (NMFS 2008). Tagged juvenile sea lions showed localized movements near shore (Briggs *et al.* 2005). Loughlin *et al.* (2003) reported that most (88 percent) at-sea movements of juvenile Steller sea lions in the Aleutian Islands were short (<15 km) foraging trips. The mean distance of juvenile sea lion trips at sea was 16.6 km and the maximum trip distance recorded was 447 km. Long-range trips represented 6 percent of all trips at sea, and trip distance and duration increase with age (Loughlin *et al.* 2003; Call *et al.* 2007). Although Steller sea lions are not considered migratory, foraging animals can travel long distances outside of the breeding season (Loughlin *et al.* 2003; Raum-Suryan *et al.* 2002).

Steller sea lions are present in Alaska year-round, with centers of abundance in the GOA and Aleutian Islands. There are five major rookery sites within the study area in the northern GOA: Chirikof, Chowiet, Atkins, Chernabura islands, and Pinnacle Rock. There are also numerous haulout sites located within the study area (see Figure 1 in the IHA Application); most haulout sites on Kodiak Island (and within the study area) are used year-round (*e.g.,* Wynne 2005). Counts are highest in late summer (Wynne 2005). Sea lion counts in the central GOA, including Kodiak Island, were reported to be declining between 1999 and 2003 (Sease and Gudmundson 2002; Wynne 2005). Evidence suggests that counts in Alaska were lowest in 2002 and 2003, but between 2003 and 2016 pup and non-pup counts have increased by 2.19 percent per year and 2.24 percent per year, respectively (Muto *et al.* 2018). These rates vary regionally, with the highest rates of increase in the eastern Gulf of Alaska and a steadily decreasing rate of increase heading west to the Aleutian Islands.

Steller sea lions are an important subsistence resource for Alaska Natives from southeast Alaska to the Aleutian Islands. There are numerous communities along the shores of the GOA that participate in subsistence hunting. In 2008, 19 sea lions were taken in the Kodiak Island region and 9 were taken along the South Alaska Peninsula (Wolfe *et al.* 2009). As of 2009, data on community subsistence harvests are no longer being collected consistently so no data are available. The most recent 5 years of data available (2004–2008) show an annual average catch of 172 steller sea lions for all areas in Alaska combined except the Pribilof Islands in the Bering Sea (Muto *et al.* 2018).

There was one sighting of 18 Steller sea lions during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011).

Northern Elephant Seal (*Mirounga angustirostris*)

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 and Perrin (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 GOA 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 (Le Boeuf *et al.* 2000; Robinson *et al.* 2012; Robinson 2016 in OBIS 2018; Costa 2017 in OBIS 2018). Post-molting seals traveled longer and farther than post-breeding seals (Robinson *et al.* 2012). Rone *et al.* (2014) reported 16 northern fur seal sightings (16 animals) in a June–July 2013 survey in the U.S. Navy training area east of Kodiak. Northern elephant seal males could occur in the GOA throughout the year (Calkins 1986).

California Sea Lion (*Zalophus californianus*)

The primary range of the California sea lion includes the coastal areas and offshore islands of the eastern North Pacific Ocean from BC, Canada, to central Mexico, including the Gulf of California (Jefferson *et al.* 2015). However, its distribution is expanding (Jefferson *et al.* 2015), and its secondary range extends into the GOA where it is occasionally recorded (Maniscalco *et al.* 2004) and southern Mexico (Gallo-Reynoso and Solórzano-Velasco 1991). California sea lions are coastal animals that often haul out on shore throughout the year. King (1983) noted that sea lions are rarely found more than 16 km offshore. During fall and winter surveys off Oregon/Washington, mean distance from shore was ~13 km (Bonnell *et al.* 1992).

California sea lion rookeries are on islands located in southern California, western Baja California, and the Gulf of California (Carretta *et al.* 2016). A single stock is recognized in U.S. waters: The U.S. Stock. Five genetically distinct geographic populations have been identified: (1) Pacific Temperate (includes rookeries in U.S. waters and the Coronados Islands to the south), (2) Pacific Subtropical, (3) Southern Gulf of California, (4) Central Gulf of California, and (5) Northern Gulf of California (Schramm *et al.* 2009). Animals from the Pacific Temperate population occur in the proposed project area. California sea lions that are sighted in Alaska are typically seen at Steller sea lion rookeries or haulouts, with most sightings occurring between March and May, although they can be found in the GOA year-round (Maniscalco *et al.* 2004).

Harbor Seal (*Phoca vitulina*)

The harbor seal is distributed in the North Atlantic and North Pacific. Two subspecies occur in the Pacific: *P.v. stejnegeri* in the northwest Pacific Ocean and *P.v. richardii* in the eastern Pacific Ocean. Eastern Pacific harbor seals occur in nearshore, coastal, and estuarine areas ranging from Baja California, Mexico, north to the Pribilof Islands in Alaska (Muto *et al.* 2016). Harbor seals inhabit estuarine and coastal waters, hauling out on rocks, reefs, beaches, and glacial ice flows. They are generally non-migratory, but move locally with the tides, weather, season, food availability, and reproduction (Scheffer and Slipp 1944; Fisher 1952; Bigg 1969, 1981). Twelve stocks of harbor seals are recognized in Alaska (Muto *et al.* 2016). The proposed survey would take place within the range of three of these stocks: North Kodiak, South Kodiak, and Cook Inlet/Shelikof Strait stocks. Nearby stocks are the Aleutian Islands, Prince William Sound, and Glacier Bay/Icy Strait stocks. There are two stocks in the Bering Sea (Bristol Bay and Pribilof Islands) and four stocks in southeast Alaska.

Female harbor seals give birth to a single pup while hauled out on shore or on glacial ice flows; pups are born from May to mid-July. The mother and pup remain together until weaning occurs at 3–6 weeks (Bishop 1967; Bigg 1969). When molting, which occurs primarily in late August, seals spend the majority of the time hauled out on shore, glacial ice, or other substrates. Juvenile harbor seals can travel significant distances (525 km) to forage or disperse, whereas adults were generally found within 190 km of their tagging location in Prince William Sound, Alaska (Lowry *et al.* 2001). The smaller home range used by adults is suggestive of a strong site fidelity (Pitcher and Calkins 1979; Pitcher and McAllister 1981; Lowry *et al.* 2001). Pups tagged in the GOA most commonly undertook multiple return trips of more than 75 km from natal areas, followed by movements of <25 km from the natal area (Small *et al.* 2005). Pups tagged in Prince William Sound traveled a mean maximum distance of 43.2 km from their tagging location, whereas those tagged in the GOA moved a mean maximum distance of 86.6 km (Small *et al.* 2005).

Harbor seals are an important subsistence resource for Alaska Natives in the northern GOA. In 2011–2012, 37 harbor seals were taken from the North Kodiak Stock and 126 harbor seals were taken from the South Kodiak Stock by communities on Kodiak Island (Muto *et al.* 2016). The number taken from the Cook Inlet/Shelikof Strait Stock for 2011–2012 is unknown, but an average of 233 were taken from this stock annually during 2004–2008 (Muto *et al.* 2016).

There was one sighting of nine harbor seals during the L–DEO seismic survey conducted in the summer of 2011 in the same area as the currently proposed survey (RPS 2011). Harbor seals could be encountered in the proposed 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 (2018) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 decibel (dB) threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. Marine mammal hearing groups and their associated hearing ranges are provided in Table 2.

TABLE 2—MARINE MAMMAL HEARING GROUPS (NMFS, 2018)

Hearing group	Generalized hearing range *
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz.
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz.

TABLE 2—MARINE MAMMAL HEARING GROUPS (NMFS, 2018)—Continued

Hearing group	Generalized hearing range *
High-frequency (HF) cetaceans (true porpoises, *Kogia,* river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*).	275 Hz to 160 kHz.
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz.
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz.

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

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 (2018) for a review of available information. Twenty-one marine mammal species (16 cetacean and 5 pinniped (3 otariid and 2 phocid) species) have the reasonable potential to co-occur with the proposed survey activities. Please refer to Table 1. Of the 16 cetacean species that may be present, 7 are classified as low-frequency cetaceans (*i.e.,* all mysticete species), 7 are classified as mid-frequency cetaceans (*i.e.,* all delphinid and ziphiid species and the sperm whale), and 2 are classified as high-frequency cetaceans (*i.e.,* harbor 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 hertz (Hz) or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the ''loudness'' of a sound and is typically described using the relative unit of the dB. A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is 1 microPascal (μPa)) and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of 1 m from the source (referenced to 1 μPa) while the received level is the SPL at the listener's position (referenced to 1 μPa).

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

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

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources), as is the case for pulses produced by the airgun 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; and

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

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

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

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

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

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

As described above, a 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 (beyond that which is already quantified as a result of exposure to the airguns) 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 dBs above (a 40-dB threshold shift approximates PTS onset; *e.g.,* Kryter *et al.,* 1966; Miller, 1974) that inducing mild TTS (a 6-dB threshold shift approximates TTS onset; *e.g.,* Southall *et al.* 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds for 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 (2016a).

Behavioral Effects—Behavioral disturbance may include a variety of effects, including subtle changes in behavior (*e.g.,* minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. Behavioral responses to sound are highly variable and context-specific and any reactions depend on numerous intrinsic and extrinsic factors (*e.g.,* species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day), as well as the interplay between factors (*e.g.,* Richardson *et al.,* 1995; Wartzok *et al.,* 2003; Southall *et al.,* 2007; Weilgart, 2007; Archer *et al.,* 2010). Behavioral reactions can vary not only among individuals but also within an individual, depending on previous experience with a sound source, context, and numerous other factors (Ellison *et al.,* 2012), and can vary depending on characteristics associated with the sound source (*e.g.,* whether it is moving or stationary, number of sources, distance from the source). Please see Appendices B–C of Southall *et al.* (2007) for a review of studies involving marine mammal behavioral responses to sound.

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

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

Changes in dive behavior can vary widely, and may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.,* Frankel and Clark, 2000; Ng and Leung, 2003; Nowacek *et al.,* 2004; Goldbogen *et al.,* 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, 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 5 kn (approximately 9.3 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 percent CI = $0 - 5.5 \times 10^{-6}$; NMFS, 2013b). In addition, a research vessel reported a fatal strike in 2011 of a dolphin in the Atlantic, demonstrating that it is possible for strikes involving smaller cetaceans to occur. In that case, the incident report indicated that an animal apparently was struck by the vessel's propeller as it was intentionally swimming near the vessel. While indicative of the type of unusual events that cannot be ruled out, neither of these instances represents a circumstance that would be considered reasonably foreseeable or that would be considered preventable.

Although the likelihood of the vessel striking a marine mammal is low, we require a robust ship strike avoidance protocol (see *Proposed Mitigation*), which we believe eliminates any foreseeable risk of ship strike. We anticipate that vessel collisions involving a seismic data acquisition vessel towing gear, while not impossible, represent unlikely, unpredictable events for which there are no preventive measures. Given the required mitigation measures, the relatively slow speed of the vessel towing gear, the presence of bridge crew watching for obstacles at all times (including marine mammals), 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 (~18 days) and would occur over a very small area relative to the area available as marine mammal habitat in the Gulf of Alaska. 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 this one cover a large area but would be transient rather than focused in a given location over time and therefore would not be considered chronic in any given location.

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

Estimated Take

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

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

Authorized takes would primarily be by Level B harassment, as use of the acoustic source (*i.e.,* 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) to result, primarily for high frequency species because predicted auditory injury zones are larger than for low-frequency species, mid-frequency species, phocids, and otariids. However as a precaution, small numbers of takes by Level A harassment are proposed for authorization for all species listed in Table 1 as likely to occur in the proposed survey area. This auditory injury is expected to be, at most, low level PTS and the proposed mitigation and monitoring measures are expected to further minimize the severity of such taking to the extent practicable.

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

Generally speaking, we estimate take by considering: (1) Acoustic thresholds above which NMFS believes the best available science indicates marine mammals will be behaviorally harassed or incur some degree of permanent hearing impairment; (2) the area or volume of water that will be ensonified above these levels in a day; (3) the density or occurrence of marine mammals within these ensonified areas; and, (4) and the number of days of activities. We note that while these basic factors can contribute to a basic calculation to provide an initial prediction of takes, additional information that can qualitatively inform take estimates is also sometimes available (*e.g.,* previous monitoring results or average group size). Below, we describe the factors considered here in more detail and present the proposed take estimate.

Acoustic Thresholds

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

Level B Harassment for non-explosive sources—Though significantly driven by received level, the onset of behavioral disturbance from anthropogenic noise exposure is also informed to varying degrees by other factors related to the source (*e.g.,* frequency, predictability, duty cycle), the environment (*e.g.,* bathymetry), and the receiving animals (hearing, motivation, experience, demography, behavioral context) and can be difficult to predict (Southall *et al.,* 2007, Ellison *et al.,* 2012). Based on what the available science indicates and the practical need to use a threshold based on a factor that is both predictable and measurable for most activities, NMFS uses a generalized acoustic threshold based on received level to estimate the onset of behavioral harassment. NMFS predicts that marine mammals are likely to be behaviorally harassed in a manner we consider Level B harassment when exposed to underwater anthropogenic noise above received levels of 120 dB re 1 µPa (rms) for continuous (*e.g.,* vibratory pile-driving, drilling) and above 160 dB re 1 µPa (rms) for non-explosive impulsive (*e.g.,* seismic airguns) or intermittent (*e.g.,* scientific sonar) sources. 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 (Version 2.0) (Technical Guidance, 2018) identifies dual criteria to assess auditory injury (Level A harassment) to five different marine mammal groups (based on hearing sensitivity) as a result of exposure to noise from two different types of sources (impulsive or non-impulsive). L–DEO's proposed seismic survey includes the use of impulsive (seismic airguns) sources.

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

TABLE 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 identifying the area ensonified above the acoustic thresholds, which include source levels and transmission loss coefficient.

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 (>1,000 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 (~1,600 m), intermediate water depth on the slope (~600 − 1,100 m), and shallow water (~50 m) in the Gulf of Mexico (GoM) 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 mitigation 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 the 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 mitigation model curve. However, the observed sound levels are found to fall almost entirely below the mitigation model. Thus, analysis of the GoM calibration measurements demonstrates that although simple, the L–DEO model is a robust tool for conservatively estimating isopleths.

In shallow water (<100 m), the depth of the calibration hydrophone (18 m) used during the GoM calibration survey was appropriate to sample the maximum sound level in the water column, and the field measurements reported in Table 1 of Tolstoy *et al.* (2009) for the 36-airgun array at a tow depth of 6 m can be used to derive isopleths.

For deep water (>1,000 m), we use the deep-water radii obtained from L–DEO model results down to a maximum water depth of 2,000 m. The radii for intermediate water depths (100–1,000 m) are derived from the deep-water ones by applying a correction factor (multiplication) of 1.5, such that observed levels at very near offsets fall below the corrected mitigation curve (Fig. 16 in Appendix H of the NSF–USGS, 2011).

The shallow-water radii are obtained by scaling the empirically derived measurements from the GoM calibration survey to account for the differences in tow depth between the calibration survey (6 m) and the proposed survey (12 m); whereas the shallow water in the GoM may not exactly replicate the shallow water environment at the proposed survey site, it has been shown to serve as a good and very conservative proxy (Crone *et al.* 2014). A simple scaling factor is calculated from the ratios of the isopleths determined by the deep-water L–DEO model, which are essentially a measure of the energy radiated by the source array.

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 (Fig. A–3 in the IHA application). For intermediate-water depths, a correction factor of 1.5 was applied to the deep-water model results. For shallow water, a scaling of the field measurements obtained for the 36-airgun array was used.

L-DEO's modeling methodology is described in greater detail in the IHA application. 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	>1,000	[1] 431
		100–1,000	[2] 647
		<100	[3] 1,041
4 strings, 36 airguns, 6,600 in^3	12	>1,000	[1] 6,733
		100–1,000	[2] 10,100
		<100	[3] 25,494

[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.
[3] Distance is based on empirically derived measurements in the GoM with scaling applied to account for differences in tow depth.

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 2016a). 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. For a more complete explanation of this modeling approach, please see ''Appendix A: Determination of Mitigation Zones'' in the IHA application.

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; $L_{E,HF,24h}$: 27462 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	232.84	233.10	232.84	232.08
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 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 provided in the IHA application, 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 4. 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. 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})	40.1	N.A.	0.1	1.3	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.

In the proposed survey area in the Gulf of Alaska, L–DEO determined the best marine mammal density data to be habitat-based stratified marine mammal densities developed by the U.S. Navy for assessing potential impacts of training activities in the GOA (DoN 2014). Alternative density estimates available for species in this region are not stratified by water depth and therefore do not reflect the known variability in species distribution relative to habitat features. Consistent with Rone *et al.* (2014), four strata were defined: Inshore: All waters <1,000 m deep; Slope: From 1,000 m water depth to the Aleutian trench/subduction zone; Offshore: Waters offshore of the Aleutian trench/subduction zone; Seamount: Waters within defined seamount areas. Densities corresponding to these strata were based on data from several different sources, including Navy funded line-transect surveys in the GOA as described below and in Appendix B.

To develop densities specific to the GOA, the Navy conducted two comprehensive marine mammal surveys in the Temporary Marine Activities Area (TMAA) in the GOA prior to 2014. The first survey was conducted from 10 to 20 April 2009 and the second was from 23 June to 18 July 2013. Both surveys used systematic line-transect survey protocols including visual and acoustic detection methods (Rone *et al.* 2010; Rone *et al.* 2014). The data were collected in four strata that were designed to encompass the four distinct habitats within the TMAA and greater GOA. Rone *et al.* (2014) provided stratified line-transect density estimates used in this analysis for fin, humpback, blue, sperm, and killer whales, as well as northern fur seals (Table 6). Data from a subsequent survey in 2015 were used to calculate alternative density estimates for several species (Rone *et al.* 2017) and the density estimates for Dall's porpoise used here were taken from that source.

DoN (2014) derived gray whale densities in two zones, nearshore (0–2.25 n.mi from shore) and offshore (from 2.25–20 nmi from shore). In our calculations, the nearshore density was used to represent the inshore zone and the offshore density was used to represent the slope zone.

Harbor porpoise densities in DoN (2014) were derived from Hobbs and Waite (2010) which included additional shallow water depth strata. The density estimate from the 100 m to 200 m depth strata was used to represent the entire inshore zone (<1,000 m) in this analysis.

Harbor seals typically remain close to shore so minimal estimates were used for the three deep water zones. To account for increased inshore density, a one thousand fold increase of the minimal density was assumed to represent the entire inshore zone (DoN 2014).

Densities for Minke whale, Pacific white-sided dolpin, and Cuvier's and Baird's beaked whales were based on Waite (2003 *in* DoN 2009). Although sei whale sightings and Stejneger's beaked whale acoustic detections were recorded during the Navy funded GOA surveys, data were insufficient to calculate densities for these species, so predictions from a global model of marine mammals densities were used (DoN 2014).

Steller sea lion and northern elephant seal densities were calculated using shore-based population estimates divided by the area of the GOA Large Marine Ecosystem (DoN 2014).

The North Pacific right whale, Risso's dolphin, and California sea lion are only rarely observed in or near the survey area, so minimal densities were used to represent their potential presence.

However, in the North Pacific right whale critical habitat off of Kodiak Island, it is reasonable to expect a higher density. In this critical habitat area, the Alaska Fisheries Science Center (LOA application available here: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities*) used a conservative density estimate based on acoustic detections (Rone *et al.* 2014) and photo identifications throughout the entirety of the Gulf of Alaska. For the portion of L–DEO's activities that occur in North Pacific right whale critical habitat, NMFS will use this more conservative density estimate (Table 6).

All densities were corrected for perception bias [$f(0)$] but only harbor porpoise densities were corrected for availability bias [$g(0)$], as described by the respective authors. There is some uncertainty related to the estimated density data and the assumptions used in their calculations, as with all density data estimates. However, the approach used here is based on the best available data and are stratified by the water depth (habitat) zones present within the survey area. These depth stratified densities allow L–DEO to better capture known variability in species distribution in the Gulf of Alaska, and accurately assess impacts. Alternative density estimates were available for species in this region, such as those used by the Alaska Fisheries Science Center (AFSC) (AFSC LOA application available here: *https://www.fisheries.noaa.gov/national/marine-mammal-protection/incidental-take-authorizations-research-and-other-activities*). AFSC density values were not stratified by water depth and represented marine mammal density throughout the entire Gulf of Alaska. While some density estimates provided in the AFSC application are more conservative, the relative proximity of surveys that generated DoN estimates and L–DEO's consideration and inclusion of publically available newer values from Rone *et al.* (2017) mean the calculated exposures that are based on these densities are best estimates for L–DEO's proposed survey.

TABLE 6—MARINE MAMMAL DENSITY VALUES IN THE PROPOSED SURVEY AREA AND SOURCE

Species [1]	Estimated density (#/1,000 km [2])				Source
	Inshore (<1,000 m)	Slope (1,000 m to Aleutian trench)	Offshore (offshore of Aleutian trench)	Seamount (in defined seamount areas)	
LF Cetaceans:					
North Pacific Right Whale	[2] 0.00001	[2] 0.00001	[2] 0.00001	[2] 0.00001	DoN (2014).
Humpback Whale	0.129	0.0002	0.001	0.001	Rone *et al.* (2014) (Table 16).
Blue whale	0.0005	0.0005	0.0005	0.002	Rone *et al.* (2014) (Table 16).
Fin Whale	0.071	0.014	0.021	0.005	Rone *et al.* (2014) (Table 16).
Sei Whale	0.0001	0.0001	0.0001	0.0001	DoN (2014), adapted from Figure 5–24.
Minke Whale	0.0006	0.0006	0.0006	0.0006	DoN (2014).
Gray Whale	[3] 0.04857	[3] 0.00243	[3] 0	[3] 0	DoN (2014)
MF Cetaceans:					
Sperm Whale	0	0.0033	0.0013	0.00036	DoN (2014).
Killer Whale	0.005	0.02	0.002	0.002	Rone *et al.* (2014) (Table 14).
Pacific White-Sided Dolphin	0.0208	0.0208	0.0208	0.0208	DoN (2014).
Cuvier's Beaked Whale	0.0022	0.0022	0.0022	0.0022	Waite (2003) in DoN (2014)
Baird's Beaked Whale	0.0005	0.0005	0.0005	0.0005	DoN (2014).
Stejneger's Beaked Whale	[4] 0.00001	0.00142	0.00142	0.00142	DoN (2014), adapted from Figure 9–12.
Risso's Dolphin	0.00001	0.00001	0.00001	0.00001	DoN (2014).
HF Cetaceans:					
Harbor Porpoise	0.0473	0	0	0	Hobbes and Waite (2010) in DoN (2014).
Dall's Porpoise	0.218	0.196	0.037	0.024	Rone *et al.* (2017).
Otarrid Seals:					
Steller Sea Lion	0.0098	0.0098	0.0098	0.0098	DoN (2014).
California Sea Lion	0.00001	0.00001	0.00001	0.00001	DoN (2014).
Northern Fur Seal	0.015	0.004	0.017	0.006	Rone *et al.* (2014) (Table 14).
Phocid Seals:					
Northern Elephant Seal	0.0022	0.0022	0.0022	0.022	DoN (2014).
Harbor Seal	0.01	0.00001	0.00001	0.00001	DoN (2014).

[1] No stock specific densities are available so densities are assumed equal for all stocks present.

[2] For North Pacific right whales, estimated density within the Kodiak Island critical habitat is 0.0053 animals/km^2, based on detections from the GOALSII survey (Rone *et al.* 2014), the assumed use of the critical habitat by all right whales in the Gulf of Alaska (Wade *et al.* 2011a), and a conservative correction factor.

[3] Gray whale density was defined in two zones, nearshore (0–2.25 n.mi from shore) and offshore (from 2.25–20 nmi from shore). In our calculations, the nearshore density was used to represent the inshore zone and the offshore density was used to represent the slope zone. In areas further offshore than the slope, density was assumed to be 0.

[4] Stejneger's whale are generally found in slope waters, therefore, assuming minimal inshore density.

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 7), 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 18 days during this Gulf of Alaska survey.

TABLE 7—AREAS (km^2) ESTIMATED TO BE ENSONIFIED TO LEVEL A AND LEVEL B HARASSMENT THRESHOLDS, PER DAY FOR GULF OF ALASKA SURVEY

	Criteria (dB)	Daily ensonified area (km)	Total survey days	25 percent increase	Total ensonified area (km)	Relevant isopleth (m)
Level B						
Inshore [1]	160	19,63.1	18	1.25	44,170.3	10,100
Slope	160	684.1	18	1.25	15,392.8	6,733
Offshore	160	1,159.5	18	1.25	26,087.8	6,733
Seamount	160	1,19.8	18	1.25	2,695.2	6,733
Level A						
LF Cetacean	.....	19.6	18	1.25	441.1	40.1
MF Cetacean	.....	6.6	18	1.25	149.6	13.6
HF Cetacean	.....	131.1	18	1.25	2,950.8	268.3
Otarid	.....	5.2	18	1.25	116.6	10.6
Phocid	.....	21.4	18	1.25	480.6	43.7

[1] Includes area ensonified above 160 dB in waters <100 m deep using an isopleth distance of 25,493 m. See application for further explanation.

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. The marine mammals predicted to occur within these respective areas, based on estimated densities, are assumed to be incidentally taken. Estimated exposures for the Gulf of Alaska seismic survey are shown in Table 8.

TABLE 8—ESTIMATED LEVEL A AND LEVEL B EXPOSURES, AND PERCENTAGE OF STOCK OR POPULATION EXPOSED DURING GULF OF ALASKA SURVEY

	Stock	Level B [1]	Level A [1]	Stock size	Percentage of stock
LF Cetaceans:					
North Pacific Right Whale	Eastern North Pacific	[2] 11	0	31	([3])
Humpback Whale	Central North Pacific (Hawaii DPS) [3]	[4] 5,101	[5] 1	11,398	([3])
	Central North Pacific (Mexico DPS) [3]	[4] 602		3,264	18.44
	Western North Pacific [3]	[4] 29		1,107	2.62
Blue whale	Eastern North Pacific	48	[5] 1	1,647	2.98
	Central North Pacific			133	([3])
Fin Whale	Northeast Pacific	3,912	1	[6] 3,168	([3])
Sei Whale	Eastern North Pacific	8	1	519	1.73
Minke Whale	Alaska	53	1	[7] 1,233	4.38
Gray Whale	Eastern North Pacific	2,182	[5] 1	26,960	8.10
	Western North Pacific			175	([3])
MF Cetaceans:					
Sperm Whale	North Pacific	85	1	[8] 345	24.93
Killer Whale	Alaska Resident	586	[5] 1	2,347	25.01
	Gulf of Alaska, Aleutian Islands, and Bering Sea Transient.			587	([3])
	Offshore			240	([3])
Pacific White-Sided Dolphin	North Pacific	1,837	1	26,880	6.84
Cuvier's Beaked Whale	Alaska	194	1	[9] NA	NA
Baird's Beaked Whale	Alaska	44	1	[9] NA	NA
Stejneger's Beaked Whale	Alaska	63	1	[9] NA	NA
Risso's Dolphin	CA/OR/WA	[10] 16	1	6,336	0.27
HF Cetaceans:					
Harbor Porpoise	Gulf of Alaska	[11] 1,879	[5] 3	31,046	[11] 6.06
	Southeast Alaska	[11] 209		975	[11] 21.74
Dall's Porpoise	Alaska	13,656	21	83,400	16.44
Otarrid Seals:					
Steller Sea Lion	Eastern U.S	865	[5] 1	41,638	2.08

TABLE 8—ESTIMATED LEVEL A AND LEVEL B EXPOSURES, AND PERCENTAGE OF STOCK OR POPULATION EXPOSED DURING GULF OF ALASKA SURVEY—Continued

	Stock	Level B [1]	Level A [1]	Stock size	Percentage of stock
	Western U.S			54,267	1.60
California Sea Lion	U.S	[12] 1	1	296,750	0.00067
Northern Fur Seal	Eastern Pacific	1,183	1	620,660	0.19
Phocid Seals:					
Northern Elephant Seal	California Breeding	194	1	179,000	0.11
Harbor Seal	South Kodiak	442	[5] 1	19,199	2.31
	Cook Inlet/Shelikof Strait			27,386	1.62
	Prince William Sound			29,889	1.48

[1] Conservatively where less than 1 take by Level A harassment was calculated, we are rounding up to propose authorizing 1 take by Level A harassment. Therefore, unless otherwise noted, all calculated takes by Level B harassment have been reduced by the number of authorized takes by Level A harassment. This prevents double counting of takes across the two levels of harassment.

[2] NMFS feels that take by Level A harassment of North Pacific right whale can be effectively avoided based on mitigation and monitoring measures, and therefore has not proposed to authorize a take by Level A harassment for the species.

[3] The percentage of these stocks expected to experience take is discussed further in the *Small Numbers* section later in the document.

[4] Takes are allocated amongst the three DPSs in the area based on Wade *et al.* 2016 (0.5% WNP, 89.0% Hawaii DPS, 10.5% Mexico DPS). Because of rounding, the total take is higher than calculated. Population sizes for the Hawaii and Mexican DPSs are provided in 81 FR 62259 (effective October 11, 2016).

[5] Where multiple stocks are being affected, for the purposes of calculating the percentage of the stock impacted, the single Level A take is being analyzed as if it occurred within each stock.

[6] Fin whale abundance estimate is the highest of Rone *et al.* (2017) estimates. Based on the limited footprint of the surveys that lead to this estimate, the true abundance of the stock is expected to be much higher.

[7] Minke whale abundance estimates is from Zerbini *et al.* (2006).

[8] Sperm whale abundance estimates is the maximum value from Rone *et al.* (2017).

[9] For beaked whales, there is no accepted estimates of abundance for the Alaska stocks.

[10] The requested number of takes by Level B harassment for Risso's dolphin has been increased to 16, the average group size. Because this is a qualitative estimate, this take request has not been reduced by 1 to facilitate the requested take by Level A harassment.

[11] Based on the range of the Southeast Alaska stock of harbor porpoises, they are expected to be very rare in the area (See ''Description of Marine Mammals in the Area of Specified Activities''). We therefore conservatively assume that at most, 10 percent of takes will occur from the Southeast Alaska population. The numbers for both Gulf of Alaska and Southeast Alaska stocks reflect this assumption. Because of rounding, the total take between the two stocks is higher than the original calculation.

[12] Only 1 take by Level B harassment was requested for California sea lion, but a take by Level A harassment was also requested. Therefore, the amount of take by Level B harassment has not be reduced by the proposed numbers of take by Level A harassment.

It should be noted that the proposed take numbers shown in Table 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 takes by Level A harassment. 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 North Pacific right whales and Risso's dolphin, we propose to authorize a different number of incidental takes than the number of incidental takes requested by L–DEO (see Table 6 in the IHA application for requested take numbers). For Risso's dolphin, we proposed to authorize take by Level B harassment of an average sized group, 16 individuals, instead of the single individual requested by L–DEO. Our rational for North Pacific right whale take is described below.

For North Pacific right whale, there is evidence of a much higher density in the critical habitat south of Kodiak Island (Table 6). This density value of 0.0053 animals/km^2 is based on detections from the GOALSII survey (4 individuals) (Rone *et al.* 2014), the assumed use of the critical habitat by all right whales in the Gulf of Alaska (Wade et al 2011a), and a conservative correction factor (4), all divided by the area of the critical habitat (3,042.2 km^2). To account for this habitat, NMFS used the Alaska Protected Resources Division Species Distribution Mapper (*https://www.fisheries.noaa.gov/resource/data/alaska-endangered-species-and-critical-habitat-mapper-web-application*) to determine a conservative approximation of L–DEO's survey path through the critical habitat based on the representative tracks in Figure 1 of the IHA Application. This measured distance was 35 km. Because the majority of this habitat is inside of the 100 m isopleth, the predicted distance to the 160-dB received sound level would be ~25.5 km. This resulted in a portion of the critical habitat 35 km long by 51 km wide (25.5 km on each side of the survey track), or 1,785 km^2 being ensonified. Applying the higher density of 0.0053 animals/km^2 to this area, results in an estimate of 9.46 North Pacific right whales exposed to Level B harassment in the critical habitat. No further correction, such as the 25 percent operation day increase, is needed for the estimate in the critical habitat, because the density of 0.0053 animals/km^2 has already been corrected to be highly conservative (AFSC Application, Table 6–10d). To account for the rest of the survey occurring outside of the critical habitat, the minimal density presented in DoN (2014), 0.00001 individuals/km^2, was used for the remainder of the survey. The expected take in the rest of the survey is 1.10 individuals. Summing these two estimates for take, in both the critical habitat and remainder of survey, results in an expected take of 10.56 individuals (rounded to 11 individuals). With other species one calculated take was conservatively assumed to be a take by Level A harassment (Table 8), however no takes by Level A harassment are proposed for authorization for North Pacific right whale given the low density of the species and NMFS evaluation of the effectiveness of mitigation and monitoring measures.

Effects of Specified Activities on Subsistence Uses of Marine Mammals

The availability of the affected marine mammal stocks or species for subsistence uses may be impacted by this activity. The subsistence uses that may be affected and the potential impacts of the activity on those uses are described below. Measures included in this IHA to reduce the impacts of the activity on subsistence uses are described in the *Proposed Mitigation* section. Last, the information from this section and the *Proposed Mitigation* section is analyzed to determine whether the necessary findings may be made in the *Unmitigable Adverse Impact Analysis and Determination* section.

In the GOA, the marine mammals that are hunted are Steller sea lions and harbor seals. In 2011–2012, 37 harbor seals were taken from the North Kodiak Stock and 126 harbor seals were taken from the South Kodiak Stock by communities on Kodiak Island (Muto *et al.* 2016). The number taken from the Cook Inlet/Shelikof Strait Stock for 2011–2012 is unknown, but an average of 233 were taken from this stock annually during 2004–2008 (Muto *et al.* 2016). The seasonal distribution of harbor seal takes by Alaska Natives typically shows two distinct hunting peaks—one during spring and one during fall and early winter; however, seals are taken in all months (Wolfe *et al.* 2012). In general, the months of highest harvest are September through December, with a smaller peak in February/March (Wolfe *et al.* 2012). Harvests are traditionally low from May through August, when harbor seals are raising pups and molting.

In 2008, 19 Steller sea lions were taken in the Kodiak Island region and 9 were taken along the South Alaska Peninsula (Wolfe *et al.* 2009). As of 2009, data on community subsistence harvests are no longer being collected consistently so few data are available. Wolfe *et al.* (2012) reported an estimated 20 sea lions taken by hunters on Kodiak Island in 2011. The most recent 5-year period with data available (2004–2008) shows an annual average catch of 172 steller sea lions for all areas in Alaska combined except the Pribilof Islands in the Bering Sea (Muto *et al.* 2018). Sea lions are taken from Kodiak Island in low numbers year round (Wolfe *et al.* 2012).

The proposed project could potentially impact the availability of marine mammals for harvest in a small area immediately around the *Langseth,* and for a very short time period during seismic operations. Considering the limited time that the planned seismic surveys would take place close to shore, where most subsistence harvest of marine mammals occurs in the Gulf of Alaska, the proposed project is not expected to have any significant impacts to the availability of Steller sea lions or harbor seals for subsistence harvest. Additionally, to mitigate any possible conflict, community outreach is planned and described further in ''Proposed Mitigation'' below.

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. 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, as well as subsistence uses. This considers the nature of the potential adverse impact being mitigated (likelihood, scope, range). It further considers the likelihood that the measure will be effective if implemented (probability of accomplishing the mitigating result if implemented as planned) the likelihood of effective implementation (probability implemented as planned) and;

(2) the practicability of the measures for applicant implementation, which may consider such things as cost, impact on operations, and, in the case of a military readiness activity, personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.

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; (7) Vessel strike avoidance measures; and (8) Sensitive Habitat 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 m exclusion zone, out to a radius of 1,000 m from the edges of the airgun array (500–1,000 m). 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 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) shall 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 four consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO.

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.

Because the North Pacific right whale is a stock of high concern, L–DEO will implement a shutdown if the species is observed at any distance. In addition, when transiting through North Pacific right whale critical habitat, L–DEO must do any such transit during daylight hours, to facilitate the ability of PSOs to observe any right whales that may be present. Additionally, for high risk circumstances, such as observation of a calf or aggregation of whales, L–DEO will shutdown if these circumstances are observed at any distance.

Finally, to minimize impact on fin whales in their feeding BIA near Kodiak Island, L–DEO must observe a larger EZ for this species while in the BIA. If a fin whale or group of fin whales is observed with 1,500 m of the acoustic source within the fin whale BIA, L–DEO must implement a shutdown.

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 Cuvier's beaked, Baird's beaked, Stejneger's beaked, and killer 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—*Lagenorhynchus and Grampus*—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.

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 delphinid exception because power-down/shutdown requirements for small delphinids under all circumstances represent practicability concerns without likely commensurate benefits for the animals in question. Small delphinids 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 delphinids commonly approach vessels and/or towed arrays during active sound production for purposes of bow riding, with no apparent effect observed in those delphinids (*e.g.,* Barkaszi *et al.,* 2012). The potential for increased shutdowns resulting from such a measure would require the *R/V Langseth* to revisit the missed track line to reacquire data, resulting in an overall increase in the total sound energy input to the marine environment and an increase in the total duration over which the survey is active in a given area. Although other mid-frequency hearing specialists (*e.g.,* large delphinids) are no more likely to incur auditory injury than are small delphinids, they are much less likely to approach vessels. Therefore, retaining a power-down/shutdown requirement for large delphinids would not have similar impacts in terms of either practicability for the applicant or corollary increase in sound energy output and time on the water. We do anticipate some benefit for a power-down/shutdown requirement for large delphinids in that it simplifies somewhat the total range of decision-making for PSOs and may preclude any potential for physiological effects other than to the auditory system as well as some more severe behavioral reactions for any such animals in close proximity to the 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.

Sensitive Habitat Measures

Because the propose survey overlaps with BIAs and critical habitat for some species (see MM Occurance), L–DEO will implement additional measures related to these areas including area avoidance and the implementation of special shutdown zones. For Steller sea lion rookeries and major haulouts, classified as critical habitat (58 FR 45269, August 27, 1993). Steller sea lions maintain rookeries and major haul-outs in the area of L–DEO's survey (Figure 1 in the IHA Application). Additionally the timing of the survey overlaps with the breeding season of Steller sea lions. As such, L–DEO must observe a three nautical mile exclusion zone around these critical habitats. This means that L–DEO avoid transiting through and operating seismic airguns in these areas.

A portion of L–DEO's proposed survey will also occur in the fin whale BIA (Ferguson *et al.* 2015). Because of the temporal and spatial overlap in the proposed survey and peak use of the fin whale BIA, L–DEO will implement a shutdown if a fin whale or group of fin whales is observed at within a 1,500 m radius from the acoustic source, within their BIA. L–DEO will refer to Ferguson *et al.* (2015) for the location of the BIA, but waters around the Semidi Islands, Kodiak Island, and Chirikof Island generally define the portion of the BIA L–DEO is expected to transit through.

The expected elevated density of North Pacific right whales in their critical habitat means that additional measures are prudent for this area. When transiting through North Pacific right whale critical habitat, L–DEO must do any such transit during daylight hours, to facilitate the ability of PSOs to observe any right whales that may be present. This measure is in addition to the requirement that L–DEO must implement a shutdown if a North Pacific right whale is observed at any distance.

Mitigation for Subsistence Uses of Marine Mammals—Community Outreach

Although impacts on subsistence uses are not expected due to the strong separation in time and space between marine mammal subsistence harvest and L–DEO's proposed activities, project principle investigators will conduct outreach with communities near the planned project area to identify and avoid areas of potential conflict, including for marine subsistence activities. This measure will mitigate any potential negative impact on subsistence hunting activities, despite there being no expected significant impact.

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS, NMFS has preliminarily determined that the proposed mitigation measures provide the means 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, and on the availability of such species or stock for subsistence uses.

Proposed Monitoring and Reporting

In order to issue an IHA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must set forth, requirements pertaining to the monitoring and reporting of such taking. The MMPA implementing regulations at 50 CFR 216.104 (a)(13) indicate that requests for authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Monitoring and reporting requirements prescribed by NMFS should contribute to improved understanding of one or more of the following:

- Occurrence of marine mammal species or stocks in the area in which take is anticipated (*e.g.,* presence, abundance, distribution, density);
- Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) Action or environment (*e.g.,* source characterization, propagation, ambient noise); (2) affected species (*e.g.,* life history, dive patterns); (3) co-occurrence of marine mammal species with the action; or (4) biological or behavioral context of exposure (*e.g.,* age, calving or feeding areas);
- Individual marine mammal responses (behavioral or physiological) to acoustic stressors (acute, chronic, or cumulative), other stressors, or cumulative impacts from multiple stressors;
- How anticipated responses to stressors impact either: (1) Long-term fitness and survival of individual marine mammals; or (2) populations, species, or stocks;
- Effects on marine mammal habitat (*e.g.,* marine mammal prey species, acoustic habitat, or other important physical components of marine mammal habitat); and
- Mitigation and monitoring effectiveness.

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 six 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 × 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. 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; and
- The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Requests shall be granted or denied (with justification) by NMFS within 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.

Reporting

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 report will 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. 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's implementing regulations (54 FR 40338; September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into this analysis via their impacts on the environmental baseline (*e.g.,* as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality, or ambient noise levels).

To avoid repetition, our analysis applies to all species listed in Table 1, 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 and Level B harassment of 21 species of marine mammal species. For 19 of these species, a single take by Level A harassment is authorized as a precaution. 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 which, because of their comparatively short duration, are considered to be of lower 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. 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 (~18 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 tracklines of this survey either traverse or are proximal to the BIAs for four baleen whale species including fin, gray, North Pacific right, and humpback whales in U.S. waters of the Gulf of Alaska (Ferguson *et al.* 2015). Additionally, there is a BIA for beluga whales in nearby Cook Inlet, but the location of the BIA means the habitat will not co-occur with L–DEO's survey (Ferguson *et al.* 2015). The North Pacific Right whale feeding BIA east of the Kodiak Archipelago is primarily used between June and September. The fin whale feeding BIA that stretches from Kenai Peninsula through the Alaska Peninsula is primarily used between June and August. The gray whale feeding BIA east of the Kodiak Archipelago is primarily used between June and August. For the North Pacific Right whale, gray whale, and fin whale feeding BIAs, L–DEO's survey planned for June 1 through June 19, 2019 could overlap with a period where BIAs represent an important habitat. However, only of a portion of seismic survey days would actually occur in or near these BIAs, and all survey efforts should be completed by mid-June, still in the early window of primary use for all these BIAs. Additionally, there mitigation measures that should further reduce take number and severity for fin whales and North Pacific right whales. These include the requirement to shutdown the acoustic source if a fin whale, within the fin whale BIA, is observed within 1,500 meters of the source and the requirement to shutdown if a North Pacific right whale is observed at any distance from the source. The gray whale migratory corridor BIA and humpback whale feeding BIAs overlap spatially with L–DEO's survey, but the timing of primary use of these BIAs does not overlap temporally with the survey. Gray whales are most commonly seen migratory northward between March and May and southward between November and January. As proposed, there is no possibility that L–DEO's survey impacts the southern migration, and presence of northern migrating individuals should be below peak during survey operations beginning in June 2019. Additionally, humpback whale feeding BIAs in the region are primarily used between July and August or September. L–DEO's survey efforts should be completed before peak use of these feeding habitats. For all habitats, 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 and invertebrate mortality, in feeding habitats, the most likely impact to prey species from survey activities would be temporary avoidance of the affected area and any injury or mortality of prey species would be localized around the survey and not of a degree that would adversely impact marine mammal foraging. 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.

Critical habitat has been designated for the ESA listed North Pacific right whale and western DPS of Steller sea lions. Only a portion of L–DEO's planned seismic survey will occur in these critical habitats. Steller sea lion critical habitat also includes a ''no approach'' zone within 3 nmi of rookeries. Steller sea lions both occupy rookeries and pup from late-May through early-July (NMFS 2008), which coincides with L–DEO's proposed survey. Thus, we are requiring that the proposed survey avoid transiting or surveying within 3 nmi of any rookeries. For North Pacific right whale critical habitat, L–DEO would only need to traverse approximately 35 km of the designated critical habitat. At a speed of approximately 9.3 km per hour (5 kn), L–DEO would only be in the critical habitat for less than 4 hours. L–DEO would only traverse this critical habitat during daylight hours to facilitate the ability of PSOs to observe any right whales that may be present, so as to reduce the potential for their exposure to airgun noise. Additionally, L–DEO would be required to shutdown seismic airguns if a North Pacific right whale is observed at any distance, further minimizing the impacts on North Pacific right whales in their critical habitat and elsewhere. The characteristics that make this habitat an important feeding area for North Pacific right whales are abundant planktonic food sources. While there are possible impacts of seismic activity on plankton (McCauley *et al.,* 2017), the currents that flow through the Gulf of Alaska will readily refresh plankton resources in the area. As such, this seismic activity is not expected to have a lasting physical impact on habitat or prey within it. Any impact would be a temporary increase in sound levels when the survey is occurring in or near the critical habitat and resulting temporary avoidance of prey or marine mammals themselves due these elevated sound levels.

After accounting for qualitative factors, the activity is expected to impact a small percentage of all marine mammal stocks that would be affected by L–DEO's proposed survey (see ''Small Numbers'' below). 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 to some extent, potential PTS in marine mammals that may otherwise occur in the absence of the proposed mitigation (although all authorized PTS has been accounted for in this analysis).

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 species or stock 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 (~18 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 potential PTS that may occur are expected to be very small in number.

Instances of potential 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, shutdowns, and enhanced measures for areas of biological importance are expected to minimize potential impacts to marine mammals (both amount and severity).

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

Small Numbers

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

There are seven stocks for which the estimated instances of take appear high when compared to the stock abundance (Table 8), including the Northeast Pacific fin whale stock, the North Pacific right whale stock, the Western North Pacific gray whale stock, the Central North Pacific blue whale stock, the Central North Pacific humpback whale stock (Hawaii DPS), the Offshore killer whale stock, and the Gulf of Alaska, Aleutian Islands, and Bering Sea transient killer whale stock. However, when other qualitative factors are used to inform an assessment of the likely number of individual marine mammals taken, the resulting numbers are appropriately considered small. We discuss these in further detail below.

For an additional three stocks (Alaska stocks of the three beaked whale species), there are no abundance estimates upon which to base a comparison. However, we note that the anticipated number of incidents of take by Level B and Level A harassment are low (46 to 196 for these three stocks) and represent a small number of animals within these stocks, which have extensive ranges across large parts of the North Pacific Ocean compared to L–DEO's proposed survey area (Muto *et al,* 2018). Based on the broad spatial distributions of these species relative to the proposed survey area, NMFS concludes that the authorized take of these species represent small numbers relative to the affected species' overall population sizes, though we are unable to quantify the authorized take numbers as a percentage of population.

For all other stocks (aside from the seven referenced above and described below and the three beaked whales), the authorized take is less than 25% as compared to the stock abundance (recognizing that some of those takes may be repeats of the same individual, thus rendering the percentage even lower).

The expected take of the Northeast Pacific stock of fin whales appears to impact a high percentage of the population (123.5 percent), but this percentage is based on an occurrence estimate which surveyed only a small portion of the range (Rone *et al.* 2017), and no representative estimate of the full stock abundance is available (Muto et al. 2018). The range of the Northeast Pacific fin whale stock extends through much of the north Pacific (Muto *et al.* 2018). Based on the small portion of the stock's range that Rone *et al.* (2017) observed, the full stock abundance would be much higher than 3,168 individuals, reducing the percentage of the population that would be impacted by take from L–DEO's activities. Additionally, L–DEO's actions are located in a small portion of the total range and will occur within a short period of less than a month. L–DEO's previous marine mammal monitoring in the Gulf of Alaska reported 79 fin whales (RPS 2011) and Zerbini *et al.* (2006) observed 530 fin whales across 3 years of summer surveys in the Northern Gulf of Alaska. Given these previous observations, it is not realistic that L–DEO will encounter 3,914 individual fin whales. Instead, given the range of the species, the known underestimate of stock abundance, and the comparatively small action area, combined with the short duration of the survey, it is more likely that there will be multiple instances of take to a smaller number of individuals that are in the action area during the proposed survey and entirely unlikely that more than a third of the stock would be exposed to the seismic survey.

The estimated instances of take for North Pacific right whales appears high compared to stock abundance (35.5 percent), but realistically 11 right whales are not likely to experience harassment. Given the higher assumed density of whales in the critical habitat area off of Kodiak Island, the vast majority of estimated takes would occur in that area (see ''*Take Calculation and Estimation*''). Overall, right whales are very rarely detected in the Gulf of Alaska, and most evidence of the region's importance for the species is based on historic whaling records (Muto *et al.,* 2018). Either visual or acoustic detections of a single right whale are rare in the Gulf of Alaska. North Pacific right whales are much more commonly detected in their Bering Sea critical habitat (73 FR 19000, April 8, 2008; Muto *et al.,* 2018). Given this evidence, only a small portion of the population is expected to be present in the Gulf of Alaska and the Kodiak Island critical habitat. As such, it is more realistic to believe there will be multiple takes of the few individuals present, comprising less than a third of the stock. Additionally, L–DEO proposed survey will only impact the North Pacific right whale critical habitat for a very short portion of their survey and there are additional mitigation measures in place to further minimize any acoustic impacts on North Pacific right whales.

The amount of take expected for the Western North Pacific stock (WNP) of gray whales appears high (1247.43 percent). In reality, 2,183 individuals will be not experience take from this stock. There are two stocks of gray whales in this area, the WNP and the Eastern North Pacific stock (ENP). It is more realistic to apportion expected takes between these stocks. NMFS has no commonly used method to estimate the relative occurrence of these stocks, but here we propose to apportion the takes between the two stocks using their relative abundances and a correction factor to ensure this number is conservative. The total abundance of the two stocks is 27,135 gray whales. Based on estimates of stock size (Table 1), 0.65 percent of encountered gray whales would be expected to come from the

WNP stock, and 99.35 percent would be expected to come from the ENP stock, which results in an apportioned take estimate for each stock of 14 (WNP) and 2,169 (ENP). To represent uncertainty in this method and produce a conservative estimate, we then double the apportioned take for the smaller stocks, resulting in an estimated 28 takes for the WNP stock. This estimated level of take is expected to impact an estimated 16 percent of the WNP stock. Further supporting this conclusion, the summer feeding grounds of WNP gray whales are believed to be off the Sakhalin Islands and other parts of coastal eastern Russia. In total, 27 to 30 whales have been observed in both the WNP and ENP, meaning that while some whales identified on these summer grounds have been observed overwintering in the eastern Pacific around North America, some also migrate to Japanese and Chinese waters (Caretta *et al.,* 2014; Caretta *et al.,* 2019 DRAFT). Based on relative abundance of gray whale stocks and knowledge of behavior, the WNP stock is expected to make up a small portion of the gray whales that will experience take from L–DEO's activity. Therefore, it is entirely unlikely that more than a third of the stock would be exposed to the seismic survey.

The expected instances of take of the Central North Pacific (CNP) stock of blue whales appears high when compared to the abundance (37 percent), however, in reality 50 CNP blue whales are not likely to be harassed. Blue whales belonging to the CNP stock appear to feed in summer in waters southwest of Kamchatka, south of the Aleutians, and in the Gulf of Alaska (Stafford 2003; Watkins *et al.* 2000). Because of this large summer range of CNP blue whales compared to the size of L–DEO's action area, it is more likely that there will be multiple takes of a smaller number of individuals that would occur within the action area, and the percentage of the stock taken will be less than a third of the individuals.

For humpback whales, takes are apportioned between the different stocks or DPSs present based on Wade *et al.* (2016). With this apportionment, the expected instances of take of the Central North Pacific stock's Hawaii DPS appears high (44.8 percent of the estimated DPS abundance). In reality, 5101 Hawaii DPS humpback whales are not likely to be harassed, as it is more likely that a smaller number of individuals will experience multiple takes. The Gulf of Alaska is an important center of humpback whale abundance, and L–DEO's survey affects a portion of the Gulf of Alaska. The highest densities of humpback whales in the Gulf of Alaska are observed between July and August (Ferguson *et al.,* 2015), while L–DEO's survey is planned for June, so the survey should not overlap with peak abundance. Additionally, there are other areas of high humpback whale density in the Aleutian Islands and Bering Sea (Muto *et al.* 2018). This evidence, plus the CNP stock's large range relative to L–DEO's action area, along with the short duration of the survey, mean that it is more likely that there will be multiple takes of a smaller portion of the individuals that occur in L–DEO's action area, and fewer than a third of the individuals in the stock will be taken.

The expected instances of take from both the Offshore and Gulf of Alaska, Aleutian Islands, and Bering Sea transient stocks of killer whales appears high when compared against the stock abundance (245 percent and 100.2 percent respectively). In reality, 588 individuals will not experience take from each of these stocks. There are three stocks of killer whales in this area, including the Eastern North Pacific Alaska Resident stock, and it is more realistic to apportion expected takes between these stocks. NMFS has no commonly used method to estimate the relative occurrence of these stocks, but here we propose to apportion the takes between the three stocks using their relative abundances and a correction factor to ensure this number is conservative. The total abundance of the three stocks in the area is 3,174 killer whales. Based on estimates of stock size, 73.9 percent of encountered killer whales would be expected to come from the Alaska resident stock, 18.5 percent would be expected to come from the Gulf of Alaska, Aleutian Islands, and Bering Sea stock, and 7.6 percent would be expected to come from the offshore stock, which come to a take estimate for each stock of 434.8, 108.7 and 44.5 respectively. To represent uncertainty in this method and produce a conservative estimate, we then double the apportioned take for each of the smaller stocks, resulting in an estimated 218 takes for the Gulf of Alaska, Aleutian Islands, and Bering Sea stock and 90 takes for the Offshore stock. Carrying these estimates along results in 37.1 percent of the Gulf of Alaska, Aleutian Islands, and Bering Sea stock experiencing take and 37.5 of the Offshore stock experiencing take. While these numbers still appear high, the extensive ranges of both stocks compared to L–DEO's action area, as well as the short duration of the survey, mean that realistically there will be multiple takes of a smaller portion of both killer whale stocks, resulting in no more than a third of the individuals of any of these stocks being taken. Individuals from the offshore stock are known to undertake large movements across their entire range, from the Aleutian Islands to the California coast and use numerous portions of this habitat in the spring and summer (Dahlheim *et al.* 2008). The Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock occupies a range that includes all of the U.S. EEZ in Alaska (Muto *et al.* 2018), with L–DEO only impacting a portion of this range for a limited time period.

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

Unmitigable Adverse Impact Analysis and Determination

In order to issue an IHA, NMFS must find that the specified activity will not have an ''unmitigable adverse impact'' on the subsistence uses of the affected marine mammal species or stocks by Alaskan Natives. NMFS has defined ''unmitigable adverse impact'' in 50 CFR 216.103 as an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

In the GOA, the marine mammals that are hunted are Steller sea lions and harbor seals. For seals, these harvests are traditionally low from May through August, when harbor seals are raising pups and molting. Sea lions are taken from Kodiak Island and other locations in the action area in low numbers year round, but harvests are minimal during late spring and summer (Wolfe *et al.* 2012).

L–DEO's proposed seismic survey would occur during a period of low harbor seal and Stellar sea lion harvest, so any impact on subsistence activities will be minimal. Additionally, the survey will occur for approximately 18 days, and the portion of the survey that would occur in nearshore waters, where

pinniped harvest is most likely, would be even shorter. L–DEO has also planned to conduct outreach to subsistence users in the area, in order to determine if potential use conflicts exists and avoid these conflicts if possible. This outreach, in combination with mitigation measures to avoid Steller sea lion rookeries and haulouts, marine mammal monitoring, and establishing exclusion zones, will effectively minimize impacts on these marine mammals and resulting impacts on subsistence users.

Based on the description of the specified activity, the measures described to minimize adverse effects on the availability of marine mammals for subsistence purposes, and the proposed mitigation and monitoring measures, NMFS has preliminarily determined that there will not be an unmitigable adverse impact on subsistence uses from L–DEO's's proposed activities.

Endangered Species Act (ESA)

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

NMFS is proposing to authorize take of blue whale, fin whale, gray whale (WNP DPS), humpback whale (Mexico DPS and Western North Pacific DPS), North Pacific right whale, sei whale, sperm whale, and Steller sea lion (Western DPS), which are listed under the ESA.

The Permits and Conservation Division has requested initiation of Section 7 consultation with the Interagency Cooperation Division for the issuance of this IHA. NMFS will conclude the ESA consultation prior to reaching a determination regarding the proposed issuance of the authorization.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to issue an IHA to L–DEO for conducting seismic surveys in the Gulf of Alaska in spring/early summer of 2019, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. A draft of the proposed IHA can be found at *https://www.fisheries.noaa.gov/permit/incidental-take-authorizations-under-marine-mammal-protection-act.*

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 survey. We also request comment on the potential for renewal of this proposed IHA as described in the paragraph below. Please include with your comments any supporting data or literature citations to help inform our final decision on the request for MMPA authorization.

On a case-by-case basis, NMFS may issue a one-year IHA renewal with an expedited public comment period (15 days) 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 under the proposed renewal are identical to the activities analyzed under the initial IHA, are a subset of the activities, or include changes so minor (*e.g.,* reduction in pile size) that the changes do not affect the previous analyses, mitigation and monitoring requirements, or take estimates (with the exception of reducing the type or amount of take because only a subset of the initially analyzed activities remain to be completed under the Renewal).

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

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

Dated: April 3, 2019.

Catherine Marzin,

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

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